FREE

WEST SYSTEM®

User Manual

& *Product Guide*

002-950

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User Manual
& Product Guide

West System Epoxy is a versatile, high-quality, two-part epoxy that is easily modified for a wide range of coating and adhesive applications. It is used for construction and repairs requiring superior moisture resistance and high strength. It bonds to fiberglass, wood, metal, plastics, fabrics, and other composite materials, and is especially suited for marine applications.

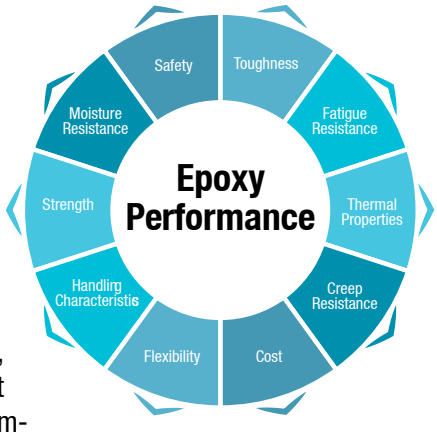
This manual is designed to help you become familiar with West System products and use them effectively.

- The User Manual provides information about safety, handling and the basic techniques of epoxy use. Understanding these basic techniques will allow you to tailor West System products to your exact repair and construction needs. These techniques are used in a wide range of repair and building procedures such as those described in detail in West System instructional publications and DVDs.
- The Problem Solver will help you identify and prevent potential problems associated with using epoxy.
- The Product Guide gives you complete descriptions of West System products, including selection and coverage guides to help you choose the most appropriate products and product sizes for your project.

West System products are available from quality marine chandleries and hardware outlets in many areas. For the name of the West System dealer nearest you, or for additional technical, product, or safety information contact Gougeon Brothers, Inc. or visit westsystem.com

Why West System Epoxy?

All epoxies are not created equal. Epoxy brands can vary widely in their formulations, quality of raw materials and their suitability for marine environments. It's easy to market an off-the-shelf industrial epoxy product as a marine epoxy, or formulate an epoxy with one or two favorable characteristics, while sacrificing other important characteristics.



It's much more difficult balancing all of the physical and mechanical properties necessary for a versatile, high-quality marine epoxy. Defining an epoxy's performance criteria, and designing a formula to meet those criteria requires good chemistry, rigorous test programs, skillful shop work and direct experience with today's high-performance boats and other composite structures.

Reliability and Performance

West System Epoxy was created by Gougeon Brothers–sailors, builders and formulators who know the engineering and the chemistry required for high-performance composite structures. We have maintained that performance driven development of marine epoxies since the company was founded in 1969, continually formulating, testing and improving West System Resins and Hardeners and developing specialty epoxies to produce the most reliable and well-balanced epoxy systems available.

Our resin and hardener formulas, ingredients and combinations are tested to compare fatigue strength, compression strength, glass transition temperature, and peak exotherm. Qualified samples undergo additional tests for hardness, tensile strength, tensile elongation, tensile modulus, flexural strength, flexural modulus, heat deflection temperature, impact resistance and moisture exclusion effectiveness. This level of testing ensures that any change in a formula

will improve one or more of a product's characteristics without diminishing any characteristics.

As an ISO 9001 certified company, Gougeon Brothers has numerous protocols in place to ensure the quality of every batch of epoxy we make. We are dedicated to providing the highest quality product to meet the standards our customers expect.

Comprehensive Testing

Good science and comprehensive testing are essential not only for the development of improved epoxy formulations, but also for the development of much better construction and repair methods. In addition to the tests conducted to support in-house product development, our materials test lab also conducts testing to support our outside builders, designers, and government organizations in the engineering of epoxy composite structures.

Aside from performing a battery of standard ASTM tests, we have developed new testing methods to evaluate adhesives and composites. Some of these tests, like our patented Hydromat Panel test, have become industry standards. This test uses a special fixture in one of the lab's MTS™ test machines to simulate the pressure loads a section of a hull would endure in a lifetime on the water. In 1999, the American Society for Testing and Materials approved the Hydromat test as an official ASTM standard (D6416). This unique testing program is used by designers and builders around the world to evaluate various combinations of sandwich composite materials and epoxy formulations and ultimately build lighter, stronger, safer structures.

The information provided by a comprehensive test program, along with our own building experience, and feedback from our customers contributes to a data base on epoxies and epoxy composites that has been growing since 1969. This knowledge is invaluable for achieving the proper balance of properties required for a versatile, high-quality marine epoxy, and assures that the building and repair information provided by Gougeon Brothers is up-to-date and reliable.

Technical Support

To help you make the most of West System Epoxy's balanced performance and versatility, Gougeon Brothers provides you with one other important ingredient—knowledge. Whether your project is large or small, West System technical publications and videos offered in this guide provide detailed procedures and instructions for specific repair and construction applications.

We are always interested in your views and welcome suggestions about our products and service. We encourage you to call or write with comments on West System products and their use.

For the most current product selection visit westsystem.com

Because Gougeon Brothers, Inc. cannot control how its products will be used, it makes no warranties, either expressed or implied, including no warranties of merchantability and fitness for purpose intended. Gougeon Brothers, Inc. will not be liable for incidental or consequential damages.

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Good science and comprehensive testing are essential for the development and improvement of epoxy formulations, and for the development of much better construction and repair methods.

Our Epoxies

Based on 105 Epoxy Resin, West System Epoxy is a versatile low-viscosity epoxy system. It is used for boat building, composite construction and repairs that require high-strength, waterproof coating, bonding, and filling. It readily wets out fabrics and porous materials, and is easily modified for a wide range of working conditions and applications. West System Epoxy is the world's most reliable and widely used marine epoxy.

G/flex Epoxy is an easy-to-use, toughened epoxy designed to make structural bonds that absorb the stresses of extraordinary expansion, contraction, shock, and vibration. Excellent adhesive properties allow you to glue a wide range of materials.

Six10 Adhesive gives you the strength and reliability of a two-part WEST SYSTEM Epoxy with the convenience of a single part product. Six10 is dispensed with a standard caulking gun. Non-sagging Six10 bonds tenaciously to wood, metals, fiberglass and concrete.

G/5 Five-Minute Adhesive is an easy-to-use epoxy for quick repairs and general bonding. It is a durable, water resistant adhesive that bonds to most materials. Use it for making jigs and fixtures quickly. An exceptionally strong and cost effective five-minute epoxy.

G/flex® Epoxy

G/flex Epoxies are toughened, resilient two-part epoxies engineered for a superior grip to metals, plastics, glass, masonry, fiberglass, and wet and difficult-to-bond woods. Make structural bonds that absorb the stresses of expansion, contraction, shock and vibration. Easy-to-use 1:1 mix ratio gives you 46 minute pot life and a long open, or working, time of 75 minutes at 72°F. Reaches an initial cure in 3–4 hours and a workable cure in 7–10 hours. Available in two consistencies:

G/flex 650 Epoxy is a versatile easily-modified liquid epoxy. It is packaged in the Aluminum Boat Repair Kit or individually.

650-8 4 fl oz resin, 4 fl oz hardener.
650-32 16 fl oz resin, 16 fl oz hardener.
Larger sizes available.

G/flex 655 Epoxy Adhesive is a convenient pre-thickened epoxy. It is packaged in the Plastic Boat Repair Kit or individually.

655-8 4.2 fl oz resin, 4.2 fl oz hardener.
655-2QT 1 qt resin, 1 qt hardener.
655-2G 1 gal resin, 1 gal hardener.
Larger sizes available.

Six10® Epoxy Adhesive

A two-part thickened epoxy adhesive in a convenient, self-metering cartridge. For permanent, waterproof, structural gap-filling and gluing. Bonds to wood, fiberglass, metals and masonry. With the included 600 Static Mixer attached you can dispense fully mixed adhesive right where you need it using a standard caulking gun. Trim the mixer tip to suit your job. A 1/8" diameter tip opening will give you a bead of adhesive about a 40' long. Working time is 42 minutes at 72°F, cures to a solid in 5–6 hours and takes high loads in 24 hours.

610 190 ml resin/hardener cartridge.
600-2 Static Mixers only, 2 ea.
600-12 Static Mixers only, 12 ea.

G/5® Five-Minute Adhesive

An easy to use, fast curing epoxy system for quick repairs, tooling and general bonding. It is a strong, water resistant adhesive that can be thickened as necessary with West System fillers. Bonds to wood, fiberglass and metal. 1:1 mixture, no pumps are required. Cures in 3-5 minutes at 72°F.

865-4 4 fl oz resin, 4 fl oz hardener.
865-16 16 fl oz resin, 16 fl oz hardener.
Larger sizes available.

Repair Kits

105-K Fiberglass Boat Repair Kit

Repair cracks and scrapes, gelcoat blisters, loose hardware, delaminated decks and panels, damaged keels and holes up to 1" diameter in solid laminates up to ¼"-thick and smaller holes in thicker laminates. Includes complete, illustrated instructions.

105-K 1 Kit.

650-K Aluminum Boat Repair Kit

Repair the most common problem with aluminum boats and canoes—leaking seams and rivets. Includes complete, illustrated instructions.

650-K 1 Kit.

655-K Plastic Boat Repair Kit

Repair splits, cracks and small holes in plastic canoes, kayaks and other small boats. Includes instructions for patching air leaks, re-bonding attachment points, repairing delaminated transoms and damaged floors in inflatable boats. Includes complete, illustrated instructions.

655-K 1 Kit.

101 Handy Repair Pack

Everything you need to complete small repairs around the boat, shop or home. The Handy Repair Pack contains two West System 105 Epoxy Resin/205 Fast Hardener packets, and enough adhesive filler to complete a variety of coating and bonding operations. Also included are a 2"×10" piece of 9 oz fiberglass tape (useful for patching, reinforcing or abrasion resistance), an application brush, mixing stick, pipe cleaner, two cleaning pads and complete instructions. The components can be mixed in the disposable package.

101 1 Kit.

101-T Resin/Hardener Packets

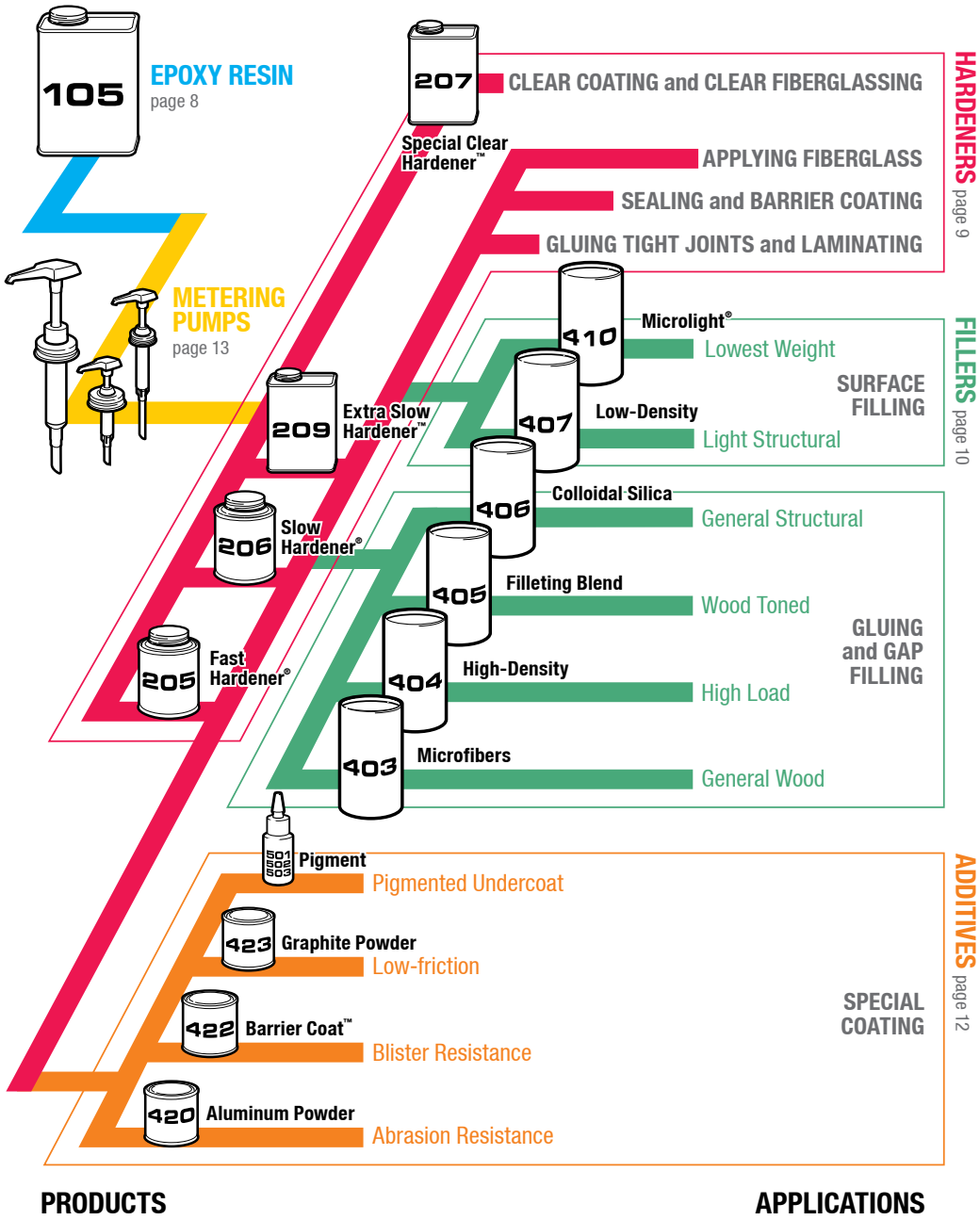
101-T Six resin/hardener packets only. Each pre-measured packet contains 16g of 105 Resin and 3.2g of 205 Fast Hardener (19.2g or 0.56 fl oz of mixed epoxy).

101-T Pack of 6.

The 105 System

WEST SYSTEM Epoxy products make up a versatile epoxy system that can be used for everything from basic long-lasting repairs to the construction of high-performance composites.

WEST SYSTEM Epoxy will cure to a high-strength plastic solid at 72°F, when you mix specific proportions of liquid epoxy resin and hardener. This plastic adheres to a wide range of materials, making it ideal for projects that require water and chemical resistance, and strong physical properties for structural bonding. Select from a range of hardeners and additives that allow you to tailor the mixture's handling characteristics and cured physical properties to suit your working conditions and specific coating or bonding application.



1 *Start with 105 Epoxy Resin, the basic ingredient of all WEST SYSTEM Epoxy compounds. Use 300 Mini Pumps for convenient and accurate metering.*

2 *Mix with one of four WEST SYSTEM hardeners. Select a hardener for its intended use and for the cure speed best suited for your job in the temperature range in which you are working.*

3 *Add one of six WEST SYSTEM fillers to thicken the mixture as needed. Select a filler for its handling characteristics or cured physical properties. Or, add one of four WEST SYSTEM additives to provide specific coating properties.*

For excellent results, in addition to proper product selection, it is important to know best practices for epoxy use, know how to use epoxy safely and have the proper tools for your project.

Instruction

We offer a range of detailed publications that can help you get started. Our publications include manuals on Fiberglass Boat Repair and Maintenance, Wooden Boat Restoration and Repair, and Boat construction. We also offer a How-To DVD which covers everything from basic epoxy handling to advanced epoxy repair techniques.

