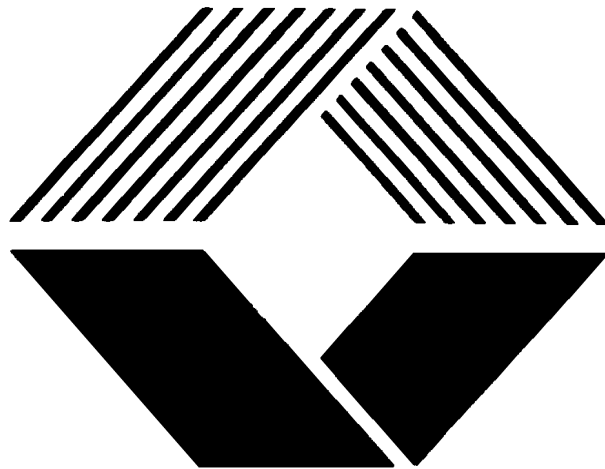


# Joining and Bonding Procedures For Resin Based FRP Equipment



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## **Introduction**

The bonding of FRP ductwork is a process requiring some degree of skill, which can readily be acquired by practicing the following recommended procedures. The methods described here can be applied to the bonding, welding, joining or repair of duct components supplied by Viron.

Installation of the Viron supplied ductwork should be performed in accordance with NBS PS 15-69 and these procedures. Note that customer specifications may over ride these procedures and should be consulted.

## **Recommended Tools**

### *Sanding and Cutting Tools*

1. Coarse rasp and file
2. Power disc sander with 24 grit paper
3. Carbide grit cutting wheel
4. Saber saw with carbide grit tipped cutting blades.

### *Bonding Tools*

1. Premium grade vinylester or polyester promoted resin
2. MEKP Catalyst
3. Glass fiber reinforcing material; 1 – ½ oz. Chopped strand mat, surfacing veil and 24 oz. Woven roving if specified.
4. Acetone
5. An assortment of stiff bristle paint brushes from 4 to 6 inches in width
6. Cans for soaking tools in acetone after use
7. Serrated aluminum rollers. One half inch diameter is recommended, smaller diameters for more intricate work. Roller length should be between 3 to 6 inches.
8. Utility knife or Scissors for cutting mat, veil, and roving
9. Plastic measuring graduate for MEKP catalyst
10. Paper cups and half gallon plastic containers for mixing resin
11. Wooden or plastic paint sticks for mixing resin
12. Rubber gloves, safety glasses, respirators, and dust masks designed for FRP work. All safety materials used should meet OSHA regulatory standards.

## **Surface Preparation**

Thoroughly clean the area with a solvent agent of a brush to be joined to remove surface contamination.

All of the surface area to be covered with fiberglass reinforcement and resin must be thoroughly sanded and roughened with a power sander. Make sure the glossy resin finish is removed.

Thoroughly clean roughened areas with a brush. The surface must be dry.

Apply resin and fiberglass as soon as possible after preparation to prevent possible recontamination of the prepared area.

### **Mixing Resin**

Under no circumstance should the catalyst and promoter be mixed in the same container or poured into the resin at the same time. When mixed together, these two chemicals can react explosively.

Resin used for repairing or joining should be the same type as the resin used in the original equipment.

Weigh sufficient resin into a suitable container. (Avoid using more than one quart at a time.) Use this weight to determine the amount of promoter and/or catalyst.

Viron will supply pre-promoted resin whenever possible. However, if the resin is not promoted, measure the required amount of promoter into a clean 10cc graduate and mix well into the resin.

Measure the required amount of catalyst into a separate graduate and mix well into the promoted resin. See gel and cure data for vinyl ester resin included within this package.

The process is affected dramatically by application temperature, and extra care is required at temperatures below 40 degrees F to ensure adequate resin cure. High outdoor temperatures can also complicate joining and repair procedures by advancing the gelation and cure of the resins, leaving the operator with inadequate working time. We recommend that operators working under conditions of temperature extremes check the gelation and cure of a resin sample at the working temperature prior to starting any field joints.

