



## **FiberSystems**

521 Kiser Street  
Dayton, OH 45404-1641  
Tel: 937-222-9000  
Fax: 937-222-9020

## *Obtaining Your "Best Buy" In FRP Tanks*

03-31-99

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### **How to Obtain Your "Best Buy" in Reinforced Composite Tanks!**

Many times a purchaser of reinforced composite tanks finds that, after placing an order and taking delivery, the vessel ends up costing more money over the tank's service life than had been anticipated. Or, early tank failures lead to costly replacement. The single most important factor in obtaining the lowest cost per year of service life is the thoroughness of the specifications established for the project.

If the specifications are carefully and thoroughly drafted, you will obtain your "Best Buy" with the lowest cost per year of service life. You will also find it much easier to review and analyze quotations - when detailed specifications are developed before the bidding process.

The following are specific points that should be included in any well-written, documented specification for FRP tanks. The inclusion of these key points in your specifications will insure that you get the "FiberSystems' quality", and will insure that all fabricators are competing on a similar basis.

#### **TANK DIAMETER:**

Most qualified fabricators have a wide range of tank mandrels from 5 ft. through 14 ft. This lets you choose the best diameter/height ratio for the project. The 5, 7, 9, and 11 ft. diameters are often helpful in getting tanks installed in tight places, and can also reduce freight costs. We strongly urge consideration of these "odd" diameters to obtain the best cost/volume ratio. *Obtaining Your Best Buy:* The use of "odd" diameters can provide the lowest cost per gallon of storage and should be used whenever possible.

We also recommend that the specifications require straight-wall mandrels of the full diameter specified. This will help insure that your vessels are not built on make-shift or temporary masonite covered, tapered wood mandrels or molds. Such mandrels do not give the highly corrosion resistant slick interior surface required for the best service life. You may also find that a "10 ft." mandrel sometimes is not 10 ft., and may even be as small as 9'-6". All of FiberSystems' mandrels are full size mandrels; with the exception of the 12 ft. dia., which to keep the diameter under certain shipping restrictions, has an o.d. of 11'-10-5/8". *Obtaining Your Best Buy:* Use specifications that call for full inside diameter straight wall mandrels, except for the 12 ft. diameter - where the specifications would call for tank shell o.d. not to exceed 12 ft.

#### **FREIGHT COSTS:**

Another consideration for tank size is the freight involved in getting the tank to the job site. In areas near FiberSystems' Dayton, Ohio plant, the larger diameter tanks can be shipped with relative ease. In some cases even a 14 ft. dia. tank can be delivered to the job.

In territories more distant from the Dayton plant, it would be wiser to specify the smaller diameter tanks. For example, we have seen instances where the freight on an 11 ft. diameter tank was only half the freight on a 12 ft. diameter tank. The trucker had to travel almost twice as far to get clearance on the extra foot of diameter. In those territories that are distant from the plant, if you can use 7 or 8 ft. diameter tanks, then they become a "legal load" and do not require special permits, routing escorts, etc. Again, the odd



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diameter sizes can often help reduce the freight costs to the more distant territories. *Obtaining Your Best Buy:* Consider freight costs when selecting the tank diameter.

### **TANK HEIGHT:**

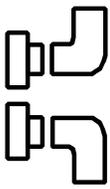
The straight shell height of filament wound tanks can be crucial to obtaining your lowest cost per gallon of storage. With the exception of the 6 and 8 ft. diameter mandrels which are 20 ft. long, all of FiberSystems' mandrels are 24 ft. long. Thus, the set-up time, extraction time, and mold prep time is essentially the same whether we are winding a 24 ft. long tank or a 6 ft. long tank. In actuality, it is more expensive to wind a 22 ft. long shell than a 24 ft. shell.

Some FRP tank fabricators "hoop-wind and chop" their tank shells in 4, 6 or 8 ft. increments, stopping the winding process - letting the shell cure, pulling the mandrel - and then starting the winding all over again. This gives the customer a tank having a great number of "side-wall seams" or discontinuities where the winding process stops and starts. On a FiberSystems tank, the sidewall, up through 24 ft., is continuous - with no breaks in the corrosion resistant liner.

You will obtain your lowest cost per year of service life when specifying tanks that use the full length of the mandrel (20 or 24 ft.). For example, your "Best Buy" would be gained by the selection of an 11 ft. diameter by 24 ft. tall tank - since it could be wound in one section with only one set-up and one extraction. *Obtaining Your Best Buy:* When possible, make sure that the specifications call for the height to be *not less* than the full mandrel length of 20 or 24 feet. Discourage specifications that favor the "stop and start" winding fabricators with their odd shell heights, by not allowing potential leaky sidewall tank seams.

