General Installation Specifications (GIS.E10)

FIBERBOND® Engineered Composite Piping Systems

Manufactured by
Future Pipe Industries, Inc. - Baton Rouge, LA, USA

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1.0 General

1.1 Intent

1.1.1 The intent of this installation specification is to establish recommendations for the receiving, handling, storage, installation, and testing of FIBERBOND® Engineered Composite Piping Systems. This specification is intended to be used as a reference document for those personnel involved in the installation of FIBERBOND® Engineered Composite Piping Systems.

1.2 Scope

1.2.1 This installation specification covers the receiving, handling, storage, installation, and testing of FIBERBOND® Engineered Composite Piping Systems. This includes the inspection of received goods, handling and storage requirements, erection, assembly, welding, certification of fitters and welders, repair procedures, quality assurance, systems testing, and safety.

2.0 Inspection of Delivered Goods

2.1 General

2.1.1 All components, spool assemblies, fabricated components, and sub-vendored items shall be inspected for compliance with the purchaser's and/or end user's requirements, as stated in the purchase order. In particular, quantities and sizes shall be verified.

2.1.2 If practical, all items shall be visually checked prior to removal from the carrier's transport (flatbed, container, etc.).

2.1.3 All crated or boxed components, and spool assemblies shall be checked for proper tagging.

2.2 Visual Inspection

2.2.1 All components, spool assemblies, fabricated components, and sub-vendored items shall be visually inspected for any damage that may have occurred during shipment. All exterior and accessible interior surfaces shall be visually inspected. Visual inspection shall include:

External surface damage such as cuts, penetrations, delaminations, crushing, impact crazing, and broken ends.

Damaged flanges.

Crazing (hairline cracks) of the liner.

Damage to skids, palettes, and/or crates, such as breakage, loose bolts, pulled nails, broken nails, broken straps, and displacement.

2.2.2 Any end / flange protection shall be temporarily removed to allow for visual inspection, if necessary.

2.2.3 All field weld kit materials (if purchased) shall be visually inspected, if practical. In any case, field weld kit materials shall be checked for proper packaging.

2.2.4 Any other loose materials shall be checked for proper packaging and, if practical, shall be visually inspected.

2.3 Evaluation

2.3.1 Any items that are not satisfactory to the purchaser and/or end user shall be so noted and will be subject to resolution with the manufacturer. Unsatisfactory items shall be reported immediately to the carrier's representative and shall be so noted on all paperwork.

2.3.2 It is recommended that photographs be taken of all items in their as-received condition, both prior to removal from the carrier's transport and after storage at the jobsite.

2.3.3 If damage is found prior to unloading from the carrier's transport, do not commence unloading until the carrier's representative has completed his/her inspection of the damaged items.

3.0 Handling and Storage

3.1 All products which are to be incorporated into the final product and the products themselves shall be identified properly.

3.2 The handling and storage functions shall be the responsibility of the installation contractor.

3.3 Resin

3.3.1 Resin shall be stored in a cool, dry place, as far away from all sources of heat as practical. In no case shall resins be exposed to sunlight for extended periods of time. The color of the resin drums shall be white to minimize the heat absorption from sunlight. Containers should remain sealed until usage to prevent moisture pickup and other contaminations. Once the container is opened for use, it must be closed after use to prevent contaminations.

3.3.2 For maximum shelf life, resins should be stored at temperatures below 100F (38c). Excursions are allowed above this temperature provided either the resin is non-promoted and is used within its specified shelf life or the resin is promoted and has at least a full month of shelf life remaining when it is used.

3.3.3 When resin is shipped, Material Safety Data Sheets (SDS or MSDS) must be provided with the shipment. The SDS shall be provided in weather resistant packaging. Personnel responsible for the storage of the resin shall keep the SDS available at all times. Personnel using the resins shall be familiar with the SDS and be able to refer to it when necessary.

3.3.4 Most resins are Class 3 flammable materials and shall be handled with the necessary precautions for these materials.

3.4 Glass Reinforcement

3.4.1 Glass reinforcement shall be stored away from water and any other contamination.

3.4.2 Glass reinforcements for field weld kits shall be packaged in weather resistant materials.

3.5 Curing Agents and Additives

3.5.1 Store all containers containing curing agents and additives away from heat, sparks, and open flames. Storage containers should remain sealed to prevent contamination. Once containers are opened for use, the containers should immediately be closed after use to eliminate contamination.

3.5.2 Most curing agents and additives should be stored at or below 100F (38c).

3.5.3 Catalysts shall be stored away from promoters and combustible materials. Catalysts and promoters shall never be mixed directly together as they can cause a violent reaction. Care shall be taken when handling catalysts and promoters in the same general area.

3.5.4 When curing agents and additives are shipped, Material Safety Data Sheets (SDS or MSDS) must be provided with the shipment. The SDS shall be provided in weather resistant packaging. Personnel responsible for the storage of curing agents and additives shall keep the SDS available at all times.

3.6 Components, Spool Assemblies, and Other Finished Products

3.6.1 Components, spool assemblies, and other finished products, once completed, shall be stored in a location where the parts shall not be subject to damage. Components, spool assemblies, and other finished products may be stored outside. All components, spool assemblies, and other finished products, shall be kept sealed for as long as practical to maintain cleanliness.