### **Hardening or Cure**

Resin must be allowed to harden or cure. The time to cure will vary according to weather conditions, temperatures and exact amount of promoter and/or catalyst used.

An external heat source such as an infrared heat lamp will decrease hardening time and may be a necessity in cold weather. Generally, work should not be done at temperatures below 55 degrees Fahrenheit unless an outside source of heat is applied. Since most resins are FLAMMABLE liquids, external heat sources should be used with caution.

Care must be exercised when using an external heat source to prevent overheating which can cause cracking and/or crazing or discoloration.

Acetone lightly rubbed onto the exposed resin surface will determine if the system is adequately cured. If surface softens or becomes tacky, an external heat source can be applied to fully cure the resin. If surface does not cure, the entire bond process must be repeated.

A Barcol Hardness tester can be used to determine if the system is cured adequately. A minimum Barcol of 35 indicates adequate cure for most resins. Consult resin data sheets for additional information.

## **Joining Duct**

### *Preparation of Duct*

Cut duct to desired length making sure that the ends are squared and butt closely together. Roughen edges and prepare surface as previously described. Support the duct parts to be joined using a jig to insure no movement occurs during assembly or curing.

### *Joining*

Coat all roughened edges with resin mix, completely filling the joint and slightly squeezing the sections together. It may be preferable to add fumed silica to resin for this step to produce a paste or light putty which will fill small voids 1/8" or less and irregularities in the joint. It is often required by 1 to 2 cc per pound.

Butted sections may be "hot-patched" together to hold alignment until a complete joint can be made. A "hot-patch" consists of 2-3 square inches of fiberglass mat saturated with resin mix. Usually it is desirable to increase the cure rate of the resin by increasing the quantity of MEKP catalyst used by 1 to 2 cc per pound. Place the prepared "hot-patch" across the joint to be made to form a tack weld. Once the "hot-patches" begin to cure, a regular bonding procedure can be used to finish the joint.

### *Preparation of Strapping*

Table 1 should be used only as a guide for the minimum joint thickness. Joint thickness should be at least as thick as the duct to be joined.

Lay the first section of fiberglass mat on a flat surface, such as cardboard or smooth plastic sheet (PVC or Polypropylene). Wet the entire surface with resin mix, using brush and/or roller.

Position the second ply of fiberglass mat offsetting approximately 1" on the on the first layer.

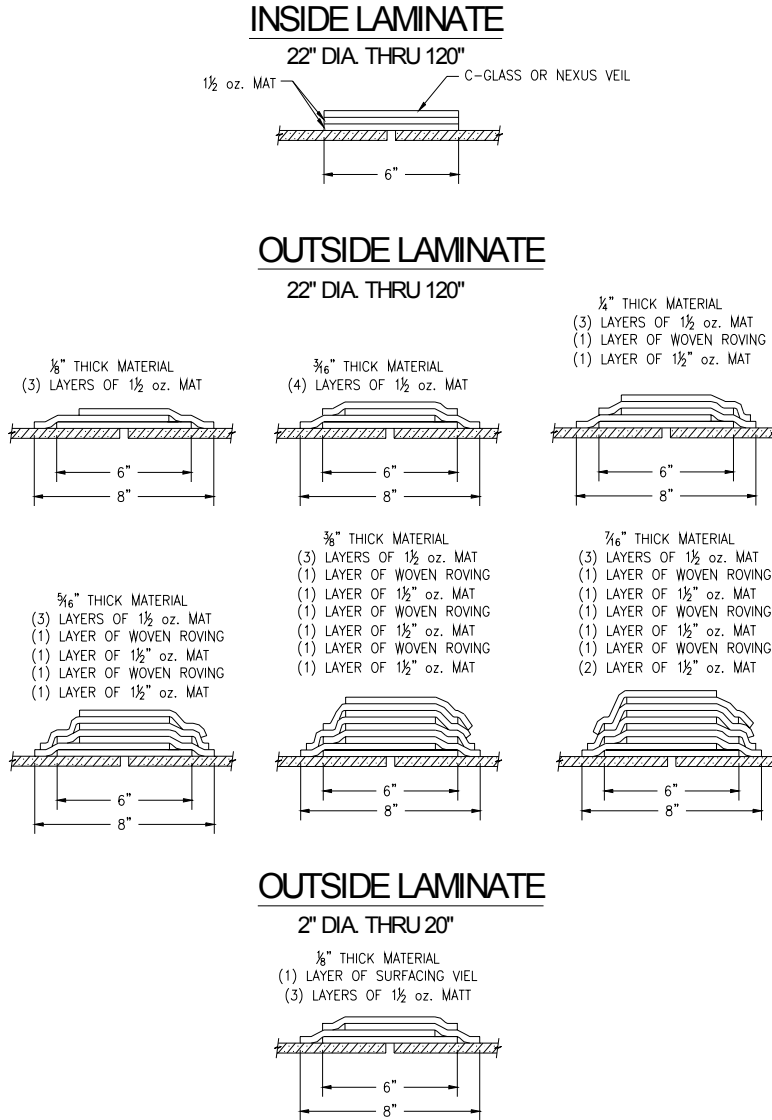
Wet out the layer with the resin mix. Remove as much air as possible with brush and/or roller moving toward the edges of the laminate section. Care must be exercised to avoid excessive pressure, which would remove too much resin from the laminate, in turn hindering the cure and strength of the joint.