(See detailed publication descriptions on page 18)

Application Tools

Roller covers, mixing sticks, mixing cups and plastic spreaders are just a few of the tools we offer that make working with epoxy easier.

(See detailed tool descriptions on page 15)

Reinforcing Materials

Whether repairing a fiberglass boat or building a wooden canoe, reinforcing materials are an important part of many building and repair projects.

(See detailed reinforcing descriptions on page 14)

Skin Protection

Our personal protective clothing is made out of microporous film laminate material which provides a superior combination of strength, barrier protection, and breathability.

(See detailed skin protection descriptions on page 17)

Resin

105 Epoxy Resin®

105 Resin is a clear, low-viscosity liquid epoxy resin. Formulated for use with one of four WEST SYSTEM hardeners, it can be cured in a wide temperature range to form a high-strength solid with excellent moisture resistance.

105 Epoxy Resin, when mixed at the proper ratio with a WEST SYSTEM hardener, is an excellent adhesive. It is designed specifically to wet out and bond to wood fiber, fiberglass, reinforcing fabrics, foam other composite materials, and a variety of metals. 105 Resin-based epoxy will bridge gaps and fill voids when modified with WEST SYSTEM fillers and can be sanded and shaped when cured.

With roller applications, it has excellent thin film characteristics, allowing it to flow out and self-level without "fish-eyeing." Multiple coats of a 105 epoxy create a superior moisture barrier and a tough, stable base for paints and varnishes.

105 Resin is formulated without volatile solvents and does not shrink after curing. It has a relatively high flash point and no strong solvent odor, making it safer to work with than polyester or vinylester resins. Resin viscosity is approximately 1000 centipoise (cP) at 72°F (22°C).

Refer to the Hardener Selection Guide for the most appropriate hardener for your application.

WEST SYSTEM Epoxy resin and hardeners are packaged in three "Group Sizes." For each container size of resin, there is a corresponding sized container of hardener. When purchasing resin and hardener, be sure both containers are labeled with the same Group Size letter (A, B or C).

Estimated Epoxy Coverage for Fabric Application

Below is an estimation of how much epoxy is needed wet out 1 sq. ft. of fiberglass cloth and apply two fill coats.

Fabric Product Number (see page 24)	Fabric weight per yd²	Mixed Epoxy Needed
740	4 oz	1.4 fl. oz.
742	6 oz	1.61 fl. oz.
729, 731, 732, 733	9 oz	1.94 fl. oz.
745	10 oz	2.05 fl. oz.
727, 737	17 oz	2.81 fl. oz.
738	23.8 oz	3.55 fl. oz.

* Includes 15% waste factor.

PACKAGE SIZE/QUANTITY				COATING COVERAGE	
Resin/Hardener Group	**Resin Quantity**	**Hardener Quantity**	**Mixed quantity**	**Saturation coat porous surfaces**	**Buildup coats non-porous surfaces**
	105-A 1 qt (946 ml) 2.40 lb	**205-A or 206-A** .43 pt (206 ml) .47 lb	1.2 qt (1.15 L) 2.87 lb	90–105 ft² (8.5–10m²)	120–135 ft² (11–12.5 m²)
		207-SA or 209-SA .66 pt (315 ml) .70 lb	1.3 qt (1.26 L) 3.1 lb	90–105 ft² (9–10 m²)	120–135 ft² (11–13 m²)
	105-B .98 gal (3.74 L) 9.50 lb	**205-B or 206-B** .86 qt (814 ml) 1.86 lb	1.2 gal (4.55 L) 11.36 lb	350–405 ft² (32–37 m²)	462–520 ft² (43–48 m²)
		207-SB or 209-SB 1.32 qt (1.23 L) 2.75 lb	1.3 gal (4.98 L) 12.25 lb	370–430 ft² (35–40 m²)	490–550 ft² (45–50 m²)
	105-C 4.35 gal (16.47 L) 41.82 lb	**205-C or 206-C** .94 gal (3.58 L) 8.20 lb	5.29 gal (20 L) 50.02 lb	1530–1785 ft² (142–165 m²)	2040–2300 ft² (190–213 m²)
		207-SC or 209-SC 1.45 gal (5.49 L) 12.0 lb	5.8 gal (21.9 L) 53.82 lb	1675–1955 ft² (155–180 m²)	2235–2520 ft² (207–233 m²)

Hardener

Hardener Selection Guide
Select a hardener for its intended use and for the cure speed best suited for your job in the temperature range in which you are working.

HARDENER	USES Resin/Hardener	HARDENER TEMPERATURE RANGE (°F) Room Temperature 40° 50° 60° 70° 80° 90° 100°	CURE SPEEDS at room temp.* POT LIFE 100g cupful	WORKING TIME thin film	CURE TO SOLID thin film
205	Fast cure—General bonding, fabric application and barrier coating		9–12 minutes	60–70 minutes	6–8 hours
206	Slow cure—General bonding, fabric application and barrier coating		20–25 minutes	90–110 minutes	10–15 hours
209	Extra Slow cure—General bonding, fabric application, barrier coating		40–50 minutes	3–4 hours	20–24 hours
207	Clear fabric application, clear coating and general bonding.		20–26 minutes	100–120 minutes	10–15 hours

*Epoxy cures faster in warmer temperatures and in thicker applications—Epoxy cures slower in cooler temperatures and in thinner applications.

205 Fast Hardener®

205 Fast Hardener is formulated for general coating and bonding applications at lower temperatures and to produce a rapid cure that develops its physical properties quickly at room temperature. 105/205 forms a high-strength, moisture-resistant solid with excellent bonding and barrier coating properties. Not intended for clear coating.

Mix ratio	5 parts resin : 1 part hardener
Pot life at 72°F (22°C)	9 to 12 min.
Cure to a solid state	6 to 8 hrs
Cure to working strength	1 to 4 days
Min. recommended temp.	40°F (4°C)

Storage/Shelf Life

Store at room temperature. Keep containers closed to prevent contamination. With proper storage, resin and hardeners should remain usable for many years. After a long storage, verify the metering accuracy of the pumps. Mix a small test batch to assure proper curing.

Over time, 105 Resin will thicken slightly and will therefore require extra care when mixing. Repeated freeze/thaw cycles during storage may cause crystallization of 105 Resin. Warm resin to 125°F and stir to dissolve crystals.

Hardeners may darken with age, but physical properties are not affected by color. If clear finishing, be aware of a possible color shift if very old and new hardeners are used on the same project.

206 Slow Hardener®

206 Slow Hardener is formulated for general coating and bonding applications when extended working and cure time are needed or to provide adequate working time at higher temperatures. 105/206 forms a high-strength, moisture-resistant solid with excellent bonding and barrier coating properties. Not intended for clear coating.

Mix ratio	5 parts resin : 1 part hardener
Pot life at 72°F (22°C)	20 to 25 min.
Cure to a solid state	10 to 15 hrs
Cure to working strength	1 to 4 days
Min. recommended temp.	60°F (16°C)

209 Extra Slow Hardener™

209 Extra Slow Hardener is formulated for general coating and bonding applications in extremely warm and/or humid conditions or when extended working time is desired at room temperature. Provides approximately twice the working time of 206 Slow Hardener. 105/209 forms a high-strength, moisture-resistant solid with excellent bonding and barrier coating properties. Not intended for clear coating.

Mix ratio	3 parts resin : 1 part hardener
Pot life at 72°F (22°C)	40 to 50 min
at 95°F (35°C)	15 to 20 min
Cure to a solid state	
at 72°F (22°C)	20 to 24 hrs
at 95°F (35°C)	6 to 8 hrs
Cure to working strength	
at 72°F (22°C)	4 to 9 days
Min. recommended temp.	70°F (21°C)

207 Special Clear Hardener™

207 Special Clear Hardener was developed for coating and fiberglass cloth application where an exceptionally clear, moisture-resistant, clear carbon fiber or natural wood finish is desired. 207 Hardener will not blush or turn cloudy in humid conditions. Thin film applications roll out and tip off smoothly, requiring less sanding in preparation for finish coatings.

Professional and first-time builders like 207 because it is reliable and easy to use. Three coats or more can be applied in one day without additional surface preparation. Fewer coats are required to fill fiberglass weave and in most cases the final coating can be sanded the following day. Builders also appreciate the excellent fiberglass wet-out characteristics achieved with 105/207, yet it won't drain from vertical surfaces like the very slow curing, low-viscosity epoxies.

105/207 has strong physical properties, so it can be used as a structural adhesive for gluing and laminating. It has excellent compatibility with paints and varnishes. An ultraviolet inhibitor in 207 helps provide a beautiful, long lasting finish when used with quality UV-filtering top coat.

Mix ratio	3 parts resin : 1 part hardener
Pot life at 72°F (22°C)	20 to 26 min
Cure to a solid state	10 to 15 hrs
Cure to working strength	1 to 4 days
Min. recommended temp.	60°F (16°C)

Fillers

Adhesive Fillers

403 Microfibers

403 Microfibers, a fine fiber blend, is used as a thickening additive that builds volume quickly and blends easily to create a multipurpose adhesive, especially for bonding wood. Epoxy thickened with Microfibers has good gap-filling qualities while retaining excellent wetting/penetrating capability. Cures to an off-white color.

405 Filleting Blend

This strong, wood-toned filler is good for use in glue joints and fillets on naturally-finished wood. It mixes easily with epoxy and has good gap-filling properties. It cures to a dark brown color, and can be used to modify the color of other West System fillers.

Fairing Fillers

407 Low-Density

407 Low-Density Filler is a blended microballoon-based filler used to make fairing putties that are easy to sand or carve. Reasonably strong on a strength-to-weight basis. Cures to a dark red/brown color.

404 High-Density

404 High-Density Filler is a thickening additive developed for maximum physical properties in hardware bonding where high-cyclic loads are anticipated. It can also be used for filleting and gap-filling where maximum strength is necessary. Cures to an off-white color.

406 Colloidal Silica

406 Colloidal Silica is a thickening additive used to control the viscosity of the epoxy and prevent epoxy runoff in vertical and overhead joints. 406 is a very strong filler that creates a smooth mixture, ideal for general bonding and filleting. It is also our most versatile filler. Often used in combination with other fillers, it can be used to improve the strength, abrasion resistance, and consistency of fairing compounds, resulting in a tougher, smoother surface. Cures to an off-white color.

410 Microlight®

410 Microlight is the ideal low-density filler for creating a light, easily-worked fairing compound especially suited for fairing large areas. Microlight mixes with greater ease than 407 Low-Density Filler or microballoons and is approximately 30% easier to sand. It feathers to a fine edge and is also more economical for large fairing jobs. Not recommended under dark paint or other surfaces subject to high temperatures. Cures to a light tan color.

Fillers are used to thicken the basic resin/hardener mixture for specific applications. Each filler possesses a unique set of physical characteristics, but they can be generally categorized as either Adhesive (high-density) or Fairing (low-density).

Filler Selection Guide

Uses—Use description—desired characteristics (Resin/Hardener mixture thickened with a Filler)	ADHESIVE FILLERS (Highest Density, Highest Strength)				FAIRING FILLERS (Lowest Density, Easiest Sanding)	
	404 High-Density	**406 Colloidal Silica**	**403 Microfibers**	**405 Filleting Blend**	**407 Low-Density**	**410 Microlight®**
Bonding Hardware—Increased fastener interface and hardware load capability—maximum strength	★★★★	★★★	★★★	★★		
General Bonding—Join parts with epoxy thickened to create a structural gap filler—strength/gap filling	★★★	★★★	★★★	★★	★	
Bonding with Fillets—Increase joint bonding area and create a structural brace between parts—smoothness/strength	★★	★★★★	★★	★★★	★★★	
Laminating—Bond layers of wood strips, veneers, planks, sheets and cores—gap filling/strength	★★	★★★	★★★★	★★	★★	
Fairing—Fill low areas and voids with an easily sanded surface filler/fairing compound—sandability/gap filling					★★★	★★★★

Filler suitability for various uses: ★★★★=excellent, ★★★=very good, ★★=good, ★=fair, (no stars)=not recommended.

Filler Buying Guide

Filler	Package Size	Quantity of Mixed Epoxy Required for: catsup consistency	mayonnaise consistency	peanut butter consistency
403-9	6.0 oz	3.8 qt	2.5 qt	1.0 qt
403-28	20.0 oz	3.2 gal	2.0 gal	.9 gal
403-B	20.0 lb	48.0 gal	32.0 gal	15.3 gal
404-15	15.2 oz	1.2 qt	.9 qt	.7 qt
404-45	43.0 oz	3.6 qt	2.8 qt	2.0 qt
404-B	30.0 lb	9.4 gal	7.4 gal	5.3 gal
405	11.0 oz	.8 qt	.6 qt	.5 qt
406-2	1.7 oz	1.3 qt	.9 qt	.5 qt
406-7	5.5 oz	1.1 gal	3.0 qt	1.7 qt
406-B	10.0 lb	27.0 gal	16.0 gal	6.0 gal
407-5	4.0 oz	.5 qt	.4 qt	.3 qt
407-15	12.0 oz	1.7 qt	1.3 qt	1.0 qt
407-B	14.0 lb	6.0 gal	4.8 gal	3.7 gal
410-2	2.0 oz	1.2 qt	.9 qt	.7 qt
410-7	5.0 oz	3.0 qt	2.4 qt	1.8 qt
410-B	4.0 lb	8.9 gal	7.2 gal	5.6 gal

Estimates based on 72°F. More filler/less epoxy may be required at higher temperatures.

Adhesive fillers are suitable for most bonding situations especially high-density materials like hardwoods and metals. Adhesive filler mixtures cure to a strong, hard-to-sand plastic useful in structural applications like bonding, filleting and hardware bonding.

Fairing filler mixtures cure to light, easily sandable material that is generally used for cosmetic or surface applications like shaping, filling or fairing. Seal all faired surfaces with epoxy before painting.

General use filler selection may be based on the handling characteristics you prefer. Fillers may also be blended to create mixtures with intermediate characteristics.

Additives

Additives are blended with mixed epoxy to alter the physical properties of epoxy when used as a coating. Additives can be used to alter the color, abrasion resistance or moisture resistance of cured epoxy.

420 Aluminum Powder

420 Aluminum Powder will increase the hardness and abrasion resistance of the coated surface and improve its moisture resistance. 420 provides limited protection from ultraviolet light in areas that will not be protected with other coatings and can be used as a base for subsequent painting. Cures to a metallic gray color.

Add to mixed resin/hardener at the rate of 5%–10% by volume or 1½ tablespoons per 8 fl oz of epoxy (10 strokes each of resin and hardener from 300 Mini Pumps). 36 oz. of 420 will modify up to five gallons of mixed epoxy.

420-36 36 oz.

423 Graphite Powder

423 Graphite Powder is a fine black powder that can be mixed with West System epoxy to produce a low-friction exterior coating with increased scuff resistance and durability. Epoxy/graphite is commonly used as a low-load, low-speed bearing surface, and as a coating on rudders and centerboards, or on the bottoms of racing craft that are dry sailed. It does not provide antifouling qualities. The epoxy/graphite mixture cures to a black color.

Add to mixed resin/hardener at the rate of 10% by volume or 1½ tablespoons per 8 fl. oz. of epoxy. 12 oz. can of 423 will approximately one gallon of epoxy.