3.6.2 All surfaces of components, spool assemblies, and other finished products, both inside and out, must be free from foreign particles.

3.6.3 All loose components such as blind flanges, flanges, and other small diameter loose manufactured parts shall be crated or, if unable to crate, shall be shipped on palettes or in boxes. Additional parts such as nuts, bolts, gaskets, etc. shall be crated or boxed. All loose components must be secured.

3.6.4 All flange faces shall be protected with plywood, cardboard, or other suitable material. All plain ends of pipe shall also be protected. This protection shall not be removed during storage.

3.6.5 Metallic piping materials and other heavy objects should not be stacked on fiberglass pipe, spool assemblies, and components.

3.6.6 Pipe should be stacked gently and only in parallel positions. Pipe should never be rested on angles as this may create high stresses and crazing of the inner surface.

3.6.7 If piping is to be stored for long periods of time, soft wood dunnage of 3-inch width minimum should be used as stringers.

3.6.8 Loose fittings, flanges, and other components should remain in the palettes, crates, or boxes that they were shipped in until needed.

3.6.9 Components, spool assemblies, and other finished products should always be lifted; never rolled, dropped, or thrown.

3.6.10 Follow these general guidelines for determining to use cranes or to manually handle fiberglass pipe or spool assemblies. The use of forklifts is not recommended for handling of fiberglass pipe, spool assemblies, or components unless the part to be lifted is protected and properly supported.

3.6.10.1 All pipe lengths and spool assemblies larger than 12 inch in diameter should not be manually lifted. Some smaller diameter heavy wall piping may be too heavy for manually lifting as well. Cranes should be utilized for these pipe sizes.

3.6.10.2 All pipe, 6 inch to 12 inch in diameter, if lifted manually, should be lifted by at least two people.

3.6.10.3 One person should not lift any piping over 10 feet in length. The weight deflection may cause internal crazing.

3.6.10.4 When manually lifting fiberglass pipe, the weight of the pipe must be balanced to avoid excessive bending from deflection.

3.6.11 For pipe lengths, spool assemblies and other components that are too heavy or too awkward to be handled by personnel, lifting slings shall be used. Lifting slings shall be made of nylon or other similar material to prevent abrasion to the fiberglass.

3.6.12 Under no circumstances shall chains, wire, or clamps of any kind be used in the handling of fiberglass pipe, spool assemblies, or components.

3.6.13 When using lifting slings, always choke the pipe. Do not saddle the pipe.

3.6.14 When lifting spool assemblies, never use nozzles or flanges for lifting points. In addition, avoid other fittings and welds for lifting points.

3.6.15 If personnel have reason to enter large diameter pipe, fittings, or spool assemblies, soft – soled shoes shall be worn.

4.0 Required Materials and Tools for Field Welding

4.1 General

4.1.1 The listing below of required materials and tools is provided for use as a reference. This listing is not typical for all FRP field welding procedures and may deviate depending upon the particular installation. Reference should be made to the project documents for a specific listing of materials and tools required for field installation.

4.2 Materials

4.2.1 The following is a general list of the materials used for field welding fiberglass reinforced plastic. This list is not necessarily a complete list nor is it typical for all FRP field welding.

4.2.2 Glass Reinforcements

Chopped Strand Mat - 1.5 oz or 0.75 oz/sq ft chopped strand mat is matrix of short, randomly oriented chopped E-glass fibers. Chopped strand mat is used in the secondary corrosion barrier and structural cage of FRP welds.

Woven Roving - 24 oz/sq yd woven roving is a matrix of woven E-glass fibers. Woven roving is used in the structural cage of FRP welds.

Veil - a synthetic veil, such as Nexus manufactured by Burlington Industries, is a surfacing material used in the external corrosion barrier of FRP welds.

Milled Fiber - A milled fiber is normally added to putty.

4.2.3 Resins

The resin used in FRP welds varies according to the piping series specified or according to the custom design. Typically, for field weld kits, there is only one resin used, however, in some custom designs, there may be a dual laminate compose of two different resins.

4.2.4 Promoters

The promoter is typically Cobalt Naphthenate, or CoNap, a 6% solution of active cobalt in a solvent.

Note: Most resins shipped to the jobsite for use as field weld kits are pre-promoted and do not require additional promotion. The container of resin shall denote whether or not the resin is pre-promoted.

4.2.5 Catalysts

The catalyst is typically Methyl Ethyl Ketone Peroxide, or MEKP, a 9% active-oxygen solution of MEKP and a plasticizer. Two other catalysts, Benzoyl Peroxide, or BPO, and Cumene Hydroperoxide, or CHP, may be specified in a custom product.

4.2.6 Accelerators

The accelerator is typically N,N-Dimethylaniline, or DMA, an amine used to accelerate MEKP, BPO, and CHP cures.

4.2.7 Additives

Thixotropies - A thixotropic material, such as Aerosil 202 manufactured by the Degussa Corporation, is typically used as putty for tacking of welds. Tween 20, an nonionic surfactant manufactured by ICI America, may also be used for making putty.

UV Absorbers - A UV absorber, such as Tinuvin 326 manufactured by Geigy Chemical, is typically used in the external corrosion barrier of FRP welds.