Repeat with the proper sequence of fiberglass until all plies have been saturated with resin and formed into one integral unit (see Figure 1). On very thick or large diameter joints, it may be easier to saturate two or three plies of fiberglass with resin at a time. This technique helps to ensure removal of trapped air and facilitates application of the strapping.

For duct joints above 1/2" in thickness should be made in two lay-ups to prevent sag and overheating of the resin during curing. Where accessible, usually 22 inch diameter or

greater, the inside surface of the duct joint must be covered with 2 plies of fiberglass mat 6 inches wide and 1 ply of 6 inch wide surfacing veil saturated with resin.

**FIGURE 1**



**Table 1**

Nominal Thickness	Number and Sequence of Plies													Drafting Symbols
	Interior			Exterior										
in.	1	2	3	4	5	6	7	8	9	10	11	12	13	
0.125	M	M	V	M	M	M								3M
0.187	M	M	V	M	M	M	M							4M
0.250	M	M	V	M	M	M	R							3M,R,M
0.312	M	M	V	M	M	M	R	M	R	M				3M,R,M,R,M
0.375	M	M	V	M	M	M	R	M	R	M	R	M		3M,R,M,R,M,R,M
0.437	M	M	V	M	M	M	R	M	R	M	R	M	M	3M,R,M,R,M,R,2M

**NOTES:**

1 Nominal thickness is calculated as follows:

V = 10 mil surface veil - 0.010 in./ply

M = 1-1/2 oz/ft<sup>2</sup> mat - 0.043 in./ply

R = 24 oz/yd<sup>2</sup> woven roving - 0.033 in./ply

2 The field bond should be applied three (3) layers at a time with a wrap length of 36 in.

*Application of Strapping*

Apply resin mix with brush and/or roller over all prepared areas of the joint. Take the entire strapping as prepared above. Make sure to center and position it properly over the butt seam. Wrap around the joint using an even forward pressure to form entire joint with offset ends overlapping smoothly. The releasing film, if used, may be lifted with the strapping composite but must be removed before the next step.

Roll out as smooth as possible, blending the edges of the strapping into the pipe. Remove all wrinkles and entrapped air – rolling from the center of the joint to the outside edge. Additional resin may be applied to provide a resin-rich surface. Care must be taken to prevent the strapping from sagging at the bottom of the joint during hardening. On large diameter duct, it may be easier to saturate only a few fiberglass plies with resin at a time and to apply strapping in two, three or four sections around the circumference to complete the wrapped joint.