When you have multiple tanks of the same size, you will obtain your lowest cost by specifying tank heights that allow multiple shell sections to be produced from one winding set-up. For example, on 8 ft. diameter by 10 ft. tall tanks, we can get two shells out of one winding. The same would hold true of 9 ft. diameter by 12 ft. tall tanks.

By the same token, tanks taller than the mandrel length should be specified only as a "last resort". FiberSystems is very efficiently set up to fit and attach the bottom on all of our tanks with the tank shell in a vertical mode. Tanks over 24 ft. tall have to be fitted, and the shells joined, with the tanks in a horizontal mode. This greatly decreases our effectiveness and efficiency. You can readily see that if a tank is specified with a 26 ft. sidewall height, we have to make an extra set-up to wind the short section, make a special sidewall butt weld, and no longer can handle and fit the tank in a vertical mode. The cost of those extra few gallons go up dramatically. *Obtaining Your Best Buy:* Select tank heights that effectively utilize the mandrel length.



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### **MINIMUM CAPACITY:**

The specifications should not only specify the minimum tank diameter and its shell height, but also the minimum capacity. This is another way of "smoking out" those "garage shop fabricators" that use undersize mandrels or tapered mandrels. *Obtaining Your Best Buy:* Always include minimum capacity in the specifications that are equal to the gallonage of FiberSystems tanks.

### **TANK TOP - CLOSED:**

FiberSystems' standard tank top is a reinforced shallow cone with a total minimum thickness of 3/4". We have special autoclave tooling to mold this head at significant cost savings for the customer. This shallow cone top has proven to provide customers with the strongest tank tops in the industry, as well as a low profile for limited head room applications.

The specifications should be written to provide for either a flat reinforced tank top or a shallow cone top, where the total tank height, not including nozzle projections, does not exceed the total overall tank shell height, plus 3" for the knuckle, plus one inch per foot of diameter. (An 8 ft. by 20 ft. tank would have an overall tank height of 20'-7".) This will insure you the opportunity of getting the strongest top, low overall tank height and save purchase dollars. *Obtaining Your Best Buy:* Have the specifications limit overall tank height - and call for either a shallow cone or flat top.

The performance specifications for any top should call for a 25 lb. per square feet snow, ice, and water load; with a concentrated top live load of 250 lbs. distributed over 16 sq. inches.

### **TANK TOP - OPEN:**

For open-top tanks, the top edge should definitely be specified as being reinforced. Note that FiberSystems' standard open-top tank has an inward reinforcing flange that is wound integrally as part of the sidewall. This inward reinforcing flange is the strongest type of reinforcement, and on a FiberSystems tank is "free" at no extra cost. We recommend the inclusion in the specifications of this extra-strong type of integral top reinforcement. *Obtaining Your Best Buy:* On open top tanks specify a top edge reinforcement - with an inward integral reinforcing flange.

### **MATERIALS OF CONSTRUCTION:**

The specifications should clearly spell out the minimum thickness for the corrosion liner and barrier. It is surprising how many specifications make no mention of the thickness of this liner and barrier. For "SPI" liners, we recommend a minimum of 20 mils of C-Veil and/or Nexus reinforcement and 80 mils of chopped fiberglass strand reinforcement. Thus the total corrosion liner and barrier would be a minimum of 0.100". Additional liner thicknesses can be provided to give an increased corrosion allowance. *Obtaining Your Best Buy:* Make sure the type and thickness of the liners are clearly called for in the specifications.



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You will receive your lowest cost per year of service life when a premium grade vinylester resin is specified for both the corrosion barrier and the structural filament wound overwrap. We are not an advocate of "dual" laminates using a premium grade resin in the liner and isophthalic polyester resin in the filament wound structural overwrap. We do offer the dual laminate when the competitive situation demands. However, we strongly urge the customer to use the same premium grade resin throughout the entire composite wall. Presently, our recommendation for a premium vinylester resin is Ashland's Hetron 922. *Obtaining Your Best Buy:* If the resin system is not generically described as a "premium grade vinylester resin," then Hetron 922 should be one of the approved vinylester resin systems.