Fire Retardant Additives - Some products require the addition of an antimony product or other type of additive for improved fire retardancy. This requirement would depend on the application and type of product used.

Retardants - In some rare cases, a gel time retardant can be added to the resin. This is normally required when the installation temperature is above normal (90F or higher). A typical gel time retardant is Union Carbide's 2,4-Pentanedione. Note that 2,4-P will not affect gel time when used with a BPO catalyst and DMA promoter.

4.2.8 External Coats

Top Coat - An epoxy paint topcoat is another form of pigmenting the piping system. A topcoat already has UV absorbers and wax solution added to it. When a topcoat is used, a separate wax solution or gel coat is not used.

4.2.9 Cleaning Solvents

Acetone - Acetone is typically used to wash brushes, rollers, and other equipment that has become coated with resin or semi-gelled resin. Acetone replacement solvents, such as Diacetone Alcohol (DAA), are also available and may sometimes be substituted for acetone.

4.3 Tools

4.3.1 The following is a general list of the tools used for field welding fiberglass reinforced plastic. This list is not necessarily a complete list nor is it typical for all FRP field welding.

4.3.2 Assembly and Welding Tools

A. Brushes - Brushes are typically 2in. or 3in. natural hair brushes used to wet out the chopped strand mat and woven roving with resin.

B. Rollers - Rollers are typically 1/2in. x 3in. metal serrated aluminum rollers used to roll out the air in a laminate.

C. Paint Rollers - Paint rollers with blue felt sleeves are typically used on large diameter welds for placement and for applying resin. Paint rollers are not used for roll out.

Note: Serrated aluminum rollers are far superior to regular paint rollers for roll out and should always be used. Regular paint rollers should not be used for roll out under any circumstances. Paint rollers may be used for placement only.

D. Buckets - Buckets (plastic) typically hold one (1) quart or one-half (1/2) gallon and are used for mixing putty or resin. Paper cups are suitable for very small mixtures.

E. Putty Sticks - Putty sticks are tongue depressors used to mix putty or resin. Wooden or plastic putty sticks or "paint paddles" can be used as well.

F. Catalyst Bottle - The catalyst bottle (also called a squeeze bottle or measuring dispenser) is a squeeze measure beaker used to measure the proper amount of catalyst into putty or resin. For making measuring above 15 cc (an example would be adding BPO to putty), a 1 oz measuring cup can be used. If DMA is being used in the cure system, a 16 oz wash bottle can be used. A wash bottle allows for dispensing a very small amount of the liquid.

G. Grinding Discs - Grinding discs are usually 24 grit discs used in surface preparation of the field weld.

H. Grinder - The grinder is typically a 4 1/2in. right angle grinder used in surface preparation of the field weld.

I. Gloves - Neoprene gloves are required by welders of fiberglass materials to prevent irritation.

J. Dust Mask - A dust mask is required during grinding of welds to prevent irritation. For confined areas, a dust mask is a requirement.

K. Sawzall or circular saw - The sawzall (sometimes referred to as a sabre saw) or circular saw is used for trimming ends of pipe to the proper length for field welding.

L. Carbide-tipped or Diamond-tipped blades - Carbide-tipped (for a sawzall) or dry-cut diamond-tipped (for a circular saw) blades are required for cutting fiberglass pipe for field welding. Standard steel blades are not suitable for cutting fiberglass.

M. Cardboard - Cardboard, or other suitable material, is typically used for wetting out plies of mat and woven roving prior to layup. Cardboard is sometimes also used for mixing putty and catalyst.

N. Level - A carpenter's level is required for fitup of the joint.

O. Tape Measure - A tape measure is used for measuring the amount of trim to remove from the pipe ends to be joined.

P. Pipe Stands - Pipe stands are sometimes used when spools are fabricated in the field. Pipe stands are required when the piping needs additional support.

Q. Paper Suits - Safety rules in some plants require the use of paper suits. When working with antimony trioxide (used for fire retardancy), paper suits are required.

R. Electric Drill with Jiffy Mixer - If the putty is going to be made on site or if a large number of welds need to be made, then an electric drill with a jiffy mixer may be required. A 3/8" drill is suitable for mixing. If drums of resin are to be mixed, then a drum mixer would be required.

S. Pencil Grinder with Burr Bits - If touch-up work may be required or if you may be working in hard to reach areas when you can not grind with an angle grinder, a pencil grinder may be required. Burr bits can be straight or tapered.

T. Eye Protection Glasses - Safety glasses should be worn at all times when working with tools.

U. Bent Shears - If glass material is going to be cut, a pair of 12in. bent shears should be used.

5.0 Installation

5.1 General

5.1.1 The recommendations for installation are typical for aboveground fiberglass piping systems, however, they are not project specific. Reference should be made to the project documents for complete installation information.

5.2 Erection

5.2.1 The recommendations for handling provided above shall be followed during the erection of fiberglass reinforced plastic.

5.2.2 Proper supporting, guiding, and anchoring of the fiberglass piping system is critical to the successful installation. The installer of the fiberglass piping shall follow the recommended guidelines of the design of the piping system.

Note: It is not the intention of this manual to establish the proper supporting, guiding, and anchoring of fiberglass piping. Reference should be made to the design documents for the particular project.