423 12 oz.

422 Barrier Coat Additive™

A proprietary blend designed to improve cured epoxy's moisture-exclusion effectiveness. 422 is used as a barrier coating additive to help prevent gelcoat blistering in polyester fiberglass boat hulls. 422 also increases the epoxy's abrasion resistance. Cures to a light gray color.

Add to mixed resin/hardener at the rate of 15 to 20% by volume or 3 tablespoons per 8 fl oz. of epoxy. 16 oz. can of 422 will modify approximately half a gallon of epoxy.

422-16 16 oz.

Color Pigments

West System pigments are epoxy-based liquid colorants used to tint the epoxy mixture to provide an even color base for the final finish system. The colored surfaces also tend to highlight flaws and imperfections. Cured, pigmented epoxy surfaces are not a final finish surface, but require an additional paint or UV filter coating for ultraviolet protection. Add to the mixed resin/hardener at a rate of approximately one teaspoon of pigment to 8 fl oz of epoxy. More pigment will increase opaqueness and mixture viscosity. One 4 fl. oz. bottle will tint approximately 1½ gal of epoxy.

501 White Pigment 4 fl. oz.
502 Black Pigment 4 fl. oz.
503 Gray Pigment 4 fl. oz.

Metering Pumps

Metering Pumps

300 Mini Pump Set

300 Mini Pumps are designed for convenient and accurate metering of Group Size A, B and C West System 105 Resin-based epoxy. The 300 Mini Pump Set contains one resin pump and two hardener pumps. Pumps mount directly on the resin and hardener containers and eliminate the mess involved with measuring by weight or volume.

300 Mini Pumps are calibrated to deliver the proper working ratio with **one full pump stroke of resin for each one full pump stroke of hardener**. 105/205-206 pumps deliver approximately 0.8 fl oz of resin/hardener with one full stroke of each pump. 105/207-209 pumps deliver approximately 0.9 fl oz of resin/hardener with one full stroke of each pump.

Made of durable polypropylene, the pumps give years of dependable service. Read and follow the priming, ratio verification and operating instructions that come with the pumps.

As packaged, the pumps are ready to install on the Group Size B containers. A package of extension tubes for Group Size A containers is included with the set. Group Size C extension tubes are included in the 105-C Resin and in the 207-SC or 209-SC packages.

Metering Scale

320 Small-Batch Epoxy Scale

For batches smaller than one Mini Pump stroke, the 320 scale accurately measures the correct ratio of resin and hardener from 4.4 fl. oz. down to just a few drops of mixed product. The scale can also be used to confirm the accuracy of your West System dispensing pumps and to consistently add pigments or other additives. The scale comes in a convenient kit for small projects. The kit includes dispensing bottles, 3¼ oz. and 1 oz. plastic mixing cups, mixing sticks, and pipe cleaners.

Large Capacity Pumps

306-23 Metering Pump

Similar to 306-25 Metering Pump described above. For metering 105 Resin and 207 Special Clear or 209 Extra Slow (3:1 ratio) Hardeners. Can be converted to 5:1 ratio.

306-25 Metering Pump

For metering 105 Resin and 205 or 206 (5:1 ratio) Hardeners. The 306-25 Pump will reduce mixing time and waste on large projects. A carrying handle allows you to move the pump where the work is. Reservoirs hold one gallon of resin, one quart of hardener. Dispenses approximately 0.5 fl oz of resin/hardener per pump stroke (about 1 qt per minute).

306-Kit Rebuild Kit

For all 306 pumps. Includes seals, balls, gaskets, springs, high-rise tubes with ferrules and new resin and hardener reservoirs with lids.

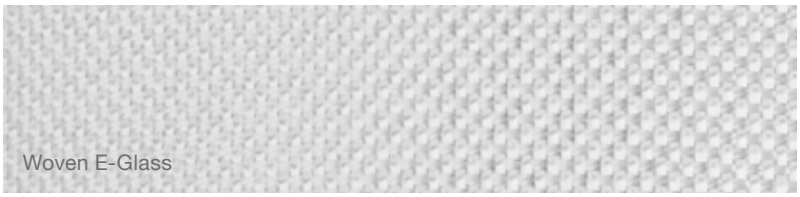
303 Positive Displacement Pump (3:1)

This positive displacement metering pump dispenses three parts resin and one part hardener (3:1) by volume. It consists of two separate parallel pump systems, one for the resin and one for the hardener. The two systems are operated simultaneously by a single lever. The pump delivers 2.3 fl. oz. of resin and hardener per full stroke of the dispensing lever. The reservoirs hold two gallons of resin and one gallon of hardener.

305 Positive Displacement Pump (5:1)

Similar to 303 Positive Displacement Pump described above, the 305 pump is designed to accurately dispense West System resins and hardeners at 5:1 by volume.

Reinforcing Materials


Woven E-Glass

Glass Fabrics

Woven E-glass fabrics are ideal for building composite laminates and repairing fiberglass structures. May also be used to provide an abrasion-resistant covering for wooden structures. When wet-out, the 4 and 6 oz fabrics become transparent, allowing a clear, natural wood finish. Perfect for stripper canoes. May be painted or varnished.

740-10 4 oz– 50" wide × 10 yd roll
740-20 4 oz– 50" wide × 20 yd roll
742-10 6 oz– 60" wide × 10 yd roll
742-20 6 oz– 60" wide × 20 yd roll
745-10 10 oz– 60" wide × 10 yd roll
745-20 10 oz– 60" wide × 20 yd roll
745-30 10 oz– 30" × 30" sheet

737 Biaxial Fabric

17 oz non-woven E-glass fabric. Two layers, ±45° fiber orientation. For composites, repairs and reinforcing. Achieves high fiber-to-resin ratio with hand wet-out.

737-20 50" wide × 20 yd roll.

738 Biaxial Fabric with Mat

17 oz non-woven E-glass fabric. Two layers, ±45° fiber orientation. The same as 737 fabric with a .75 oz/sq ft mat backing. Approximately 23.8 oz/sq yd total fabric weight.

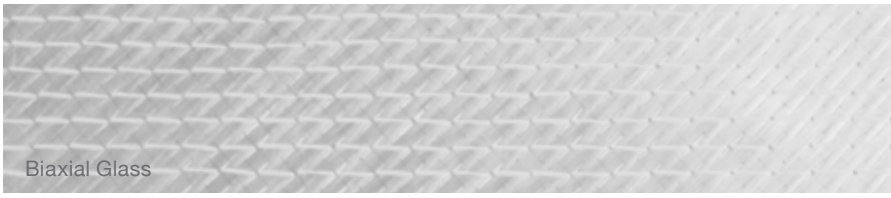
738-20 50" wide × 20 yd roll.

To determine the number of fabric layers required to achieve a specific laminate thickness, divide the thickness desired by the single layer thickness of the tape or fabric you intend to use.

Product	Fabric Weight	Single Layer Thickness*
740	4 oz	.008"
742	6 oz	.010"
713	11 oz	.012"
702	11 oz	.015"
729	9 oz	.017"
745	10 oz	.016"
737	17 oz	.035"
738	23.8 oz	.042"

*Average of multiple layers applied by hand lay-up

Unidirectional Carbon


Biaxial Glass

Unidirectional Carbon Tapes

Unidirectional 11.1 oz carbon fiber reinforcing tapes are used for selective reinforcement to improve tensile strength and stiffness in one direction while adding minimum thickness and weight. Fiber bundles are held in place by a polyester fill thread for easy handling and wet out. 144,000 fibers per inch of tape width.

702-12 1½" wide × 12' roll.
702-50 1½" wide × 50' roll.
703-12 3" wide × 12' roll.
703-50 3" wide × 50' roll.

713 Unidirectional Glass Tape

Unidirectional 11.1 oz E-glass fiber reinforcing tape is used to add strength in one direction, but with less stiffness than carbon fiber. Easy to handle and wet out.

713-50 3" wide × 50' roll.

727 Biaxial Tape

17 oz non-woven E-glass fabric. Two layers at a ±45° fiber orientation are held together by a light stitching. Flat, non-crimped fibers yield reduced print-through and higher stiffness than woven fabrics. Ideal for repairs, tabbing and reinforcing.

727-10 4" wide × 10' roll.
727-20 4" wide × 20 yd roll.

Glass Tape

Versatile West System 9 oz woven E-glass fabric tapes, with bound edges, are ideal for reinforcing chines, hull/deck corners and similar structural applications. When bonded with West System Epoxy, they provide additional tensile strength to resist hairline crack development and abrasion.

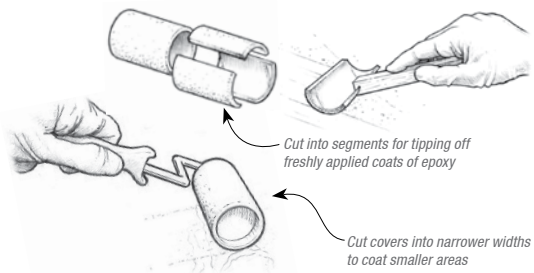
729-10 2" wide × 10' roll
729 2" wide × 50 yd roll
731 3" wide × 50 yd roll
732-10 4" wide × 10' roll
732 4" wide × 50 yd roll
733 6" wide × 50 yd roll

Application Tools

800 Roller Covers

These thin polyurethane foam covers are the only roller covers recommended for epoxy application. The thin foam allows you to control film thickness, avoid drips and runs and get a smoother coating. The 7" covers can be cut for smaller jobs, narrow strips and tight areas. Cut segments make ideal tipping brushes.

800-2 2 ea.



801-HD Roller Frame

3" caged roller frame holds 7" full-width covers and covers cut to narrower widths. 1 ea.

Epoxy will not bond to many plastic tools or mixing pots because their glossy surface does not provide enough texture, or tooth, for epoxy to key into. When cured, flex the tool to loosen epoxy. Thick films pop off easier than thin films. As a tool gets scuffed and scratched from use, it will become more difficult to pop the cured epoxy from the surface.

802 Roller Pan

Heavy duty, flexible plastic roller pan allows you to "pop out" epoxy after it has cured so the pan can be re-used. Eliminates the need for liners. 1 ea.

803 Glue Brushes

Handy, disposable, ½" × 6" glue application brushes with a metal handle. These brushes are useful in a wide variety of small bonding and coating applications.

803-12 12 ea.
803-144 144 ea.

804 Reusable Mixing Sticks

A practical mixing, application, filleting, and cleaning tool. Squared, beveled end reaches mixing pot corners for thorough mixing and blending in fillers and for cleaning up excess epoxy. Use rounded end to shape 3/8" radius fillets. Cured epoxy pops off easily, so they can be reused many times. ¾"-wide × 5½".

804-8 8 ea.
804-60 60 ea.

805 or 806 Mixing Pots

Cured epoxy pops out of these heavy-duty, reusable plastic mixing pots. Convenient batch sizes for most projects. Pots are calibrated to help mix larger batches.

805 16 oz pot, 1 ea.
806 32 oz pot, 1 ea.

807 Syringes

Reusable syringes that can be loaded with epoxy mixture for injecting into tight spots. Ideal for hardware bonding and small repairs. Holds 12 cc (about 0.4 fl oz).

807-2 2 ea.
807-12 12 ea.

808 Flexible Plastic Spreader

Flexible, reusable 3½"× 6" double-edged spreader for flow coating, fairing, filling and applying fabrics.

808-2 2 ea.
808-12 12 ea.

809 Notched Spreader

Stiff 4" × 4" plastic spreader with 1/8", 3/16" and ¼" notches on three sides for quickly applying thickened epoxy at a constant rate over large areas. Thin straight edge is ideal for applying layers of reinforcing fabrics.

809 1 ea.

810 Fillable Caulking Tubes

For use with a standard caulking gun. Great for injecting large amounts of epoxy, laying a lengthy bead of epoxy or making fillets. Can be refilled several times, before epoxy begins to cure. Tubes can be refilled again after cured epoxy is popped out. Holds approximately 10 fl oz.

810-2 2 ea.
810-24 24 ea.

Specialty Items

879 Release Fabric

Release Fabric is a tough, finely woven nylon fabric treated with a release agent. It is used to separate the breather fabric and vacuum bag from the laminate in vacuum bagging operations. Excess epoxy bleeds through and is peeled from the cured laminate along with the Release Fabric. It's also used in hand lay-up applications to allow more squeegee pressure and protect the lay-up from contamination and blush. Peels easily and leaves a smooth textured surface, ready for bonding, sanding or finishing. Not recommended for post-cure temperatures over 120°F (49°C).

879-2 60" wide × 2 yd roll
879-10 60" wide × 10 yd roll
879-18 60" wide × 9" sheet

881 Breather Fabric

Breather Fabric is a lightweight, polyester blanket that provides excellent air passage within the vacuum envelope while it absorbs excess epoxy.

881-10 45" wide × 10 yd roll

882 Vacuum Bag Film

Clear, heat-stabilized, modified nylon resin film. Can be used at temperatures up to 350°F (176°C) for typical composite cure cycle times. A tough, stretchable film for high vacuum pressures.

882-20 60" wide × 20 yd roll

883 Vacuum Bag Sealant

Mastic tape sealant for airtight seals between vacuum bags and molds. Easy to work around difficult angles, patching small leaks in the vacuum system.

½" wide × 25' roll

885-5 Vacuum Gauge

0–30 Hg (mercury) vacuum gauge.

885-6 Venturi Vacuum Generator

Includes silencer. Generator develops over 20 inches Hg (mercury) of vacuum (10 psi) at .4 SCFM (standard cubic feet per minute) and is designed to run off of conventional shop air compressors delivering at least 65 psi at 3.5 SCFM continuously.

885-34 Vacuum Cups and Tubing

Includes 3 vacuum cups and 20' of ¼" I.D. vacuum tubing.

885 Vacuum Bagging Kit

A complete starter kit for room temperature repairs and small laminating projects up to 13 square feet. Some item specifications may vary. Kit includes:

- Venturi Vacuum Generator with Silencer
- 3 Vacuum Cups, 20' of ¼" I.D. Vacuum Tubing
- 0–30Hg Vacuum Gauge
- 2 Junction "T" barbs
- 15 sq. ft. Release Fabric
- 15 sq. ft. Breather Fabric
- 15 sq. ft. Vacuum Bag Film
- 25' Vacuum Bag Sealant
- Complete, illustrated instructions

Vacuum Bagging is a clamping system used for laminating a wide range of fabrics, core materials and veneers. It uses atmospheric pressure to deliver firm, even clamping pressure over the entire surface area of a composite part or repair, regardless of the material or materials being laminated. By laminating over simple molds, composites can be molded into an endless variety of functional shapes.

Special Tools

875 Scarffer®

A unique tool designed by boatbuilders for cutting accurate scarf joints in plywood up to ⅜" thick. Attaches easily to most circular saws and is easily removed. Saw must have a base plate extension (outside of the blade) ½" or wider.

1 ea (saw not included).

Skin Protection

Our personal protective clothing is made out of a microporous film laminate material which provides a superior combination of strength, barrier protection and breathability.

It is much easier and safer to keep epoxy off your skin than it is to clean it off. Gloves, coveralls, aprons, lab coats and sleeves help you work clean.

832 Disposable Gloves

Lightweight, seamless neoprene gloves are more chemically resistant than latex gloves. They provide excellent protection while retaining good finger sensitivity and dexterity and they are more puncture resistant than conventional disposable gloves. Large size fits most.