After the joint has hardened, a topcoat of resin mix should be applied to all interior laminates. For exterior laminates, a number of topcoat variations are available depending on duct construction specifications. Viron supplies in each bonding kit the topcoat specified to finish the joint. The major variations follow:

1. Tinted get coat with UV inhibitors. Viron supplies a tinted resin mixture to be brushed on each joint. The gel coat is a customer specified (or customer accepted) color tint mixture that contains UV stabilizers and is recommended for all outdoor installed ductwork. The gel coat matches the resin used in the duct construction and should be catalyzed as detailed in these bonding procedures. It can then be applied with a paintbrush and allowed to cure. A minimum 5 mil thickness of gel coat should be applied to each joint to ensure proper coverage.

2. Intumescent paint for ICBO low flame and smoke development. Viron supplies as intumescent paint that will meet ICBO specifications as a fire resistant coating. This special paint does not require catalyzation and can be applied just as a paint. The intumescent paint is white in color and cannot be used on exterior duct installations. It is recommended that the joint be completely cured and sanded with large grit paper prior to paint application to ensure good adhesion to the duct. A minimum 5 mil thickness of paint is required to ensure proper coverage in accordance with ICBO standards.
3. Wax coat. To minimize surface tackiness and air inhibition of cure, a wax topcoat resin may be specified to protect the surface from contact with air. A small amount of high-melting paraffin wax (140 – 150 degrees F melting point) is used in the final resin surface or topcoat. When using resin containing wax, a faster gel and cure system is recommended. Resin containing wax should not be used during build-up of laminate because adhesion of laminate layers will be retarded. Viron provides all tinted gel coats with wax premixed.

### **Bell and Spigot Bonds**

For a “slip joint” or “bell” fitted duct, the bonding area is prepared in the same manner as the butt jointed duct, except the portion of the duct that fits into the “bell housing” will have a larger prepared surface.

The two pieces of duct must be sanded on each side of the seam to a length specified in Table 1, as a minimum, for the thickness of the duct.

With the bonding surfaces prepared, the inside pipe surface should be coated with resin mix. Immediately after coating the slip end must be inserted into the bell fitting. The prepared surfaces will be sealed internally by the applied resin mix. The area or gap resulting from the overlap of the two duct pieces should be filled with a resin putty formulated by adding fumed silica to the resin.

After all gaps are filled, the entire overlapping area is coated with the resin mix and the joint is completed by applying straps as detailed above.

### **Repair of Interior and Exterior Surfaces**

The same procedures for joining duct pieces are generally applicable. Prepare the surface and apply resin mixtures as outlined above. Place first, smallest layer of fiberglass mat over area and saturate with resin using roller and/or a small brush. Make sure all entrained air is removed. Repeat with subsequent layers of fiberglass mat.

Each layer must be larger than the underlying layer by a minimum ½ inch all around. For the last layer of interior repairs, use one ply of a glass surface veil. Cover this with a topcoat. Exterior repairs should include a topcoat with UV inhibitors. Allow the repair to cure thoroughly prior to returning to service.

### **Repair of Holes, Leaks, Cracks, Etc.**

The contents must be drained and dried. Then plug and repair using new fiberglass stock or, for smaller holes, the “hot-patch” method described above can be utilized. The

surface must be prepared as described above. For large damaged area, it may be necessary to apply a temporary backing of sheet metal or cardboard with a release agent before proceeding with the repair.

### **Installation of Nozzles**

Follow general procedures detailed above. A generous filler of resin putty must be applied to all portions of pipe neck on both sides of the wall and allowed to harden. The lay-up procedures outlined above should be followed to complete the installation. It is recommended that each strap be cut to shape the connection for better adhesion. Interior surfaces must include a veil as the final layer, and exterior surfaces should be finished with an appropriate topcoat.

### **Clean-up**

All equipment should be cleaned immediately after use with a solvent like acetone or methylene chloride. Solvents can also be used to clean work areas or resin spills. Care should be taken in the safety of using these solvents.