5.2.3 In no case shall FRP piping be bent or purposely misaligned to provide fit-up.

5.2.4 In high traffic areas, where installed FRP piping may be subject to impact damage, the installer shall make provisions to provide temporary protection of the piping system.

5.3 Assembly (Field Welds Only)

5.3.1 Once the spool assemblies are erected, it is the responsibility of the field fitter to properly prepare and assemble the field joint.

Note: The steps in the assembly and welding sections are for reference purposes only. It is not the intention of this document to provide the reader with full details for performing fiberglass welding. In no way should this information be used as a substitute for training. Personnel not properly trained in working with fiberglass composites should not rely on this information nor this manual alone for specific instructions. Furthermore, any personnel working with fiberglass composites should be properly supervised.

5.3.2 Steps for surface preparation

1. All contamination must be removed from the surfaces to be joined. All surfaces to be joined must be dry.

2. The surface to be welded must be thoroughly sanded and roughened. There should be no glossy resin finish. Measure the surface area to be ground and then sand 1in. past this.

3. Once grinding is complete, the welding should be performed as soon as possible. Under no circumstances shall the welding be performed more than twelve (12) hours after the grinding is complete. Under no circumstances shall the welding be performed if the area has become contaminated.

5.3.3 Steps for putty and resin mixing

1. For putty, mix the appropriate amounts of filler (Silica Whacker) and resin. A typical mixture is 4.5 gallons of Silica Whacker and 2.5 gallons of resin. This will normally produce 5 gallons of putty. The amount of Silica Whacker can be adjusted to produce the desired thickness. The Silica Whacker only acts as a thickener, it does not affect the mechanical properties of the putty. To this, 25 - 35 cc of Tween 20 is added. 0.5 gallons of milled fiber can be added to this, but it is not required. An electric drill with a jiffy mixer is suitable for mixing.

2. Once mixed, the putty should be promoted with either BPO or CoNap. BPO (followed by a DMA catalyzation) will provide a much faster cure and is normally preferred by experienced welders. CoNap (followed by a MEKP catalyzation) will take longer to cure. Normally, BPO is added at a rate of 10.0cc per pound of putty (90cc per gallon). CoNap is added at a rate of 1.5cc per pound of putty (14cc per gallon). Once promoted, the putty will have a shelf life of one month or less.

3. For puttying a field weld, measure the needed portion of the putty mixture and place onto a strip of cardboard with a putty stick. Mix the appropriate amount of catalyst thoroughly into the putty. Working time with this mixture will vary depending upon the resin used, the amount of catalyst, and the temperature. You may need to refer to the resin manufacturer's literature for gel time information. Typically, BPO-promoted putty is catalyzed with 1cc of DMA per pound of putty. CoNap-promoted putty is catalyzed with 8.0cc of MEKP per pound of putty.

4. For resin, measure out the appropriate amount of promoted resin into a bucket. Resin at the jobsite is normally promoted. Be sure to check that the resin has been promoted. If any additives are required, these are normally added after the resin is promoted.

5. Once promoted and once any additives are added, draw off the resin that is needed for making the field weld. Mix the appropriate amount of catalyst thoroughly into the resin. Working time with this mixture will vary depending upon the resin used, the amount of catalyst, and the temperature. You may need to refer to the resin manufacturer's literature for gel time information.

Batch Conversion Factors

Weight %	cc per pound	cc per kilogram	cc per gallon	cc per liter	fluiz oz per drum	cc per drum (452lb, 50gal, 190L)
0.10%	0.5	1.0	4.1	1.1	7.7	204
0.20%	0.9	2.0	8.2	2.2	15.5	409
0.30%	1.4	3.0	12.3	3.2	23.2	613
0.40%	1.8	4.0	16.4	4.3	31.0	818
0.50%	2.3	5.0	20.4	5.4	38.7	1022
0.60%	2.7	6.0	24.5	6.5	46.4	1226
0.70%	3.2	7.0	28.6	7.6	54.2	1431
0.80%	3.6	8.0	32.7	8.7	61.9	1635
0.90%	4.1	9.0	36.8	9.7	69.7	1840
1.00%	4.5	10.0	40.9	10.8	77.4	2044
1.25%	5.7	12.5	51.1	13.5	96.8	2555
1.50%	6.8	15.0	61.3	16.2	116.1	3066
1.75%	7.9	17.5	71.5	18.9	135.5	3577
2.00%	9.1	20.0	81.8	21.6	154.8	4088
2.25%	10.2	22.5	92.0	24.3	174.2	4599
2.50%	11.4	25.0	102.2	27.0	193.5	5110

(1) gallon = (4) quarts = (3.8) liters; (1) quart = (2) pints; (1) pint = (2) cups; (1) cup = (8) ounces; (1) ounce = 29.57cc

Based on cured resin weight (cured resin S.G. of 1.08, liquid resin S.G. of 1.15, liquid additive density of 1.00).

Recommended Catalyzation - Putty

Temperature	Working Time		
	5 minutes	10 - 20 minutes	20 - 30 minutes
55 - 65F (12-18c)	2.5% BPO (102cc per gallon) (27cc per liter) 0.10% DMA (0.5cc per pound) (1.0cc per kg)	0.40% CoNap (16.4cc per gallon) (4.3cc per liter) 2.0% MEKP (9.1cc per pound) (20.0cc per kg)	N/A
65 - 75F (18-24c)			N/A
75 - 85F (24-29c)			N/A

See Important Note following these tables.