832-4 4 pr.
832-50 50 pr.

834 Lab Coat

For upper body protection, use the lab coats with gloves to prevent accidental skin and clothing contact with uncured epoxy.

834-L 1 ea.
834-XL 1 ea.

835 Apron

For torso protection, use the aprons with gloves to prevent accidental contact with uncured epoxy. For added protection, use with sleeves.

835 1 ea.

836 Coverall

These suits are inexpensive enough to be disposable, yet durable enough to be reused again and again. For maximum personal protection, use coveralls with gloves to prevent accidental contact with uncured epoxy. Elastic wrists and ankles help prevent sleeves and pant legs from riding up. Coveralls available in large, extra-large and XXL.

836-L 1 ea.
836-XL 1 ea.
836-XXL 1 ea.

838 Sleeves

If you need to cover only your arms, try these convenient sleeves. 18" sleeves with elastic top and cuff. Use with coverall and gloves for extra protection.

838-2 2 pr.

Working Cleanly

In addition to gloves, coveralls, aprons, lab coats and sleeves, there are a two other common, yet essential, items you can use to help contain epoxy and work more cleanly.

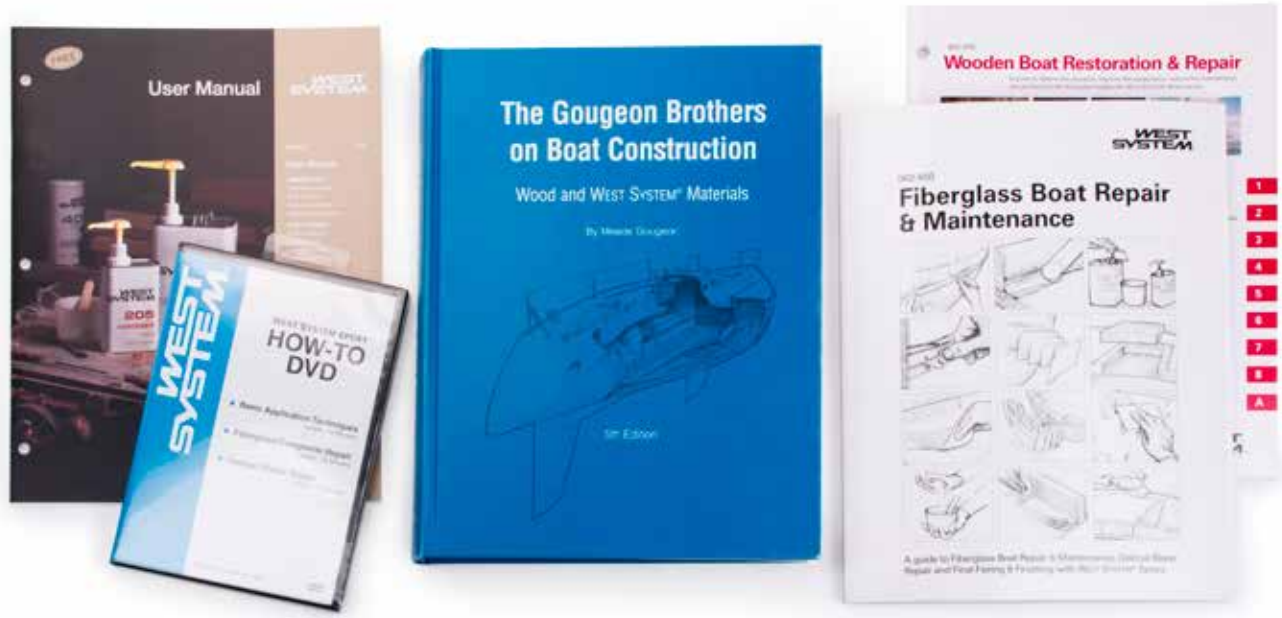
Always keep a roll of paper towels within reach before mixing a batch of epoxy. We recommend using paper towels to clean spills and wipe up excess epoxy. To remove contamination from bonding surfaces, we recommend plain white (non-printed) towels as the ink may be a contaminant that can affect bonding.

It is also a good practice to use plastic sheeting (4 or 6 mil) to protect floors and work surfaces from epoxy spills and mask off areas of your project you want to protect.

Epoxy won't bond to plastic sheeting and will peel off when cured. Use small pieces of plastic under clamps to avoid inadvertent bonding. Clear plastic packaging tape also works well to protect clamps, tools and other surfaces you don't want epoxy to stick to.

Instruction

For more about West System products or technical information for a building or repair project, Gougeon Brothers offers a range of detailed publications that can help get you started. Our print publications are available as free downloadable PDFs at westsystem.com.



002-898 West System Epoxy How-To DVD

A compilation of three instructional videos demonstrating basic handling and advanced epoxy repair techniques. Basic Application Techniques—A guide to the optimum use of West System Epoxy products, including epoxy safety and procedures for coating, bonding and fairing. Fiberglass Repair with West System Epoxy—making structural repairs on fiberglass boats, including repairs to cored and non-cored hulls and how to apply gelcoat over epoxy repairs. Gelcoat Blister Repair with West System Epoxy—A guide for analyzing the causes of blister formation, repairing and preventing gelcoat blisters on fiberglass boats. Interactive menus allow for easy navigation through these subjects. DVD—59 minutes.

002 The Gougeon Brothers on Boat Construction

Decades of experience building with wood and epoxy are compiled in this classic on wood/epoxy boat building. Extensive chapters on lofting, safety, tools and construction methods are described with the aid of hundreds of detailed illustrations and photographs. This 5th edition includes about 20% new and updated material and a revised layout for easier navigation. Used as a textbook in boat building schools. Over 100,000 copies in print. Hardcover—406 pages.

002-550 Fiberglass Boat Repair & Maintenance

This is a complete, illustrated guide to a variety of fiberglass repair problems, including detailed instructions on repairing cracks and holes, delamination, rot and keel damage. It also covers fairing keels, hardware bonding, final fairing and finishing, installing teak veneers and gelcoat blister diagnosis, prevention and repair. Softcover—122 pages.

002-970 Wooden Boat Restoration & Repair

This manual shows you how to do professional level repairs and renovations that dramatically extend the life of your wooden boat. Dry rot repairs, structural frame repairs, and plank repairs using modern products and techniques are among the many solutions covered in this fully illustrated manual. Softcover—80 pages.

000-605 EPOXYWORKS® FREE (USA and Canada only)

EPOXYWORKS is a FREE semiannual magazine published by Gougeon Brothers, Inc. It discusses building, restoring and repairing with epoxy. It offers helpful tips, the latest techniques, projects you can build, readers' projects, and news from the Gougeon research and test labs.

Subscribe to the print edition of EPOXYWORKS by calling Gougeon Brothers at 866-937-8797, or by visiting westsystem.com or epoxyworks.com to fill out the online form. Subscriptions do not expire.

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westsystem.com

Our website is a great resource for product information, technical information such as SDS, how-to videos, customer projects, the latest updates and dealer information. Search our extensive database for articles on boat repair and construction, techniques and materials, home and architecture, building and restoring vehicles of every kind and the arts.

Safety Data Sheets

Safety Data Sheets (SDS) for specific West System products are available at westsystem.com, through West System distributors or by contacting Gougeon Brothers, Inc. For additional information about the use or suitability of West System products contact the Gougeon Technical Staff at 866-937-8797.

Six10
ADHESIVE

Epoxy Handling

This section explains the fundamentals of epoxy safety, curing and the steps for proper dispensing, mixing and adding fillers to assure that every batch cures to a reliable high-strength solid.

Epoxy Safety

Precautions

1. Avoid contact with resin, hardeners, mixed epoxy and sanding dust from epoxy that is not fully cured. Wear protective gloves and clothing whenever you handle West System Epoxies. If you do get resin, hardener or mixed epoxy on your skin, remove it as soon as possible. Resin is not water soluble—use a waterless skin cleanser to remove resin or mixed epoxy from your skin. Hardener is water soluble—wash with soap and warm water to remove hardener or sanding dust from your skin. Always wash thoroughly with soap and warm water after using epoxy. Never use solvents to remove epoxy from your skin.

   Stop using the product if you develop an allergic type of reaction. Resume work only after the symptoms disappear, usually after several days. When you resume work, improve your safety precautions to prevent exposure to epoxy, its vapors, and sanding dust. If problems persist, discontinue use and consult a physician.

1. Protect your eyes from contact with resin, hardeners, mixed epoxy, and sanding dust by wearing appropriate eye protection. If contact occurs, immediately flush the eyes with water under low pressure for 15 minutes. Seek medical attention or advice.

2. Avoid breathing concentrated vapors and sanding dust. West System Epoxies have low volatile organic content (VOC), but vapors can build up in unventilated spaces. Use adequate ventilation to avoid breathing vapors, fumes and sanding dust, particularly when working in confined spaces, such as boat interiors. When ventilation cannot be made adequate to keep exposures below safe levels, use a NIOSH approved respirator with an organic vapor cartridge, organic vapor cartridge + P100 particulate filter or a multi-contaminant cartridge. Consult with your respiratory and cartridge supplier to ensure the proper selection based on chemical ingredients and specific workplace conditions.

Provide ventilation and wear a dust mask when sanding epoxy, especially uncured epoxy. Breathing dust from epoxy that is not fully cured increases your risk of sensitization. Although epoxy cures quickly to a sandable solid, it may take over two weeks at room temperature, or post-curing, to cure completely.

3. Avoid ingestion. Wash thoroughly after handling epoxy, especially before eating or smoking. If epoxy is swallowed, rinse mouth with water—DO NOT induce vomiting. Because hardeners are corrosive, they can cause additional harm if vomited. Call a physician immediately. Refer to First Aid procedures on the Safety Data Sheet.

4. KEEP RESINS, HARDENERS, FILLERS AND SOLVENTS OUT OF THE REACH OF CHILDREN. For additional safety information or data, refer to the Safety Data Sheets or write to: EPOXY SAFETY, West System, P.O. Box 908, Bay City, MI 48707 USA

Caution! Large pots of curing epoxy can get hot enough to ignite surrounding combustible materials and give off hazardous fumes. Place pots of mixed epoxy in a safe and ventilated area, away from workers and combustible materials. Dispose of the solid mass only if cure is complete and the mass has cooled. Follow federal, state or local disposal regulations.

Hazards

Epoxies are safe when handled properly. To use West System Epoxies safely, you must understand their hazards and take precautions to avoid them.

The primary hazard associated with epoxy involves skin contact. West System Resins may cause moderate skin irritation. West System Hardeners are corrosive and may cause severe skin irritation. Resins and hardeners are also sensitizers and may cause an allergic reaction similar to poison ivy. Susceptibility and the severity of a reaction varies with the individual. Although most people are not sensitive to West System Resins and Hardeners, the risk of becoming sensitized increases with repeated contact. For those who become sensitized, the severity of the reaction may increase with each contact. These hazards also apply to the sanding dust from epoxy that has not fully cured. These hazards decrease as resin/hardener mixtures reach full cure. Refer to product labels or Safety Data Sheets (SDS) for specific product warnings and safety information.

Cleanup

Contain large spills with sand, clay or other inert absorbent material. Use a squeegee to contain small spills and collect as much material as possible. Follow up with absorbent towels.

DO NOT use sawdust or other fine cellulose materials to absorb hardeners.

DO NOT dispose of hardener in trash containing sawdust or other cellulose materials—spontaneous combustion can occur.

Clean *resin* or mixed epoxy residue with lacquer thinner, acetone or alcohol. Follow all safety warnings on solvent containers. Clean *hardener* residue with warm soapy water. Clean 207 Hardener residue with lacquer thinner, acetone or alcohol.

Dispose of resin, hardener and empty containers safely. Puncture a corner of the can and drain residue into the appropriate new container of resin or hardener. DO NOT dispose of resin or hardener in a liquid state. Waste resin and hardener can be mixed and cured (in small quantities) to a non-hazardous inert solid.

Removing uncured or non-curing epoxy. Uncured epoxy is removed as you would spilled resin. Scrape as much material as you can from the surface using a stiff metal or plastic scraper—warm the epoxy to lower its viscosity. Clean the residue with lacquer thinner, acetone, or alcohol. (Follow safety warnings on solvents, and provide adequate ventilation.) Allow solvents to dry before re-coating.

Removing fiberglass cloth applied with epoxy. Use a heat gun to heat and soften the epoxy. Start in a small area a near a corner or edge. Apply heat until you can slip a putty

knife or chisel under the cloth (about 250°F). Grab the edge with a pair of pliers and slowly pull up on the cloth while heating just ahead of the separation. On large areas, use a utility knife to score the glass and remove in narrower strips. Resulting surface texture may be coated or remaining epoxy may be removed as follows. Provide ventilation or wear a respirator when heating epoxy.

Removing cured epoxy coating. Use a heat gun to soften the epoxy (about 250°F). Heat a small area and use a paint or cabinet scraper to remove the bulk of the coating. Sand the surface to remove the remaining material. Provide ventilation or wear a respirator when heating epoxy.

CAUTION! Heating epoxy that has not gelled will lower its viscosity, allowing the epoxy to run or sag more easily on vertical surfaces. In addition, heating epoxy applied to a porous substrate (soft wood or low density core material) may cause the substrate to "out-gas" and form bubbles or pinholes in the epoxy coating. To avoid out-gassing, wait until the epoxy coating has gelled before warming it. Never heat mixed epoxy in a liquid state over 120°F (49°C). Regardless of what steps are taken to control the cure time, thorough planning of the application and assembly will allow you to make maximum use of epoxy's open time and cure time.

Epoxy Chemistry

Epoxy's Cure Stages

Mixing 105 Epoxy Resin® with a hardener begins a chemical reaction that transforms the combined liquid ingredients to a solid. This period of transformation is the cure time. As it cures, epoxy passes from the liquid state, through a gel state, before it reaches a solid state (Figure 1).

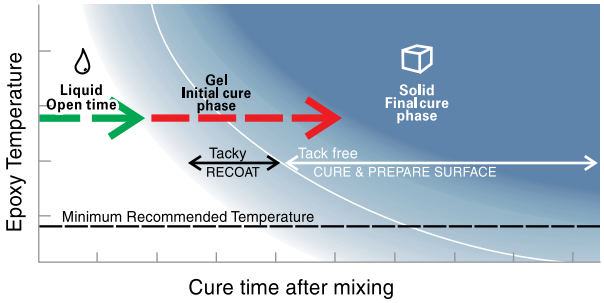


Figure 1 As it cures, mixed epoxy passes from a liquid state, through a gel state, to a solid state.

← Cure time is *shorter* when the epoxy is warmer.

← Cure time is *longer* when the epoxy is cooler.

Liquid—Open Time

Open time (also working time or wet lay-up time) is the portion of the cure time, after mixing, that the resin/hardener mixture remains a liquid and is workable and suitable for application. All assembly and clamping should take place during the open time to ensure a dependable bond.

Gel—Initial Cure Phase

The mixture passes into an initial cure phase (also called the green stage) when it begins to gel, or "kick-off." The epoxy is no longer workable and will progress from a tacky, gel consistency to the firmness of hard rubber, which you will be able to dent with your thumbnail.