Rigid resin systems (i.e. Atlac 382, Hetron 700, Hetron 197, rigid isophthalic polyesters, etc.) should be vigorously discouraged for thin wall filament wound tanks and vessels. You are asking for "trouble" when you allow these types of materials to remain in the specifications for filament wound equipment. For many applications; including high-temperature service, applications with very high pH's, and applications containing solvents - a high temperature vinylester (i.e. Derakane 470 or Hetron 980) may be the best resin for the service. If these resin systems are required, they should be clearly detailed in the specifications so that all fabricators are quoting on the same basis.

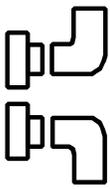
We also see many service environments that dearly demand the use of a "non-glass" reinforcing veil in the liner. The specifications however often make no mention of this requirement. Thus, less knowledgeable fabricators may be quoting on the basis of C-Veil as opposed to the more costly use of Nexus synthetic reinforcing veil. *Obtaining Your Best Buy:* If Nexus veil is required, it should be clearly called for in the specifications, along with the minimum veil thickness desired.

Another way of obtaining your lowest cost per year of service life is to determine if furan and epoxy resin systems might provide better performance or a longer service life. FiberSystems has the unique capability of being able to filament wind furan and epoxy composites. A furan vessel will often provide the only acceptable resin system for environments including organics and solvents.

FiberSystems can also provide you with filament wound epoxy composite tanks and vessels. There is a substantial requirement in the corrosion containment area for epoxy tanks. Probably 70% of all of the piping running to and from FRP vessels is epoxy. If someone has made a determination that epoxy pipe is the best piping for the service application - why not also an epoxy tank. *Obtaining Your Best Buy:* There is no better way to realize your lowest cost per year of service life for many applications, than by specifying epoxy or furan resin for the composite. This will also open up many cost savings opportunities for composite tanks that can not be met by polyester resins.

### **VESSEL EXTERIOR:**

FiberSystems has always been a strong proponent of the use of a pigmented UV inhibiting exterior resin coat. A pigmented resin coat on the tank exterior gives superior UV inhibition, increasing the tank's service life. The exterior coating also protects the tank's contents against sunlight degradation, UV initiated reactions, and chemical changes. With a light colored exterior coating, the tank's contents also maintain a more uniform and constant temperature.



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Finally, by selecting the tank color, a more pleasing appearance can be achieved, and external spillage is not as likely to present an unattractive appearance. (If external spillage is expected to be a significant factor, use a pigmented color similar to the color of the dried spillage.) In the case of external spillage we would also recommend the addition of a surfacing veil reinforced pigmented exterior coating.

FiberSystems is very efficiently set up to provide this pigmented coating. The vertical method of fitting and finishing tanks lends itself to this external pigmentation.

*Obtaining Your Best Buy:* Provide yourself with a more pleasing end product - with improved life and protection of the tank contents, and at the same time, gain a significant cost per year of service life advantage by specifying a pigmented external resin coating.

### **INSULATED TANKS:**

Where tanks are to be insulated, make sure the specifications clearly call out the thickness of the insulation and specify that the insulation is to have additional filament wound FRP protection on the sidewall, with contact-molded FRP protection for the tank top. With FiberSystems' long mandrels, it is very efficient for us to insulate the entire tank at one time and filament wind over the insulation for the external protection. The "wind and pull" fabricators usually just "chop" an FRP skin over the insulation.

*Obtaining Your Best Buy:* Establish specifications requiring the use of filament wound FRP protection over the sidewall insulation. You will get a much stronger protective layer from the filament winding, and you will gain your lowest cost per year of service life.

The specifications on insulated tanks should also require that the welds to install all fittings and accessories be made to the inner tank shell only. Gusset welds, nozzle welds, and accessory welds should not be made to both the inner shell and the exterior fiberglass protective overwrap. Even though it is easier to weld to both shells, doing so puts undue stress on such dual shell welds and accessories because of the difference in the thermal coefficient of expansion of the two skins. *Obtaining Your Best Buy:* Make sure the specifications clearly call for all secondary bonds and welds to be made only to the inner shell.

### **LIFTING, HANDLING & HOLDDOWNS**

FiberSystems' standard tank lifting and handling mechanism is a lifting bar that is bolted to the top center manway. This bar is a very cost-effective way of unloading, erecting, and handling a tank when compared to the use of separately laminated-on FRP lifting lugs that can tear off. *Obtaining Your Best Buy:* Specify the use of a top center lifting bar to lift, handle and erect the tanks.