Recommended Promotion & Catalyzation - Resin*

Temp.			
Cold - 50s (10-15c)	0.40% CoNap 2.5% MEKP 0.05 to 0.10% DMA	16.4cc per gallon 11.4cc per pound 0.2 to 0.5cc per pound	4.3cc per liter 25.0cc per kg 0.5 to 1.0cc per kg
Cool - 60s (15-20c)	0.30% CoNap 2.5% MEKP 0.0 to 0.10% DMA 0.40% CoNap 2.0 to 2.5% MEKP 0.0 to 0.05% DMA	12.3cc per gallon 11.4cc per pound 0.0 to 0.5cc per pound 16.4cc per gallon 9.1 to 11.4cc per pound 0.0 to 0.2cc per pound	3.2cc per liter 25.0cc per kg 0.0 to 1.0cc per kg 4.3cc per liter 20.0 to 22.5cc per kg 0.0 to 0.5cc per kg
Mild - 70s (20-25c)	0.20% CoNap 1.0 to 1.75% MEKP 0.05% DMA 0.30% CoNap 1.75% MEKP 0.40% CoNap 2.25% MEKP	8.2cc per gallon 4.5 to 7.9cc per pound 0.2cc per pound 12.3cc per gallon 7.9cc per pound 16.4cc per gallon 10.2cc per pound	2.2cc per liter 10.0 to 17.5cc per kg 0.5cc per kg 3.2cc per liter 17.5cc per kg 4.3cc per liter 22.5cc per kg
Warm - 80s (25-30c)	0.20% CoNap 1.25% MEKP 0.0 to 0.035% 2,4-P 0.30% CoNap 1.5 to 1.75% MEKP 0.40% CoNap 2.0 to 2.25% MEKP	8.2cc per gallon 5.7cc per pound 0 to 0.16cc per pound 12.3cc per gallon 6.8 to 7.9cc per pound 16.4cc per gallon 9.1 to 10.2cc per pound	2.2cc per liter 12.5cc per kg 0 to 0.35cc per kg 3.2cc per liter 15.0 to 17.5cc per kg 4.3cc per liter 20.0 to 22.5cc per kg
Hot - 90s (30-35c)	0.20% CoNap 1.0 to 1.5% MEKP 0.0 to 0.05% 2,4-P 0.30% CoNap 1.25 to 1.75% MEKP 0.40% CoNap 1.75 to 2.25% MEKP	8.2cc per gallon 4.5 to 6.8cc per pound 0 to 0.2cc per pound 10.8cc per gallon 5.0 to 7.0cc per pound 14.4cc per gallon 7.0 to 9.0cc per pound	2.2cc per liter 10.0 to 15.0cc per kg 0 to 0.5cc per kg 2.8cc per liter 11 to 15.4cc per kg 3.8cc per liter 15.4 to 19.8cc per kg

See Important Note following these tables.

Recommended Catalyzation - Gelcoats (Promoted)*

Temperature	Working Time		
	10 - 20 minutes	**20 - 30 minutes**	**30 - 40 minutes**
55 - 65F (12-18c)	4.4% MEKP (20.0cc per pound) (44.2cc per kg)	3.6% MEKP (16.4cc per pound) (36.1cc per kg)	2.2% MEKP (10.0cc per pound) (22.1cc per kg)
65 - 75F (18-24c)	3.6% MEKP (16.4cc per pound) (36.1cc per kg)	3.0% MEKP (13.7cc per pound) (30.1cc per kg)	1.8% MEKP (8.2cc per pound) (18.1cc per kg)
75 - 85F (24-29c)	3.0% MEKP (13.7cc per pound) (30.1cc per kg)	2.2% MEKP (10.0cc per pound) (22.1cc per kg)	

See Important Note on this page.

Important Note: It is not the intention of this manual to provide specific formulating information for proper curing of fiberglass laminates. Characteristics of resins vary from manufacturer to manufacturer, working conditions fluctuate during the day, weather conditions vary from jobsite to jobsite, and desired gel times vary from one fabricator to another. It is not uncommon for actual catalyzation levels to vary from 50 to 150% of the values in these tables. The resin manufacturer's literature can be referenced for general information, however, personnel not properly trained in working with fiberglass composites should not rely on this information nor this manual alone for specific instructions. Furthermore, any personnel working with fiberglass composites should be properly supervised.

5.3.4 Steps for assembly

1. All cut pipe lengths must be square and butted as close together as possible.

2. Roughen all edges (As in step 2, under Surface Preparation), then coat with resin.

3. Butt together the pieces of pipe to be joined. Apply putty to the joint from the exterior to fill any gaps and irregularities in the joint.

4. After the putty hardens, it must be ground for a good anchor pattern. All putty, except that required to fill any cracks or crevices, must be removed.

5.4 Welding (Field Welds Only)

5.4.1 Once the pipe has been fitted and puttied, it is the responsibility of the FRP welder to complete the weld.

5.4.2 Steps for resin mixing

Follow the steps under assembly for resin mixing.

5.4.3 Steps for welding

1. Refer to the field weld kit packages for the laminate sequence. The glass reinforcement materials are already cut to the proper length and width for field welding.