The mixture will become tack free about midway through the initial cure phase. While it is still tacky (about like masking tape), a new application of epoxy will still chemically bond with it, so you may still bond to or recoat the surface without special preparation. However, this ability diminishes as the mixture approaches the final cure phase.

Solid—Final Cure Phase

The epoxy mixture has cured to a solid state and can be dry sanded. You will no longer be able to dent it with your thumbnail. At this point the epoxy has reached most of its ultimate strength, so clamps can be removed. A new application of epoxy will no longer chemically bond to it, so the surface of the epoxy must be properly prepared and sanded before re-coating to achieve a good mechanical, secondary bond. See *Surface Preparation.*

The mixture will continue to cure for the next several days to two weeks at room temperature, becoming an inert plastic solid.

You can improve epoxy's thermal performance and reduce the potential for fabric "print-through" by applying modest heat to the epoxy after it has cured to a solid state. Contact our technical staff for more information about post curing.

Controlling Cure Time

Open time and overall cure time govern much of the activity of building and repairing with epoxy. Open time dictates the time available for mixing, application, smoothing, shaping, assembly and clamping. Cure time dictates how long you must wait before removing clamps, or before you can sand or go on to the next step in the project. Two factors determine an epoxy mixture's open time and overall cure time—hardener cure speed and epoxy temperature.

1. Hardener Cure Speed

Each hardener has an ideal temperature cure range. At any given temperature, each resin/hardener combination will go through the same cure stages, but at different rates. Select the hardener that gives you adequate working time for the job you are doing at the temperature and conditions you are working under. The *Hardener Selection Guide* and container labels describe hardener pot lives and cure times.

Pot life is a term used to compare the cure speeds of different hardeners. It is the amount of time a specific mass of mixed resin and hardener remains a liquid at a specific temperature (a 100g-mass mixture in a standard container, at 72°F). Because pot life is a measure of the cure speed of a specific contained mass (volume) of epoxy rather than a thin film, a hardener's pot life is much shorter than its open time.

WARNING! Curing epoxy generates heat. Do not fill voids or cast layers of epoxy thicker than ½"—thinner if enclosed by foam or other insulating material. Several inches of mixed epoxy in a confined mass (such as a mixing cup) will generate enough heat to melt a plastic cup, burn your skin or ignite combustible materials if left to stand for its full pot life. For this reason do not use foam or glass mixing containers or pour into confined spaces. If a pot of mixed epoxy begins to exotherm (heat up), quickly move it outdoors. Avoid breathing the fumes. Do not dispose of the mixture until the reaction is complete and has cooled.

2. Epoxy Temperature

The warmer the temperature of curing epoxy, the faster it cures (Figure 1, page 23). The temperature of curing epoxy is determined by the ambient temperature plus the exothermic heat generated by its cure.

Ambient temperature is the temperature of the air or material in contact with the epoxy. Air temperature is most often the ambient temperature unless the epoxy is applied to a surface with a different temperature. Generally, epoxy cures faster when the air temperature is warmer.

Exothermic heat is produced by the chemical reaction that cures epoxy. The amount of heat produced depends on the thickness or exposed surface area of mixed epoxy. In a thicker mass, more heat is retained, causing a faster reaction and more heat. The mixing container's shape and the mixed quantity have a great effect on this exothermic reaction. A contained mass of curing epoxy (8 fl oz or more) in a plastic mixing cup can quickly generate enough heat to melt the cup and burn your skin. However, if the same quantity is spread into a thin layer, exothermic heat is dissipated, and the epoxy's cure time is determined by the ambient temperature. The thinner the layer of curing epoxy, the less it is affected by exothermic heat, and the slower it cures.

Adapting to Warm and Cool Temperatures

In warm conditions, gain open time by using a slower hardener. Mix smaller batches that can be used up quickly, or pour the epoxy mixture into a container with greater surface area (a roller pan, for example), thereby allowing exothermic heat to dissipate and extending open time. The sooner the mixture is transferred or applied (after thorough mixing), the more of the mixture's useful open time will be available for coating, lay-up or assembly.

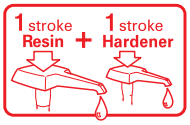
In cool conditions use a faster hardener, or use supplemental heat to raise the epoxy temperature above the hardener's minimum recommended application temperature. Use a hot air gun, heat lamp or other heat source to warm the resin and hardener before mixing or after the epoxy is applied. At room temperature, supplemental heat is useful when a quicker cure is desired. NOTE! Unvented kerosene or propane heaters can inhibit the cure of epoxy and contaminate epoxy surfaces with unburned hydrocarbons.

Dispensing and Mixing 105 Resin and Hardeners

Careful measuring of epoxy resin and hardener and thorough mixing are essential for a proper cure. Whether the resin/hardener mixture is applied as a coating or modified with fillers or additives, observing the following procedures will assure a controlled and thorough chemical transition to a high-strength epoxy solid.

Figure 2 Dispense the proper proportions of resin and hardener.

With Mini Pumps—Pump one full pump stroke of resin for each one full pump stroke of hardener.



Dispensing

Dispense the correct proportions of resin and hardener into a clean plastic, metal or wax-free paper container (Figure 2). Don't use glass or foam containers because of the potential danger from exothermic heat buildup.

DO NOT attempt to adjust the epoxy cure time by altering the mix ratio. An accurate ratio is essential for a proper cure and full development of physical properties.

Dispensing With Mini Pumps

Most problems related to curing of the epoxy can be traced to the wrong ratio of resin and hardener. To simplify dispensing and reduce the possibility of errors, we recommend using calibrated West System Mini Pumps to meter the correct working ratio of resin to hardener.

Pump **one full pump stroke of resin for each one full pump stroke of hardener**. Depress each pump head fully and allow the head to come completely back to the top before beginning the next stroke. Partial strokes will give the wrong ratio. Read the pump instructions before using pumps.

Before you use the first mixture on a project, verify the correct ratio according to the instructions that come with the pumps. Recheck the ratio anytime you experience problems with curing.

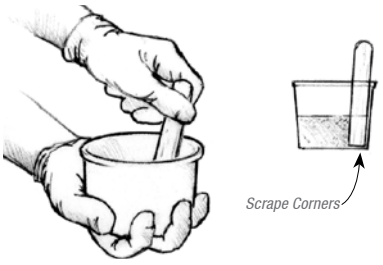


Figure 3 Stir resin and hardener together thoroughly—at least 1 minute, longer in cooler temperatures.

Dispensing Without Mini Pumps—Weight/Volume Measure

To measure 105 Resin and 205 or 206 Hardener by weight or volume, combine 5 parts resin with 1 part hardener. To measure 105 Resin and 207 or 209 Hardener by volume, combine 3 parts resin with 1 part hardener. To measure 207 or 209 Hardener by weight, combine 3.5 parts resin with 1 part hardener. (The weight measurement for these ratios is slightly different from the volume ratio due to hardener density.)

First Time Users

If this is the first time you have used West System Epoxy, begin with a small test batch to get the feel for the mixing and curing process, before applying the mixture to your project. This will demonstrate the hardener's open time for the temperature you are working in and assure you that the resin/hardener ratio is metered properly. Mix small batches until you are confident of the mixture's handling characteristics.

Mixing

Stir the two ingredients together thoroughly—at least 1 minute—longer in cooler temperatures (Figure 3). To assure thorough mixing, scrape the sides and bottom of the pot as you mix. Use the flat end of the mixing stick to reach the inside corner of the pot. If you are using a power mixer, occasionally scrape the sides and corners of the mixing pot while mixing. If you are going to be using the mixture for coating, quickly pour it into a roller pan to extend the open time.

If you have any questions about selecting or using West System products that are not answered in this manual, contact our technical staff. Call 866-937-8797 toll free or visit westsystem.com, where you can fill out a form and receive an emailed response to your question.

Figure 4 Epoxy can be thickened to the ideal consistency needed for a particular job. The procedures in this manual refer to four common consistencies: syrup, catsup, mayonnaise and peanut butter.

CONSISTENCY	**Unthickened** (neat)	**Slightly Thickened**	**Moderately Thickened**	**Maximum Thickness**
	Syrup	Catsup	Mayonnaise	Peanut Butter
GENERAL APPEARANCE				
CHARACTERISTICS	Drips off vertical surfaces.	Sags down vertical surfaces.	Clings to vertical surfaces, peaks fall over.	Clings to vertical surfaces, peaks stand up.
USES	Coating, "wetting-out" before bonding, applying fiberglass, carbon fiber and other fabrics.	Laminating/bonding flat panels with large surface areas, injecting with a syringe.	General bonding, filleting, hardware bonding.	Gap filling, filleting, fairing, bonding uneven surfaces.

Figure 5 Stir in small handfuls of filler until the desired consistency is reached.

Adding Fillers and Additives

Fillers

Throughout this and other West System manuals, we refer to epoxy or resin/hardener mixture, meaning mixed resin and hardener without fillers added; and thickened mixture or thickened epoxy, meaning mixed resin and hardener with fillers added. Fillers are used to thicken epoxy for specific applications such as bonding or fairing.

After selecting an appropriate filler for your job (see *Filler Selection Guide*, page 11), use it to thicken the epoxy mixture to the desired consistency. The thickness of a mixture required for a particular job is controlled by the amount of filler added. There is no strict formula or measuring involved—use your eye to judge what consistency will work best. Figure 4 gives you a general guide to the differences between unthickened (neat) epoxy and the three consistencies referred to in this manual.

Always Add Fillers in a Two-Step Process:

1. Mix the desired quantity of resin and hardener thoroughly before adding fillers. Begin with a small batch—allow room for the filler.
2. Blend in small amounts of the appropriate filler until the desired consistency is reached (Figure 5).

For maximum strength, add only enough filler to completely bridge gaps between surfaces without sagging or running out of the joint or gap. A small amount should squeeze out of joints when clamped. For thick mixtures, don't fill the mixing cup more than 1/3 full of epoxy before adding filler. When making fairing compounds, stir in as much 407 or 410 as you can blend in smoothly—for easy sanding, the thicker the better. Be sure all of the filler is thoroughly blended before the mixture is applied.

Spread the mixture into a thinner layer, either around the inside of the mixing cup or onto a flat non-porous surface or palette to extend its working life.

Thinning Epoxy

There are epoxy-based products specifically designed to penetrate and reinforce rotted wood. Those products, basically an epoxy thinned with solvents, do a good job of penetrating wood. But the solvents compromise the strength and moisture barrier properties of the epoxy. West System Epoxy can be thinned with solvents for greater penetration, but this results in similar compromises in strength and moisture resistance. Acetone and lacquer thinner have been used to thin West System Epoxy and duplicate these pene-

trating epoxies with about the same effectiveness. If you choose to thin the epoxy, keep in mind that the strength, especially compressive strength, and moisture protection of the epoxy are lost in proportion to the amount of solvent added.

There is a better solution to get good penetration without losing strength or moisture resistance. We recommend moderate heating (up to 120°F) of the project area with a heat gun or heat lamp before applying epoxy. On contact with the warmed substrate, the epoxy will thin out, penetrating cavities and pores, and will be drawn even deeper into pores as the substrate cools. Although the working life of the epoxy will be considerably shortened, slower hardeners (206, 207, 209) will have a longer working life and should penetrate more than 205 Hardener before they begin to gel. When the epoxy cures it will retain all of its strength and effectiveness as a moisture barrier, which we feel more than offsets any advantages gained by adding solvents to the epoxy.

Additives

Additives are used to give epoxy additional physical properties when used as a coating. Although additives are blended with mixed epoxy in the same two-step process as fillers, they are not designed to thicken the epoxy. Refer to the Additive descriptions. Follow the mixing instructions on the individual additive containers.

Coloring Epoxy

West System pigments are available to color epoxy black, white or gray. Powdered pigments (tempera paint, colored tile grout, aniline dyes) and universal tinting pigment can be added to the epoxy mixture to tint it any color. Acrylic paste pigments (available from marine chandleries) can also be used to tint the mixture, as long as they are specified for use with polyester or epoxy resin. 423 Graphite Powder will also color the epoxy black or impart darker shades to colors.

Generally, coloring agents can be added to the mixed epoxy up to 5% by volume with minimal effect on the cured epoxy's strength. Always make test samples to check for desired color and opaqueness and for proper cure. None of these coloring additives provide UV resistance to the cured epoxy, so limit their use to areas not exposed to sunlight unless additional UV protection is applied.

Basic Techniques

The following basic techniques are common to most repair or building projects, regardless of the type of structure or material you are working with.

Figure 6 Clean the surface. Use a solvent, if necessary, to remove all contaminates.

Figure 7 Dry the surface. Allow wet surfaces to dry thoroughly or use heat or a fan to speed drying.

Figure 8 Sand non-porous surfaces. Provide a texture for epoxy to key into.

Surface Preparation

Whether you are bonding, fairing or applying fabrics, the success of the application depends not only on the strength of the epoxy, but also on how well the epoxy adheres to the surface to which it is being applied. Unless you are bonding to partially cured epoxy, the strength of the bond relies on the epoxy's ability to mechanically "key" into the surface. That is why the following three steps of surface preparation are a critical part of any secondary bonding operation.

For good adhesion, bonding surfaces should be:

1. **Clean**—Bonding surfaces must be free of any contaminants such as grease, oil, wax or mold release. Clean contaminated surfaces with lacquer thinner, acetone or other appropriate solvent (Figure 6). Wipe the surface with paper towels before the solvent dries. Clean surfaces before sanding to avoid sanding the contaminant into the surface. Follow all safety precautions when working with solvents.
2. **Dry**—All bonding surfaces must be as dry as possible for good adhesion. If necessary, accelerate drying by warming the bonding surface with a hot air gun, hair dryer or heat lamp (Figure 7). Use fans to move the air in confined or enclosed spaces. Watch for condensation when working outdoors or whenever the temperature of the work environment changes.
3. **Sanded**—Sand smooth non-porous surfaces—thoroughly abrade the surface (Figure 8). 80-grit aluminum oxide paper will provide a good texture for the epoxy to "key" into. Be sure the surface to be bonded is solid. Remove any flaking, chalking, blistering, or old coating before sanding. Remove all dust after sanding.

Special Preparation for Various Materials

Cured Epoxy—Amine blush may appear as a wax-like film on cured epoxy surfaces, except for epoxy 207 Special Clear Hardener. It is a byproduct of the curing process and

may be more noticeable in cool, moist conditions. Amine blush can clog sandpaper and inhibit subsequent bonding, but it is water soluble and can easily be removed. It's a good idea to assume it has formed on any cured epoxy surface.

To remove the blush, wash the surface with clean water (not solvent) and an abrasive pad, such as Scotch-brite™ 7447 General Purpose Hand Pads. Dry the surface with paper towels to remove the dissolved blush before it dries on the surface. Sand any remaining glossy areas with 80-grit sandpaper. Wet-sanding will also remove the amine blush. If a release fabric is applied over the surface of fresh epoxy, amine blush will be removed when the release fabric is peeled from the cured epoxy and no additional sanding is required.

Epoxy surfaces that are still tacky may be bonded to or coated with epoxy without washing or sanding. Before applying coatings other than epoxy (paints, bottom paints, varnishes, gelcoats, etc.), allow epoxy surfaces to cure fully, then wash and sand.

Hardwoods—Sand with 80-grit paper.

Teak/Oily Woods—Wipe with acetone 15 minutes before coating, allowing the solvent to evaporate before coating. Use G/flex epoxy for bonding.