### **General and Safety Information**

1. Serrated aluminum rollers are far superior to common paint rollers and should be used whenever possible.
2. Rapid dabbing with a stiff bristled brush can be used to remove entrapped air.
3. For maximum shelf life, store resin, promoter, catalyst, etc., separately at ambient room temperature. All materials and work performed should be done at 45 – 85 degrees F. temperature. Higher or lower temperatures will adversely affect the cure of the resin.
4. Do not smoke in the work area.
5. Safety glasses must be worn at all times.
6. Rubber or plastic gloves must be worn and protective hand creams are recommended, in addition to wearing gloves.
7. Workers should wash immediately after each job.
8. Ventilation must be adequate to maintain airborne concentrations of vapors below Threshold Limit Values (TLV). Consult Material Safety Data Sheets provided with each Viron bonding kit for additional safety precautions.
9. No joints should be made in the snow, rain or excessively high humidity.
10. Fiberglass reinforcement materials must be kept, and used, clean and dry.
11. All materials must be kept away from all ignition sources, sparks and open flames.

### **Troubleshooting**

*Poor Bond* – Check for surface cleanliness, contamination and preparation. Glass reinforcement must be dry. Resin, catalyst, promoter, or other additives must be fresh and uncontaminated.

*Air Bubbles or Blistering* – Check for improper rolling or too “hot” cure system.



White Blush – White cast or appearance after curing. Glass reinforcement may have contained moisture or the joint was made in a very humid environment. Surface resin may not have properly cured because of high humidity.

*Poor Glass Wet-Out* – Check for improper rolling. Resin may have been too thick or too thin (drainage).

*Tacky or Wet Resin* – Check for proper concentrations of catalyst and promoter. Check cure temperature. Check to see that wax was added to final laminate layer.

*Cracking and Crazing* – Check for proper concentrations of catalyst. Check work area temperature and thickness of lay-up.

*Hot Spots and Spotty Cure* – Check mixing procedures.

*Low Barcol Hardness Levels* – Check concentration of catalyst. Make sure resin and catalyst are fresh and uncontaminated. Check cure temperature.

# **APPENDIX**

1. Quick Reference Guide to Wet Lay-up Joint Instructions



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### WET LAY-UP JOINT INSTRUCTIONS

Thoroughly clean and sand the area to be joined. Using vinylester resin and fiberglass mat, the joint may be efficiently performed by applying a coat of resin to the duct ends; then place the mat on same and saturated with additional resin. If desired, the glass can be saturated before applying to the area to be joined. An aluminum roller may be used to spread resin evenly, making sure to work out the air pockets and leave no dry glass fibers exposed. Additional layers of mat may be added until sufficient build-up has been achieved. Care should be taken to catalyze only the amount of resin that can be used during the pot life of the resin (half-hour or less). A little experience will quickly determine the proper handling of the resin.

The rate of curing fiberglass products is dependent on temperature. At low temperatures, vinylester resins have a longer working life and require longer curing periods; working time is decreased and curing takes place more rapidly as the temperature increases. Decreasing the amount of catalyst prolongs working time.

The following table gives approximate pot life at various temperatures and catalyst proportions:

Amount Resin	Amount Catalyst	Ambient Temperature	Approximate Pot Life
1 quart	2/3 oz.	50 – 60° F	20 min.
1 quart	1/2 oz.	60 – 70° F	20 min.
1 quart	1/3 oz.	70 – 80° F	20 min.
1 quart	1/4 oz.	80 – 90° F	20 min.
1 quart	1/6 oz.	Over 90° F	20 min. or less

The catalyst should be carefully proportioned to the amount of resin to be used, and thoroughly mixed to a uniform blend. Duct joints should be allowed to cure at least 24 hours before being used.

If additional lamination is to be made over a cured area, the surface would be broken by sanding before application.

### **CLEAN UP**

Preferably acetone, or lacquer thinner may be used for cleaning tools and hands. Soap and hot water may be used, though not as effectively as acetone. Thorough clean up must be made before resin cures. Care should be exercised to keep catalyst and resin from contact with the skin. A hand cream applied before working with resin and after clean up is highly desirable.

### **KEEP AWAY FROM OPEN FLAME AND USE WITH ADEQUATE VENTILATION**

Viron International Corporation has no control over the conditions in which these materials may be handled, stored or applied. Therefore, Viron can offer no guarantees as to stability or performance.