2. For the first sequence, "wet out" (saturate with resin) the three (3) smallest plies onto a strip of cardboard. Each ply should be staggered approximately one (1) inch, with the widest ply on the bottom. A 2in. or 3in. brush should be used for wet out.

Note: Be sure the mat is thoroughly wet out. There should be no white strands showing.

3. Lift the mat from the cardboard and place one end over the puttied joint (The narrowest ply should be placed to the inside.). The weld should be centered on the joint. While holding one end of the wetted sequence, start rolling (circumferentially around the pipe) the sequence on the joint. Continue rolling until 180degrees of the joint is covered.

Note: When you first begin rolling, it is important to hold the other end of the sequence in your hand to prevent stretching.

4. Form the remainder of the weld around the joint and continue rolling in the direction of the wrap until all the air is removed.

Note: Keep the roller going in one direction. If all the air has not been removed, continue rolling in the same direction for another pass around the joint.

Note: If the roller is picking up strands of mat or causing more air bubbles, clean the roller. Shake all the cleaner off of the roller and dip the roller in catalyzed resin and continue rolling.

Note: Do not let direct sunlight make contact with the weld. It may cause burns. Shade the joint with cardboard or other suitable protection.

5. Once rolling is completed, the first sequence needs to harden and cool down (part of its curing process). During curing, do not let the joint be moved or impacted. Do not let the joint become contaminated with water, dirt, etc.

6. After the first sequence has hardened and cooled down, it should be lightly sanded to smooth down any glass that may be sticking up that might cause air entrapment in the second sequence.

Note: If the first sequence cures for more than 12 hours, it must be reground with a 24 grit disc on an electric sander before applying the second sequence.

7. For the second and remaining sequences, repeat steps 2 through 4. Note that in the remaining sequences, there are normally more than 3 plies, depending upon the resin. Also note that normally there are woven plies in these sequences.

8. Once the final structural sequence has cured, visual inspection should be performed. Visually look for air entrapment, burns, drains, and contamination. Also ensure that the weld is properly positioned over the joint.

9. Once visual inspection is performed a synthetic surfacing veil is applied. The resin used in this step must have UV absorbers added to it (0.2% by weight). Wetout and layup of the surfacing veil follows steps #2 - #4.

10. Once the surfacing veil has hardened and cooled down, an external coat is applied. This external coat can be a waxcoat, gelcoat, or topcoat.

Waxcoat:

Mix the wax solution into the resin (4% wax solution / 96% resin, by weight).

Brush the wax / resin mixture onto the exterior surface of the joint, ensuring that the entire joint is coated.

Gelcoat:

A gelcoat is a pigmented resin that can be painted onto the exterior surface of the joint. Before painting, mix the wax solution (4% by weight) into the gelcoat. Also mix UV absorbers (.2% by weight) into the gelcoat.

Apply the gelcoat to the exterior surface with a brush being sure to cover the entire surface.

Topcoat:

A topcoat is a pigmented resin that already contains wax solution and UV absorbers.

Apply the topcoat to the exterior surface with a brush being sure to cover the entire surface.

5.5 Flanged Connections

5.5.1 Bolt torquing of FRP flanges should only be performed by personnel experienced with FRP materials. FRP flanges are susceptible to damage from overtorquing. The recommended torque values and sequences in the tables section of this document are recommended values. In some cases the torque level may exceed this value for complete seating and sealing.

5.5.2 FRP Flange to FRP Flange

5.5.2.1 For FRP flange to FRP flange bolting, follow the recommended torque sequences in Section 11.0 in this document. Note that different recommended torque values are provided for flanges utilizing full face gaskets and o-ring gaskets.

5.5.2.2 Refer to Section 11.0 for this type of connection.

5.5.3 FRP Flange to Flat Face Metallic Flanges and Lug-Type In-Line Valves

5.5.3.1 When bolting an FRP flange to a metallic flat-faced flange or to a metallic or other plastic full face, flat face valve, follow the recommended torque sequences in Section 11.0.

5.5.4 FRP Flange to Raised Face Metallic Flanges

5.5.4.1 When possible, the bolting of flat-faced FRP flanges directly to raised face flanges should be avoided. However, FRP flanges can be properly torqued to raised-face flanges. The raised-face surface of a metallic flange actually provides a very good sealing surface, however, care must be taken to ensure that the FRP flange is not overtorqued because damage could result to the FRP flange.

5.5.4.2 In the case where FRP flanges are being bolted to raised-face flanges, a filler ring made of a material such as teflon can be used (but is not required) as a shim around the raised-face flange to provide a flat surface. The sole purpose of this filler ring is to prevent damage to the FRP flange from overtorqueing.

5.5.4.3 Some applications using filler rings have shown the filler ring to provide little improvement in protecting the flange from damage from overtorqueing. The main reason for this is believed to be due to the very tight tolerances required of the filler ring in order to ensure a full, flat surface. This is mainly true on 0.06in. raised face flanges.

5.5.4.4 Refer to Section 11.0 for bolting to raised-face metallic flanges.

5.5.5 FRP Flange to Wafer Type In-Line Valves

5.5.5.1 Connections to wafer type valves are similar to connections to raised-face flanges. The wafer type valve does not provide the full flat surface of a flat-faced valve. However, just as is the case with raised-face flanges, FRP flanges can be properly torqued to wafer type valves. The wafer type valve is usually easier to install than a full-face valve and the surface of this valve also provides a very good sealing surface. However, care must be taken to ensure that the FRP flange is not overtorqued because damage could result to the FRP flange.