Porous Woods—No special preparation needed. If surface is burnished, possibly by dull planer or saw blades, sand with 80-grit paper to open pores. Remove dust.

Steel, Lead—Remove contamination, sand or grind to bright metal, coat with epoxy then (wet) sand freshly applied epoxy into surface. Re-coat or bond after first coat gels.

Aluminum—Remove contamination, sand to a bright finish and then wet sand. Follow kit directions. Use G/flex epoxy, especially on flexible pieces.

Fiberglass (Polyester)—Clean contamination with a silicone and wax remover such as DuPont Prep-Sol™ 3919S. Sand with 80-grit paper to a dull finish.

Plastic—Clean plastics, except for polycarbonate, with isopropyl alcohol to remove contamination. Sand all plastics including polycarbonate with 80-grit sandpaper to provide texture for good adhesion. Flame treat (Pass the flame of a propane torch across the surface quickly—about 12 inches per second) ABS and PVC for additional benefit. HDPE (high-density polyethylene) and LDPE (low-density polyethylene) must be flame treated for good adhesion. Use G/flex epoxy for plastics.

Bonding (Gluing)

This section describes two methods of structural bonding. Two-step bonding is the preferred method for most situations because it promotes maximum epoxy penetration into the bonding surface and prevents epoxy-starved joints. Single-step bonding can be used when joints have minimal loads and excess absorption into porous surfaces is not a problem. In both cases, epoxy bonds best when it is worked into the surface with a roller or brush.

Before mixing epoxy, check all parts to be bonded for proper fit and surface preparation (see *Surface Preparation*), gather all the clamps and tools necessary for the operation, and cover any areas that need protection from spills.

Primary/Secondary Bonding

Primary bonding relies on the chemical bonding of adhesive layers such as the wet lay-up of fiberglass laminate in a mold. All the layers of adhesive cure together into a single fused layer. Epoxy applied over partially cured epoxy will chemically bond with it and is considered a primary bond. The ability to chemically bond diminishes

as the previous layer of epoxy cures. You must then prepare the cured surface for a secondary bond.

Secondary bonding relies on mechanical, rather than chemical, bonding of an adhesive to a material or cured epoxy surface. The adhesive must "key" into pores or scratches in the surface—a microscopic version of a dovetail joint. Proper surface preparation provides a texture that will help bond the cured epoxy to the surface. Except for bonding to uncured or partially cured epoxy surfaces, all epoxy bonds are secondary bonds.

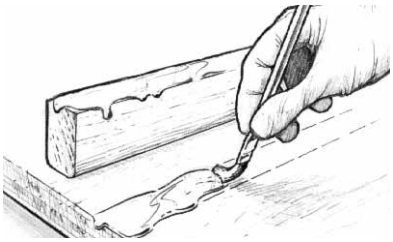


Figure 9 Apply resin/hardener mixture to the bonding surfaces.

Figure 10 Apply thickened epoxy to one of the bonding surfaces.

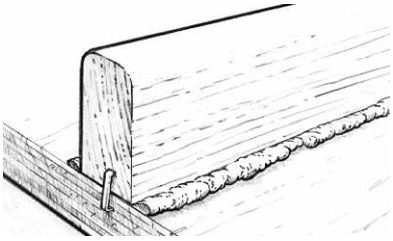


Figure 11 Clamp components in place before the epoxy gels.

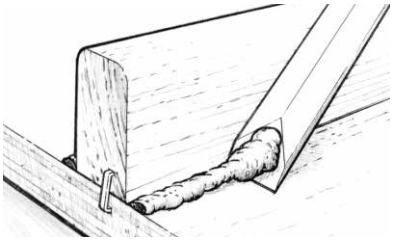


Figure 12 Remove or shape excess epoxy that squeezes out of the joint.

Clamping

Any method of clamping is suitable as long as there is no movement between the parts being joined. Common methods include spring clamps, "C" clamps and bar clamps, rubber bands, packaging tape, applying weights, and vacuum bagging. If necessary, cover clamp pads with tape, or use polyethylene sheeting or release fabric under the clamps so they don't inadvertently bond to the surface. Staples, nails or drywall screws are often used where conventional clamps will not work. In a corrosive environment, any fasteners left in should be a non-corroding alloy such as bronze. In some cases the thickened epoxy or gravity will hold parts in position without clamps. Avoid excessive clamping pressure.

Two-Step Bonding

1. Wet-out bonding surfaces—Apply an unthickened resin/hardener mixture to the surfaces to be joined (Figure 9). Wet out small or tight areas with a disposable brush. Wet out larger areas with a foam roller or by spreading the resin/hardener mixture evenly over the surface with a plastic spreader. You may proceed with step two immediately or any time before the wet-out coat becomes tack free.
2. Apply thickened epoxy to one bonding surface. Modify the resin/hardener mixture by stirring in the appropriate filler until it becomes thick enough to bridge any gaps between the mating surfaces and to prevent "epoxy-starved" joints. Apply enough of the mixture to one of the surfaces so that a small amount will squeeze out when the surfaces are joined together with a force equivalent to a firm hand grip (Figure 10).

   Thickened epoxy can be applied immediately over the wet-out surface or any time before the wet-out is no longer tacky. For most small bonding operations, add the filler to the resin/hardener mixture remaining in the batch that was used for the wet-out. Mix enough resin/hardener for both steps. Add the filler quickly after the surface is wet out and allow for a shorter working life of the mixture.
3. Clamp components. Attach clamps as necessary to hold the components in place. Use just enough clamping pressure to squeeze a small amount of the epoxy mixture from the joint, indicating that the epoxy is making good contact with both mating surfaces (Figure 11). Avoid using too much clamping pressure, which can squeeze all of the epoxy mixture out of the joint.
4. Remove or shape excess adhesive that squeezes out of the joint as soon as the joint is secured with clamps. An 804 mixing stick is an ideal tool for removing the excess (Figure 12). Allow to cure thoroughly before removing clamps.

Single-Step Bonding

Single-step bonding is applying the thickened epoxy directly to both bonding surfaces without first wetting out the surfaces with neat resin/hardener. We recommend that you thicken the epoxy no more than is necessary to bridge gaps in the joint (the thinner the mixture, the more it can penetrate the surface) and that you do not use this method for highly-loaded joints, especially when bonding end grain or other porous surfaces.

Laminating

The term "laminating" refers to the process of bonding numbers of relatively thin layers, like plywood, veneers, fabrics or core material to create a composite. A composite may be any number of layers of the same material or combinations of different materials. Methods of epoxy application and clamping will differ depending on what you are laminating.

Because of large surface areas and limitations of wet lay-up time, roller application is the most common method for applying epoxy. A faster method for large surfaces is to simply pour the resin/hardener mixture onto the middle of the panel and spread the mixture evenly over the surface with a plastic spreader. Apply thickened mixtures with an 809 Notched Spreader.

Using staples or screws is the most common method of clamping when you laminate a solid material to a solid substrate. An even distribution of weights will work when you are laminating a solid material to a base that will not hold staples or screws, such as a foam or honeycomb core material.

Vacuum bagging is a specialized clamping method for laminating a wide range of materials. Through the use of a vacuum pump and vacuum bag film, the atmosphere is used to apply perfectly even clamping pressure over all areas of a panel regardless of the size, shape or number of layers.

Pre-coating porous surfaces with neat (unthickened) epoxy before applying a thickened epoxy adhesive or fairing compound improves adhesion. Neat epoxy penetrates and "keys" into surface pores and end grain better than thicker epoxy.

Bonding with Fillets

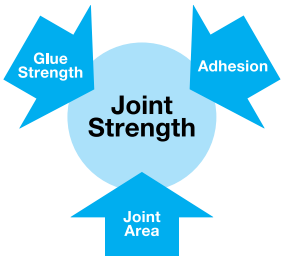
A fillet (fil'it) is a cove-shaped application of thickened epoxy that bridges an inside corner joint. It is excellent for bonding parts because it increases the surface area of the bond and serves as a structural brace. All joints that will be covered with fiberglass cloth will require a fillet to support the cloth at the inside corner of the joint.

Joint strength is the ability of a joint to adequately transfer a load from one part to another—depends on the combined effects of three factors.

GLUE STRENGTH—Careful metering and thorough mixing will assure the epoxy mixture cures to full strength.

ADHESION—For the best adhesion and load transfer, the joint's bonding surfaces must be properly prepared.

JOINT AREA—The bonding area of the joint must be adequate for the load on the joint and materials being joined. Increased overlap, scarf joints, fillets and reinforcing fibers can be used to increase joint bonding area.



The procedure for bonding with fillets is the same as normal bonding except that instead of removing the squeezed-out thickened epoxy after the components are clamped in position, you shape it into a fillet. For larger fillets, add thickened mixture to the joint as soon as the bonding operation is complete, before the bonding mixture becomes tack free, or any time after the final cure and sanding of exposed epoxy in the fillet area.

1. Bond parts as described in *Bonding*.
2. Shape and smooth the squeezed-out thick epoxy into a fillet by drawing a rounded filleting tool (804 Mixing Stick) along the joint, dragging excess material ahead of the tool and leaving a smooth cove-shaped fillet bordered on each side by a clean margin. Some excess filleting material will remain outside of the margin (Figure 13). Use the excess material to refill any voids. Smooth the fillet until you are satisfied with its appearance. A mixing stick will leave a fillet with about a 3/8" radius. For

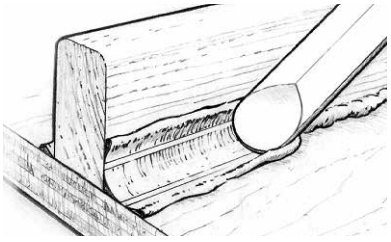


Figure 13 Shape and smooth the fillet with a rounded filleting tool.

larger fillets, an 808 Plastic Spreader, cut to shape or bent to the desired radius, works well.

Apply additional thickened epoxy to fill voids or make larger fillets. Apply the mixture along the joint line with the rounded mixing stick, using enough mixture to create the desired size of fillet. For longer or multiple fillets, empty caulking gun cartridges or disposable cake decorating bags can be used. Cut the plastic tip to lay a bead of thickened epoxy large enough for the desired fillet size. Heavy duty, sealable food storage bags with one corner cut off may also be used.

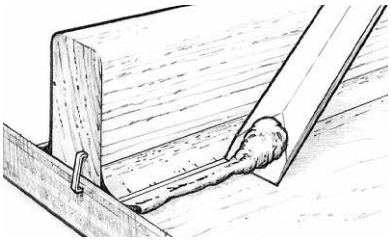


Figure 14 Clean up the excess epoxy outside of the fillet margin.

3. Clean up the remaining excess material outside of the margin by using a mixing stick or a putty knife (Figure 14). Fiberglass cloth or tape may be applied over the fillet area before the fillet has cured (or after the fillet is cured and sanded).
4. Sand smooth with 80-grit sandpaper after the fillet has fully cured. Wipe the surface clean of any dust and apply several coats of resin/hardener over the entire fillet area before final finishing.

Bonding Fasteners and Hardware

Installing screws and other threaded fasteners with West System Epoxy dramatically improves load carrying capacity by spreading the fastener's load into a greater area of the substrate. There are several methods or levels of hardware bonding depending on the loads on the hardware.

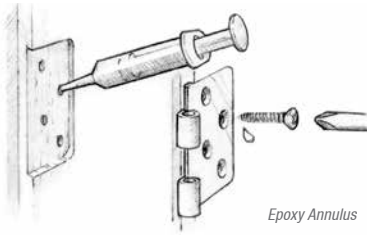


Figure 15 Wet out a standard pilot hole and install the fastener.

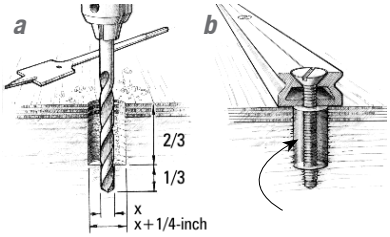


Figure 16 Drill oversized holes to increase the exposed substrate area and the amount of epoxy around the fastener.

Basic Fastener Bonding

For improved pullout strength and waterproof connections, the easiest fastener bonding method is to simply wet out stripped fastener holes and new pilot holes before installing the screws. Epoxy penetrates the fiber around the hole, effectively increasing the fastener diameter. Epoxy also provides a stronger interface with the fastener threads than wood fiber and keeps out water.

1. Wet out a standard-size pilot hole. Work the mixture well into the hole with a pipe cleaner or syringe (Figure 15). Thicken a second coat of epoxy as necessary for stripped or oversized holes.
2. Insert the fastener in the hole and allow the epoxy to cure.

Advanced Fastener Bonding

For greater strength and stability, drill oversized holes to increase the exposed substrate area and the amount of epoxy around the fastener.

1. Drill oversized holes $^{2}/_{3}$–$^{3}/_{4}$ the depth of the fastener. The hole diameter is ¼" larger than the fastener diameter (Figure 16-a).
2. Drill a normal sized pilot hole at the bottom of the oversized hole to the full length of the fastener. The normal sized pilot hole serves to hold or clamp the hardware in position until the epoxy cures. If the fastener/hardware can be clamped by other means, the oversized hole can be extended to the end of the fastener.
3. Wet out the holes and the fastener with epoxy. Allow the epoxy to thoroughly soak into the exposed substrate.
4. Fill the hole with thickened epoxy/adhesive filler. Use 404 High-Density (preferred) or 406 Colloidal Silica.
5. Install the fasteners with just enough force to hold the hardware in place. Allow the epoxy to cure thoroughly before applying load to the hardware (Figure 16-b).

Bonding Hardware

Bonding hardware goes a step beyond bonding the fasteners only. By bonding the hardware base directly to the surface you further increase hardware load capacity and provide a solid bearing surface for the hardware. It also seals the substrate underneath, and is a stronger, longer lasting attachment than bonding the fasteners only. It is especially useful to mount hardware on curved, uneven or un-level surfaces.

1. Prepare the mounting surface and the hardware base for good adhesion (see *Surface Preparation*).
2. Wet out the oversized hole with epoxy. Allow the epoxy to soak into the exposed substrate (as with faster bonding).
3. Coat the bottom contact surface of the hardware with unthickened epoxy. Wire brush or sand the wet epoxy into the surface with 50-grit sandpaper.
4. Inject a non-sagging epoxy/404 or 406 mixture into the hole. Use enough mixture so there are no voids in the hole after inserting the fastener. Coat the bottom of the hardware and the fastener threads with thickened epoxy (Figure 17).
5. Place the hardware in position. Insert and tighten fasteners until a small amount of the mixture squeezes out of the joint (Figure 18).
6. Remove excess epoxy or shape into a fillet. Allow the epoxy to cure at least 24 hours before applying load to the hardware. Allow more time in cool weather.

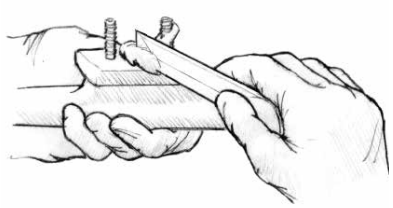


Figure 17 Coat the hardware bottom and the fastener threads with thickened epoxy.