5.5.5.2 Refer to Section 11.0 for bolting to wafer type valves.

5.5.5.3 Special installation steps may be required when the flanges in the piping system may be exposed to a potential fire hazard. In these cases, the flanged connection may have to be passively fire protected.

5.5.5.4 For valves where the diameter of the disc is larger than the inside diameter of the FRP piping, it may be necessary to use a plastic "spacer" that has an I.D. that is larger than the valve disc to allow the disc to turn properly when installed. Most FRP flanges up to 12" diameter have exact I.D.s (2in. pipe has a 2.00in. I.D.; 12in. pipe has a 12.00in. I.D.). In sizes 14" and larger, the I.D. is approximately 0.25" larger than the size (14" pipe has a 14.25in. I.D.; 30in. pipe has a 30.25in. I.D.).

5.5.6 Tie-Ins to Other Piping Systems

5.5.6.1 When FRP piping is being tied-in to other piping materials, only flange to flange connections should be used. Follow the bolt torquing procedures in the previous section for these tie-ins.

6.0 Repairs

6.1 General

6.1.1 The procedures for welding in section 5.4 apply for repairing fiberglass piping.

6.1.2 Repairing fiberglass piping requires some degree of skill and should not be performed by any personnel not properly trained.

6.2 Repair Procedure for Burns and Excessive Air

6.2.1 Steps for surface preparation

Thoroughly grind away all of the burns or excess air. Check for removal by rubbing acetone or alcohol on the grounded surface.

When grinding is complete, hand sand the area to be repaired to remove any solvent film.

6.2.2 Steps for welding

Cut strips of chopped strand mat for welding. Cut the thinnest strips first and complete with a strip wide enough to completely cover the ground surface. Be sure that enough mat strips are cut to replace all of the thickness that was ground away.

Follow the steps for welding under 5.4.3. Most repairs will require only one sequence.

6.3 Repair Procedure for Damaged Assemblies

6.3.1 Scratches, chips, and/or cracks that may result from improper handling, storage, etc. may be repaired on-site.

6.3.2 Follow the steps under section 6.2 for the repair procedure. Be sure when grinding away the damaged surface area, that the entire damaged material is removed.

6.4 Repair Procedure for Erosion of the External Corrosion Barrier

6.4.1 All FIBERBOND® Piping Systems include an external corrosion barrier with a pigmented exterior. Due to high traffic and general wear, patches of the external corrosion barrier may be chipped, scratched, etc. These areas can be renewed with the application of a gelcoat or topcoat.

6.4.2 Follow step 10 in section 5.4.3 for either the gelcoat or topcoat, whichever was specified for the product.

7.0 Certification

7.1 General

7.1.1 All pipe fitters and welders must be trained and qualified for field installation and welding of fiberglass piping systems.

7.1.2 The installation and field welding of fiberglass piping systems must be supervised by personnel with experience in that area. Minimum experience for supervisors of installation is five (5) years. Minimum experience for inspectors of installation and field welding is five (5) years.

7.2 Pipe Fitters and Welders

7.2.1 All pipe fitters and welders shall be properly trained to handle, inspect, install, and field weld fiberglass piping systems.

7.2.2 All pipe fitters and welders must have a working knowledge of the following areas:

Handling and storage of fiberglass piping
Inspection of the piping to be joined
Cutting and grinding fiberglass piping
Resin mixing, addition of catalysts, and general formulation of batches
Wetout and welding
Inspection of the completed joint
Health and safety

7.3 Supervisors and Inspectors

7.3.1 All supervisors and inspectors must have experience in the manufacture, fabrication, inspection, installation, and testing of fiberglass piping systems.

8.0 Quality Assurance

8.1 General

8.1.1 Quality assurance shall be maintained during all phases of installation of fiberglass piping systems. This includes unloading, handling, storage, erection, field welding, and system testing.

8.1.2 Quality assurance should include, as a minimum, 1) inspection of received goods, 2) inspection of field welds, 3) inspection of installed piping, and 4) verification of system testing.

8.2 Inspection

8.2.1 All of the field welds shall be inspected upon completion.

8.2.2 It is recommended that field welds be visually inspected prior to any painting. It is also recommended that barcol hardness readings be taken to ensure adequate curing.

8.2.3 Upon completion of all field installation, a final inspection shall be made of the entire piping system prior to testing and operation. This final inspection shall be performed to ensure that all piping is installed and supported properly and is acceptable for testing and operation.

9.0 System Testing

9.1 General

9.1.1 This sections covers the minimum recommendations for field testing of fiberglass piping systems. This section is not intended to be a procedure for field testing, nor is it intended to replace the purchaser's / end user's requirements for field testing.

9.1.2 All field installation shall be completed prior to testing the piping system.

9.1.3 All pipe supports, guides, anchors, risers, hangers, etc. must be fully installed before any testing.

9.1.4 All field joints must be fully cured prior to any system testing.

9.1.5 Under no circumstances shall air or any other gas be used for testing fiberglass piping systems. Testing with air can cause damage to the piping system and can be a hazard to personnel in the event of a failure in the piping system. If a fiberglass piping system were to fail during a hydrotest, the piping system would be subject to significant shock due to the release of energy from the compressed gas.