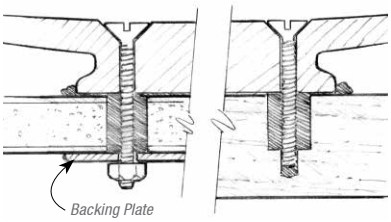


Figure 18 Tighten fasteners until a small amount of epoxy squeezes from the joint.

Casting a Base

Use the thickened epoxy to cast a base under the hardware when mounting hardware to a curved or uneven surface, or mounting hardware at an angle to the surface.

1. Prepare the fasteners, holes, substrate and base as described above.
2. Bond small blocks to the substrate to support the base at the desired height and position (e.g., winch base, Figure 19-a).
3. Apply enough thickened epoxy to cover the blocks. If the gap between the base and the surface is over ½", fill the gap in two separate layers to avoid exotherm.
4. Place the hardware in position, resting on the blocks (Figure 19-b) and install the fasteners.
5. Smooth the excess epoxy into the desired fillet shape around the base (Figure 19-c). Allow the epoxy to cure fully before loading. Protect exposed epoxy from UV.

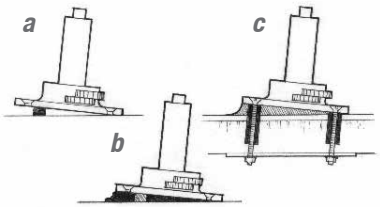


Figure 19 Support the base in position with blocking. Fill the void with thickened epoxy.

Bonding Studs

Bond threaded rods or studs into the substrate (instead of bolts or screws) and attach the hardware with nuts. This variation is appropriate for many engine, motor or machine installations. Coat the base with wax/mold release to make the hardware removable. Although the hardware is not "bonded" to the substrate, the epoxy will still provide a bearing surface that perfectly matches and supports the base of the hardware.

1. Prepare the stud/threaded rod by waxing the upper end (above the surface) and cleaning the lower end (below the surface). Place a nut on the stud, positioned with the top of the nut slightly above the surface.
2. Fill the hole $^{2}/_{3}$ full with epoxy. Allow to penetrate and refill as necessary.
3. Wet out the lower end of the stud and push it into the epoxy filled hole. Top off the hole or clean away excess as necessary. Allow the epoxy to cure thoroughly before attaching hardware and tightening the nut (Figure 20).

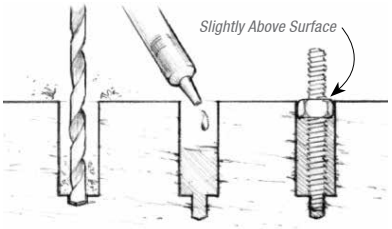


Figure 20 Bond threaded rods or studs into the substrate as an alternative for easily removable hardware.

Removing Fasteners

If you know that you will want to remove the fastener, you can coat the threads with wax or mold release (contaminating the surface enough to prevent a good bond).

Remove a permanently bonded fastener by applying heat to the head of the fastener with a soldering iron or propane torch. Use a heat shield to protect the surrounding area. Heat will travel down the fastener, softening the epoxy in contact with it. At about 250°F the epoxy should soften enough to allow the fastener to be backed out. Allow more time for heat to travel down longer or larger diameter fasteners.

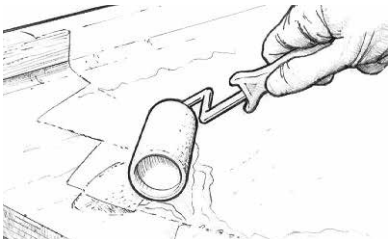


Figure 21 Wet out porous surfaces before applying fairing compound.

Figure 22 Apply fairing compound to fill all voids and smooth to shape.

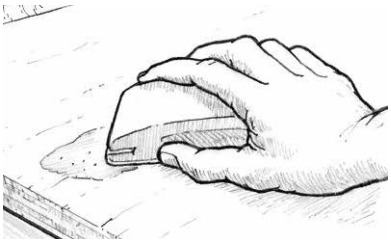


Figure 23 Sand cured fairing compound to desired contour.

Fairing

Fairing refers to the filling of low areas and the shaping and smoothing of a surface to blend with the surrounding areas and appear "fair" to the eye and touch. After major structural assembly has been completed, final fairing can be easily accomplished with West System Epoxy and low-density fillers.

1. Prepare the surface as you would for bonding (see *Surface Preparation*). Sand smooth any bumps or ridges on the surface and remove all dust from the area to be faired.
2. Wet out porous surfaces with unthickened epoxy (Figure 21).
3. Mix resin/hardener and 407 Low-Density or 410 Microlight® filler to a peanut butter consistency. The thicker the mixture, the easier it will be to sand when cured.
4. Trowel on the thickened epoxy mixture with a plastic spreader, working it into all voids and depressions. Smooth the mixture to the desired shape, leaving the mixture slightly higher than the surrounding area (Figure 22). Remove any excess thickened epoxy before it cures. If the voids you are filling are over ½" deep, apply the mixture in several applications or use 206 Slow Hardener® or 209 Extra Slow Hardener™, depending on ambient temperature.

   Note: On vertical and overhead surfaces, allow the wet-out coat to gel before applying fairing compound. The fairing compound may sag or slide off the fresh wet-out coat. Apply the fairing compound while the wet-out is still tacky.
5. Allow the final thickened epoxy application to cure thoroughly.
6. Sand the fairing material to blend with the surrounding contour (Figure 23). Begin with 50-grit sandpaper if you have a lot of fairing material to remove. Use 80-grit paper on the appropriate sanding block when you are close to the final contour. CAUTION! Don't forget your dust mask. Remove the sanding dust and fill any remaining voids following the same procedure.
7. Apply several coats of resin/hardener to the area with a disposable brush or roller after you are satisfied with the fairness. Allow the final coat to cure thoroughly before final sanding and finishing. Note: 410 Microlight filler can be affected by the solvents in most paints. Surfaces faired with 410 filler must be sealed with epoxy before applying any solvented paints.

Applying Woven Cloth and Tape

Fiberglass cloth is applied to surfaces to provide reinforcement and/or abrasion resistance. It is usually applied after fairing and shaping are completed, and before the final coating operation. It is also applied in multiple layers and in combination with other materials to build composite parts.

Fiberglass cloth may be applied to surfaces by either of two methods. The "dry" method refers to applying the cloth over a dry surface. The "wet" method refers to applying the

cloth to an epoxy-coated surface often after the wet-out coat becomes tacky, which helps it cling to vertical or overhead surfaces. Since this method makes it more difficult to position the cloth, the dry method is the preferred method especially with thinner cloth.

Dry Method

1. Prepare the surface as you would for bonding (see *Surface Preparation*).
2. Position the cloth over the surface and cut it several inches larger on all sides. If the surface area you are covering is larger than the cloth size, allow multiple pieces to overlap by approximately two inches. On sloped or vertical surfaces, hold the cloth in place with masking or duct tape, or with staples.
3. Mix a small quantity of epoxy (three or four pumps each of resin and hardener).
4. Pour a small pool of resin/hardener near the center of the cloth.
5. Spread the epoxy over the cloth surface with a plastic spreader, working the epoxy gently from the pool into the dry areas (Figure 24). Use a foam roller or brush to wet out fabric on vertical surfaces. Properly wet out fabric is transparent. White areas indicate dry fabric. If you are applying the cloth over a porous surface, be sure to leave enough epoxy to be absorbed by both the cloth and the surface below it. Try to limit the amount of squeegeeing you do. The more you "work" the wet surface, the more minute air bubbles are placed in suspension in the epoxy. This is especially important if you plan to use a clear finish. You may use a roller or brush to apply epoxy to horizontal as well as vertical surfaces.

   Smooth wrinkles and position the cloth as you work your way to the edges. Check for dry areas (especially over porous surfaces) and re-wet them with epoxy as necessary before proceeding to the next step. If you have to cut a pleat or notch in the cloth to lay it flat on a compound curve or corner, make the cut with a pair of sharp scissors and overlap the edges for now.
6. Squeegee away excess epoxy before the first batch begins to gel (Figure 25). Slowly drag the spreader over the fabric at a low (almost flat) angle, using even-pressured, overlapping strokes. Use enough pressure to remove excess epoxy that would allow the cloth to float off the surface, but not enough pressure to create dry spots. Excess epoxy appears as a shiny area, while a properly wet-out surface appears evenly transparent, with a smooth, cloth texture. Later coats of epoxy will fill the weave of the cloth.
7. Trim the excess (Figure 26) and overlapped cloth after the epoxy has reached its initial cure. The cloth will cut easily with a sharp utility knife. Trim overlapped cloth, if desired, as follows:

   a) Place a metal straightedge on top of and midway between the two overlapped edges.

   b) Cut through both layers of cloth with a sharp utility knife (Figure 27), being very careful not to cut too deeply.

   c) Remove the topmost trimming and then lift the opposite cut edge to remove the overlapped trimming (Figure 28). d) Re-wet the underside of the raised edge with epoxy and smooth into place.

   The result should be a near perfect butt joint, eliminating double cloth thickness. A lapped joint is stronger than a butt joint, so if appearance is not important, you may want to leave the overlap and fair in the unevenness after coating.
8. Coat the surface to fill the weave before the wet-out becomes tack free (Figure 29). Follow the procedures for final coating in the next section. It will take two or three coats to completely fill the weave of the cloth and provide a thick enough coating to allow for a final sanding that will not affect the cloth.

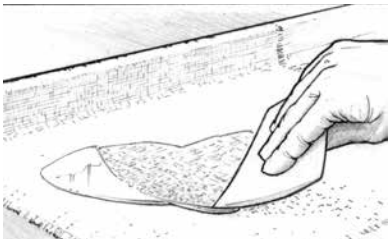


Figure 24 Spread the epoxy over the cloth surface with a plastic spreader.

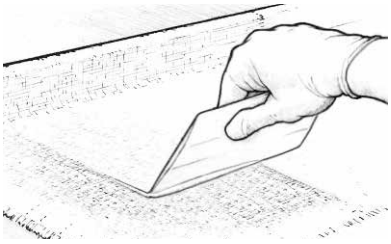


Figure 25 Squeegee away excess epoxy before it begins to gel.

Figure 26 Trim excess cloth after the epoxy gels.

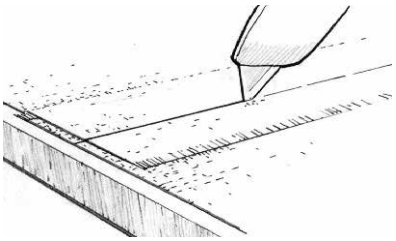


Figure 27 Trim overlapped cloth after the epoxy gels.

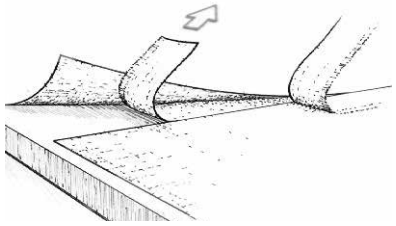


Figure 28 Remove the topmost trimming, lift the opposite cut edge to remove the overlapped trimming.

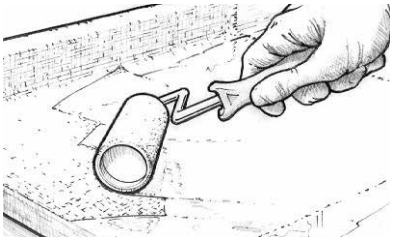


Figure 29 Coat the surface to fill the weave before the wet-out becomes tack free.

A variation of this method is to apply the fabric after a wet out coat has cured thoroughly and the surface has been prepared for bonding. This method assures a thorough wet out of the substrate and fabric, and the fabric can still be positioned easily while it is being wet out.

Wet Method

An alternative is to apply the fabric or tape to a surface coated with wet epoxy. As mentioned, this is not the preferred method, especially with large pieces of cloth, because of the difficulty removing wrinkles or adjusting the position of the cloth as it is being wet out. However, you may come across situations, such as applying fabric on vertical or overhead surfaces, when this method may be useful or necessary.

1. Prepare the surface for bonding (see *Surface Preparation*). Pre-fit and trim the cloth to size. Roll the cloth neatly so that it may be conveniently rolled back into position later.
2. Roll a heavy coat of epoxy on the surface.
3. Unroll the glass cloth over the wet epoxy and position it. Surface tension will hold most cloth in position. If you are applying the cloth vertically or overhead, you may want to thicken the epoxy slightly with 406 filler, then wait until it becomes sticky. Work out wrinkles by lifting the edge of the cloth and smoothing from the center with your gloved hand or a plastic spreader.
4. Apply a second coat of epoxy with a foam roller. Apply enough epoxy to thoroughly wet out the cloth.
5. Remove the excess epoxy with a plastic spreader, using long overlapping strokes. The cloth should appear consistently transparent with a smooth cloth texture.
6. Follow steps 7 and 8 under the Dry method to finish the procedure.

   Any remaining irregularities or transitions between cloth and substrate can be faired by using an epoxy/filler fairing compound if the surface is to be painted. Any additional fairing done after the final coating should receive several additional coats over the faired area.

Barrier Coating

The object of barrier coating is to build up an epoxy coating that provides an effective moisture barrier and a smooth base for final finishing.

Apply a minimum of two coats of West System Epoxy for an effective moisture barrier—three coats if sanding is to be done (recommended for most wooden boats). Moisture protection will increase with additional coats, up to six coats or about a 20 mil thickness. Six coats, with 422 Barrier Coat Additive™ in the final five coats, provides maximum moisture protection (recommended for polyester fiberglass boats with gelcoat blisters). Additives or pigments should not be added to the first coat. Mixing thinners with West System Epoxy is not recommended (see *Thinning Epoxy*).

West System 800 Roller Covers, allow you greater control over film thickness, are less likely to cause the epoxy to exotherm and leave less stipple than thicker roller covers. Cut the covers into narrower widths to reach difficult areas or for long narrow surfaces like stringers. A paint brush can be used for smaller areas, if the bristles are stiff enough to spread the epoxy to an even film. If necessary, cut the bristles shorter. Foam brushes are generally too flexible.

Epoxy applied with the 800 Roller Cover at room temperature (70°F), and tipped off as described, results in a film 3–4 mils thick. A 6 or 7 mil film thickness (two coats—three coats if sanded) provides an excellent moisture barrier for most exterior surfaces. A 9 or 10 mil film thickness is the minimum recommended for hull bottoms or other surfaces

that are continuously wet. Additional coats provide additional moisture protection up to 20 mils (five or six coats). Epoxy film thickness per coat will vary with temperature—thinner in warm temperatures, thicker in cooler temperatures.

Six coats with the last five modified with 422 Barrier Coat Additive provide maximum protection and are generally recommended only for polyester fiberglass hull bottoms prone to gelcoat blistering.

Complete all fairing and cloth application before beginning the final coating. Allow the temperature of porous surfaces to stabilize before coating. Otherwise, as the material warms up, air within the porous substrate may expand and pass from the material (out-gassing) through the coating and leave bubbles in the cured coating.

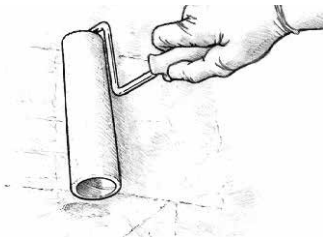


Figure 30 Roll lightly and randomly over a small area. Spread the epoxy into a thin even film.

Figure 31 Tip off the coating by dragging a foam roller brush lightly over the fresh epoxy.

1. Prepare the surface for bonding (see *Surface Preparation*).
2. Mix only as much resin/hardener as you can apply during the open time of the mixture. Pour the mixture into a roller pan as soon as it is mixed thoroughly.
3. Load the roller with a moderate amount of the epoxy mixture. Roll the excess out on the ramp part of the roller pan to get a uniform coating on the roller.
4. Roll lightly and randomly over an area approximately 2'×2' to transfer the epoxy evenly over the area (Figure 30).
5. As the roller dries out, increase pressure enough to spread the epoxy into a thin even film. Increase the coverage area if necessary to spread the film more thinly and evenly. The thinner the film, the easier it is to keep it even and avoid runs or sags in each coat.
6. Finish the area with long, light, even strokes to reduce roller marks. Overlap the previously coated area to blend both areas together.
7. Coat as many of these small working areas as you can with each batch. If a batch begins to thicken before it can be applied, discard it and mix a fresh, smaller batch.
8. Tip off the coating by dragging a foam roller brush lightly over the fresh epoxy in long, even, overlapping strokes after each batch is applied. Use enough pressure to smooth the stipple, but not enough to remove any of the coating (Figure 31). Alternate the direction in which each coat is tipped off, 1st coat vertical, 2nd coat horizontal, 3rd coat vertical, etc. An 800 Roller Cover can be cut into segments to make a tipping brushes.

Re-coating

Apply second and subsequent coats of epoxy following the same procedures. Re-coat when the previous coat is still tacky (about as tacky as masking tape). To avoid sanding between coats, apply all of the coats when previous coats have cured to this tacky stage. After the final coat has cured, wash and sand it to prepare for the final finish (see *Surface Preparation—Cured Epoxy*.)

Final Surface Preparation

Proper finishing techniques will not only add beauty to your efforts, but will also protect your work from ultraviolet light, which will break down epoxy over time. The most common methods of finishing are painting or varnishing. These coating systems protect the epoxy from ultraviolet light and require proper preparation of the surface before application. Preparation for the final finish is just as important as it is for re-coating with epoxy. The surface must first be clean, dry and sanded.

1. Allow the final epoxy coat to cure thoroughly.
2. Wash the surface with a Scotch-brite™ pad and water to remove amine blush. Dry with paper towels.

Figure 32 Sand to a smooth finish.

Figure 33 Rinse the surface with fresh water after sanding.

3. Sand to a smooth finish (Figure 32). If there are runs or sags, begin sanding with 80-grit paper to remove the highest areas. Sand until the surface feels and looks fair. Complete sanding with the appropriate grit for the type of coating to be applied—check coating instructions. Paint adhesion relies on the mechanical grip of the paint keying into the sanding scratches in the epoxy's surface. If a high-build or filling primer is to be applied, 80–100 grit is usually sufficient. 120–180 grit may be adequate for primers and high-solids coatings. Finishing with 220–400 grit paper will result in a high-gloss finish for most paints or varnishes. Grits finer than this may not provide enough tooth for good adhesion. Wet sanding is preferred by many people because it reduces sanding dust and it will allow you to skip Step 2. **See coating manufacturer's instructions for proper surface preparation.**
4. After you are satisfied with the texture and fairness of the surface, rinse the surface with fresh water (Figure 33). Rinse water should sheet evenly without beading or fish-eyeing. If rinse water beads up (a sign of contamination), wipe the area with solvent and dry with a paper towel, then wet sand again until beading is eliminated.

   Proceed with your final coating after the surface has dried thoroughly. To reduce the possibility of contamination, it is a good idea to begin coating within 24 hours of the final sanding. **See coating manufacturer's instructions for proper surface preparation.** A good trick used by professionals is to make a test panel to evaluate the degree of surface preparation required and the compatibility of the finish system.

Finish Coatings

Coating Function

A finish coating—paint or varnish—over an epoxy barrier coat protects the epoxy from sunlight as well as decorating the surface. In doing so, the finish coating extends the life of the epoxy moisture barrier, which in turn, provides a stable base that extends the life of the finish coating. Together, the two form a protective system far more durable than either coating by itself.

Protection from sunlight is a primary consideration in the selection of a finish coating. Long term UV protection of the barrier coat depends on how well the finish coating itself resists UV and keeps its pigments, or its shield of UV filters on the surface of the epoxy barrier coat. A high gloss finish reflects a higher proportion of the light hitting the surface than a dull surface. All other things being equal, a white (especially a glossy white) coating will last the longest.

Coating Compatibility

Most types of coatings are compatible with epoxy. Thoroughly cured epoxy is an almost completely inert hard plastic. Most paint solvents will not soften, swell or react with it.

One-part polyurethanes and polyester gelcoat can be affected by epoxy amines and if used must be applied when the epoxy is thoroughly cured, generally after two weeks at room temperature. A thorough cure can be achieved much quicker with elevated temperature post curing. Post curing will also improve epoxy's thermal properties and is recommended if dark paint is to be applied over epoxy.

Finish Coating Types

Latex paints are largely compatible with epoxy, even partially cured epoxy, and they do an adequate job of protecting the epoxy barrier from UV radiation. In many architectural applications, a latex paint may be the most suitable coating to use. Their durability is limited.

Alkyd finishes—enamel, alkyd enamel, marine enamel, acrylic enamel, alkyd modified epoxy, traditional varnish and spar varnish—offer ease of application, low cost, low toxicity, and easy availability. Their disadvantages are low UV resistance and low abrasion resistance. Make a test panel to ensure compatibility.

One-part polyurethanes offer easy application, cleanup and better properties than alkyds. They are also more expensive and some may be incompatible with amine cure epoxy systems such as West System Epoxy, although 207 Hardener may offer better compatibility. Be sure epoxy has cured thoroughly. Make a test panel to ensure compatibility.

Epoxy paints are available in one-part and two-part versions. Two-part epoxies offer many characteristics similar to the higher performance polyurethanes. They are durable and chemical resistant, but offer limited UV protection compared to the linear polyurethanes. Make a test panel to ensure compatibility.

Two-part linear polyurethane (LP) paints offer the most durable protection available. LPs are available as pigmented or clear coatings and offer excellent UV protection, gloss retention, abrasion resistance, plus compatibility with epoxy. However, compared to other types of coatings, they are expensive, require more skill to apply and present a greater health hazard, especially when sprayed. Make a test panel to ensure compatibility.

Bottom paints are available in a variety of formulations. Most bottom paint systems are compatible with epoxy and can be applied directly over a prepared epoxy barrier coat. If you are unsure of compatibility or have curing or adhesion problems with a specific bottom paint, use only a primer recommended for that bottom paint over the barrier coat. Follow the recommendations given for preparation of fiberglass surfaces. Other paints, including marine LP's and primers, are not recommended for use below the waterline.

Primers are usually not needed to help a paint film bond to epoxy, although interfacing primers may be required with some specialized bottom paints and high-build primers are useful for hiding scratches or flaws in the substrate. If the instructions on your paint or varnish recommend a specially primed surface, follow the recommendations given for fiberglass preparation. Self-etching primers do not work well on an epoxy coating because of epoxy's chemical resistance. Make a test panel to ensure compatibility.

Polyester gelcoat is a pigmented version of the resin used to build fiberglass boats and other products. Gelcoat is sprayed into a mold before the glass fabric and resin are applied to provide a smooth pre-finished surface when the part is removed from the mold. It is not often used as a post-production finish coating, **but it can be applied over epoxy** and is useful in some repair situations. Epoxy must be cured thoroughly. Refer to 002-550 Fiberglass Boat Repair & Maintenance, for detailed information on patching gelcoat over an epoxy repair.

Follow all instructions from the coating systems manufacturer. It is a good idea to make a test panel to evaluate the degree of surface preparation required, and the compatibility and handling characteristics of the finish system.

Problem Solver

This guide is designed to help identify and prevent potential problems you may encounter using WEST SYSTEM Epoxy. If the solutions described here do not resolve the problem, call the Gougeon Brothers technical staff, 866-937-8797.

The epoxy mixture has not cured after the recommended cure time has passed.

POSSIBLE CAUSES	Off ratio—too much or too little hardener will affect the cure time and thoroughness of the cure.	SOLUTION	1. Remove epoxy. Do not apply additional material over non-curing epoxy. See Removing epoxy, page 22. 2. Check correct number of pump strokes—use equal strokes of resin and hardener. DO NOT add extra hardener for faster cure! 3. Check for correct pump (5:1 or 3:1 ratio). 4. Check pump metering ratio (see pump instructions). See Dispensing, page 25.
	Low temperature—epoxy mixtures cure slower at low temperatures.		1. Allow extra curing time in cool weather. 2. Apply heat to maintain the chemical reaction and speed the cure. Raise the temperature above the hardener's minimum recommended cure temperature. (NOTE! Unvented kerosene or propane heaters can inhibit the cure of epoxy and contaminate epoxy surfaces.) 3. Use a faster hardener, designed to cure at lower temperatures. See Controlling Cure Time, page 24.
	Insufficient mixing.		1. Remove epoxy. Do not apply additional material over non-curing epoxy. See Removing Epoxy, page 22. 2. Mix resin and hardener together **thoroughly** to avoid resin rich and hardener rich areas. 3. Add fillers or additives after resin and hardener have been thoroughly mixed. See Mixing, page 25.
	Incorrect products.		1. Remove epoxy. Do not apply additional material over non-curing epoxy. See Removing epoxy, page 22. 2. Check for proper resin and hardener. Resin will not cure properly with other brands of hardener or with polyester catalysts.

Bond Failure

POSSIBLE CAUSES	Insufficient cure.	SOLUTION	See above.
	Resin starved joint-epoxy has wicked into porous surfaces leaving a void at the joint.		Wet out bonding surfaces before applying thickened epoxy. Re-wet very porous surfaces and end grain. See Two-step Bonding, page 30.
	Contaminated bonding surface.		Clean and sand the surface following the procedure on page 28. Sand wood surfaces after planing or joining.
	Bonding area too small for the load on the joint.		Increase bonding area by adding fillets, bonded fasteners or scarf joints.
	Too much clamping pressure squeezed epoxy out of the joint.		Use just enough clamping pressure to squeeze a small amount of epoxy from the joint. See Clamping, page 30.

Clear coating turned cloudy.

POSSIBLE CAUSES	Moisture from condensation or very humid conditions reacts with components in uncured hardener.	SOLUTION	1. Apply moderate heat to partially cured coating to remove moisture and complete cure. See out-gassing caution, page 23. 2. Use 207 Special Clear Hardener for clear coating applications and for bonding thin veneers where epoxy may bleed through to the surface.
	Entrapped air from aggressive roller application.		1. Apply coating at warmer temperature—epoxy is thinner at warmer temperatures. 2. Apply epoxy in thin coats. 3. Apply moderate heat to release trapped air and complete cure. See Caution, page 23.

Waxy film appears on surface of cured epoxy.

CAUS.	Amine blush formation is a typical result of the curing process.	SOLU.	1. Blush is water soluble. Remove with water. See Special preparation—Cured Epoxy, page 28. 2. Use 207 Special Clear Hardener. 207 Hardener is blush free.

Runs or sags in coating.

POSSIBLE CAUSES	Epoxy applied too thickly.	SOLUTION	1. Use 800 Roller Covers and roll the coating out into a thinner film. A thin film will flow out much smoother than a thicker film after it is tipped off with the foam roller brush. 2. Warm the epoxy to thin it or apply the coating at a warmer temperature. See Barrier Coating, page 36.
	Coating curing too slowly.		1. Apply the coating at a warmer temperature. 2. Warm the resin and hardener before mixing to speed the cure in cool weather. 3. Switch to a faster hardener if possible. See Controlling Cure Time, page 24.

Fairing Compound (epoxy/407 or 410 mixture) sags and is difficult to sand.

CAUS.	Fairing material not thick enough.	SOLU.	Add more filler to the mixture until it reaches a “peanut butter” consistency—the more filler added, the stiffer and easier it will be to sand.

Thick fairing compound (epoxy/407 or 410 mixture) sags.

CAUS.	Fresh epoxy wet-out won’t support weight of fairing.	SOLU.	Allow the wet-out coat to gel before applying the fairing material to vertical surfaces. See Fairing, page 34.

Paint, varnish or gelcoat will not set up over epoxy.

POSSIBLE CAUSES	Epoxy not completely cured.	SOLUTION	Allow the final epoxy coat to cure thoroughly. Allow several days if necessary for slow hardeners at cooler temperatures. Apply moderate heat to complete the cure if necessary. See Controlling Cure Time, page 24.
	Coating incompatible with epoxy.		1. Use a different type of paint. Some paints and varnishes may be incompatible with some hardeners. If unsure, test for compatibility on a coated piece of scrap material. 2. Use 207 Hardener. It is compatible with most paints and varnishes.
	Epoxy surface not thoroughly prepared.		Remove the amine blush and sand the surface thoroughly before applying paints or varnishes. See Final Surface Preparation, page 37.

Epoxy became very hot and cured too quickly.

POSSIBLE CAUSES	Batch too large, or left in mixing pot too long.	SOLUTION	1. Mix smaller batches. 2. Transfer the mixture to a container with more surface area,such as a paint roller tray, immediately after mixing. See Controlling Cure Time, page 24, Dispensing and Mixing, page 25.
	Temperature too warm for the hardener.		Use 206 Slow or 209 Extra Slow Hardener in very warm weather.
	Application too thick.		Apply thick areas of fill in several thin layers.

Bubbles formed in coating over porous material (bare wood or foam).

CAUSES	Air trapped in the material escapes through coating (out-gassing) as the material’s temperature is rising.	SOLUTION	1. Coat the wood as its temperature is dropping—after warming the wood with heaters or during the later part of the day. 2. Apply a thinner coat, allowing air to escape easier. 3. Tip off the coating with a roller cover brush to break bubbles. See Caution, page 23.

Pinholes appear in epoxy coating over abraded fiberglass or epoxy.

CAUSES	Surface tension causes epoxy film to pull away from pinhole before it gels.	SOLU.	After applying epoxy with an 800 Roller Cover, force epoxy into pinholes with a stiff plastic or metal spreader held at a low or nearly flat angle. Re-coat and tip off coating after all pinholes are filled.

Fish-eyeing in coating

CAUSES	Contamination of the coating or surface or improper abrasion for the coating.	SOLUTION	1. Be sure mixing equipment is clean. Avoid waxed mixing containers. 2. Be sure surface is properly prepared. Use proper grit sandpaper for the type of coating you are applying. (See coating manufacturer’s instructions for proper surface preparation.) After surface is prepared, avoid contamination—fingerprints, exhaust fumes, rags with fabric softener (silicone). Coat within hours of preparation. After wet sanding, rinse water should sheet without beading (beading indicates contamination). Wipe with appropriate solvent and re-rinse until rinse water no longer beads.

Hardener has turned red after several years storage.

CAUS.	Moisture in contact with hardener and metal container.	SOLU.	Red color is a normal condition. It will not affect epoxy handling or cured strength. Avoid using hardener for clear coating or exposed areas where color is not desired.

Your only limit is your imagination...

Portola - Greg Hatten

Adagio

Drums - Tom Pawlak

16' Runabout - Bill Beran

FIBERwave Pavilion - IIT Architecture Students

Rebel - Nelson Niederer

Pedal Car - Tuscola Technology Center Students

PT Spear Dinghy - Russle Brown

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