9.1.6 All flanged connections must be properly torqued prior to testing. Care must be taken to ensure that the fiberglass flanges are not overtorqued.

9.1.7 Water or seawater is the recommended medium for flushing and testing fiberglass piping systems.

9.1.8 Any piping systems that were designed for duct service and were not intended to handle fluids shall be properly supported during the hydrotest.

9.1.9 In lieu of a hydrotest, an initial service leak test may be performed to ensure system integrity.

9.2 Flushing and Pressure Testing

9.2.1 It is recommended that all fiberglass piping systems be flushed with water upon completion of installation.

9.2.2 Valves should be set to the fully open position during flushing.

9.2.3 The main headers of the piping system and all branches should be flushed until clear water is seen discharging from the low points in the line.

9.2.4 Once flushing is complete, any components that were removed from the piping system shall be replaced.

9.2.5 It is recommended that fiberglass piping systems designed for positive internal pressure be field hydrotested. Any fiberglass piping systems that are atmospheric should be leak tested.

9.2.6 For hydrotesting, water shall be admitted into the low point of the piping system. All air must be removed from the piping system.

9.2.7 Once all air is removed from the piping system, it is recommended that the system be hydrotested to no more than 1.5 times the design pressure of the lowest-rated component in the piping system. The pressure shall be raised slowly from atmospheric to the hydrotest pressure. Provisions shall be made to prevent any sudden changes in pressure during testing.

9.2.8 Once the hydrotest pressure is obtained, the test pressure shall be held for a minimum of one (1) hour.

9.2.9 During hydrotesting, all field joints and field connections shall be inspected.

9.2.10 Any leakage in the piping system shall constitute a failure and must be repaired prior to completion of the testing.

10.0 Health and Safety

10.1 General

10.1.1 The information contained in this section provides general safety and health information for those personnel working with materials for fiberglass construction. This information is not intended to be a complete health and safety program, nor is it intended to replace any health or safety requirements of the purchaser and/or end user. For more detailed information, refer to the SDS for the particular product.

10.1.2 All personnel working with fiberglass shall have copies of all SDS for all materials that they are using.

10.1.3 Smoking, eating, and / or drinking is prohibited while working with or being near fiberglass materials.

10.1.4 Rubber gloves are recommended when working with fiberglass materials to prevent irritation.

10.1.5 Good ventilation shall be maintained in all working areas. In confined spaces where ventilation is poor, respirators shall be used.

10.1.6 Safety glasses shall be worn at all times.

10.1.7 Under no circumstances shall promoters be mixed directly with catalysts containing peroxides. Such an event may cause an explosion.

10.2 Resin

10.2.1 Polyester and epoxy vinyl ester resins are not considered carcinogens, however, these resins due contain styrene that can cause irritation if inhaled over long periods of time. OSHA recommends that personnel working with resins containing styrene work in an environment with styrene levels below 50ppm over an eight (8) hour time-weighted period.

10.2.2 Extreme caution must be taken when working with resins in confined spaces where styrene may accumulate, such as inside large diameter piping, non-ventilated workspaces, etc. Personnel must supervise fabricators working in these areas. Ventilation must be supplied while fabricators are working in these areas. Respirators are recommended where fabricators may be working for long periods of time.

10.2.3 Resins must be stored at room temperatures. Liquid resin must be treated as a flammable material. Exposure to heat or sunlight can cause polymerization.

10.3 Promoters, Accelerators, and Catalysts

10.3.1 Peroxides, which are found in typical catalysts, must be used with extreme caution. Peroxides are active chemicals and will react if exposed to heat or mixed with other chemicals. Catalysts, such as MEKP, should never be mixed directly with promoters, such as CONAP or DMA.

10.3.2 Eye protection must be used when working with peroxides, such as MEKP.

10.4 Reinforcement

10.4.1 Grinding of fiberglass surfaces will generate dust which can be an irritant to some personnel. Where the risk of inhaling glass fibers is present, a face mask or respirator should be used. For those who become irritated from exposure to fiberglass dust, the hands, arms, and face should be washed.

10.4.2 Fiberglass is a skin irritant, however, it is a mechanical irritant. If irritation is a problem when working with fiberglass, take the following precautions:

Wear loose fitting clothes. Always wear a long sleeve shirt and long pants. Gloves can also be worn to reduce irritation.

If your work is above you, wear a hat or safety helmet.

Do not rub irritated skin. Wash with soap and water. Some hand creams may help reduce irritation.

If irritation persists, you should consult your doctor.

10.5 Additives

10.5.1 Antimony trioxide and antimony pentoxide, which are used in some laminates for fire retardancy, are Class B poisons and must be used with extreme care. Paper suits are required when working with antimony trioxide or antimony pentoxide.

10.6 Finished Products

10.6.1 Fiberglass products made with polyester and vinyl ester resins that are completely polymerized are considered inert and pose no handling hazards.

10.6.2 Grinding on finished products can generate dust which can be an irritant to some personnel.

11.0 Installation Figures (Separate)

Lifting Pipe
Supporting Pipe
Flange Connections
Torque Charts