Our standard holddown lugs are FRP lugs with matching steel clips. These clips make it easier for the customer to line up the tank holddown lugs with the anchor bolts cast in the concrete. Because of the way we wind these lugs in place at the same time the bottom is wound to the tank shell - it is easy for us to add additional FRP holddown lugs when required. *Obtaining Your Best Buy:* Specify the use of FRP lugs of the same material from which the tank is constructed, with matching steel clips that allow easy field adjustment to match the anchor bolts. Also make sure that an adequate number of lugs is specified.



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### **SEISMIC DESIGN:**

If seismic design is required, it should be clearly called for in the specifications. We can then provide additional holddown lugs, or holddown lugs of special design to meet those requirements. We have noted many inquiries that have come through recently where seismic zone design and construction should clearly have been specified - but was not. Thus, those fabricators that do not quote on the basis of seismic design will be providing you a less than adequate tank, and could end up costing many dollars in lost product, expensive clean-up costs and replacement. *Obtaining Your Best Buy:* When required, make sure the specifications call for seismic design and construction; with documented engineering calculations by a registered engineer.

### **VENTING:**

Venting is mandatory on all FRP vessels, but we see a very large number of tank specifications come through where no consideration has been given to this requirement. The vents should always be equal to the largest size inlet or outlet; or preferably be one size larger. (We saw one tank recently come through with an 18 in. outlet and a 4 in. vent. Guess what will happen to that tank.) Over the years, the biggest single cause of failure of FRP tanks has been through either a pressure or vacuum applied to a tank designed for atmospheric service. *Obtaining Your Best Buy:* Make sure that proper venting is specified so that service problems and extra costs are not experienced "down the road". The preferred type of vent would be a "V" or "U" goose-neck style.

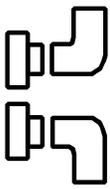
### **MANWAYS - TOP:**

FiberSystems' reinforced shallow-cone top comes standard with a 24" diameter top center manway. The pressure mold for producing the top also automatically produces this top center molded style manway. Standard bolting hardware is cadmium-plated steel and the standard gasket is neoprene. Because of FiberSystems' nearly flat roof, access to the top center manway is very easy. It is really no different than gaining access to a flat roof type manway. (An anti-slip top surface for this head can be provided at reasonable cost if so desired.) *Obtaining Your Best Buy:* All specifications should call for the tank to be furnished with a 24" dia. top center located bolted-cover manway.

### **MANWAYS - SIDE:**

Most tanks and vessels with over a 10 or 12 ft. sidewall height should also be provided with a side entrance manway. Obviously, FiberSystems can provide any diameter manway the customer wants - but we believe that for ease of entrance and, perhaps more important, for safety as an emergency exit, this manway should be a full 24 inch diameter. We see far too many 18", 20", and 22" diameter manways being specified in tank sidewalls. Take a yard stick and hold it up to your shoulders and see where 18" comes to. *Obtaining Your Best Buy:* Make sure that a full 24" diameter sidewall manway is always specified.

Just as the most common cause of tank mechanical failure is a vacuum or pressure applied to an atmospheric designed vessel, this failure often shows up as failure in the tank top or sidewall around the



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manway. The industry is full of "horror stories" of manway failures. The specifications should take special note of sidewall manway requirements; calling for the manway opening and tank wall to be reinforced per ASTM Specification D-3299.

In addition, it is our judgment that a 25 psi designed manway should be used regardless of tank diameter or height. Typically all other nozzles in the tank are specified for a minimum 25 psi design, and we think that it is only common sense to use a manway built to this same design. FiberSystems has standardized on a 25 psi design manway and cover for all tanks. Again, standard hardware is cadmium-plated steel and gasket is neoprene. *Obtaining Your Best Buy:* Make sure that the specifications call for tank walls around sidewall manways to be reinforced per ASTM D-3299, and for the use of a 25 psi rated manway and cover.

### **TANK FITTINGS:**

It is our recommendation that all tank nozzles 1-1/2" diameter and smaller be provided by using NPT FRP threaded fittings. These types of fittings are less costly to install and are less likely to get damaged during shipping, installation, and subsequent usage. Many fabricators have successfully used large quantities of FRP threaded fittings on a routine and regular basis. *Obtaining Your Best Buy:* Specify NPT threaded fittings made of FRP for all small diameter nozzles.

### **GUSSETING OF NOZZLES:**

All flanged nozzles 6" diameter and smaller should be specified as gusseted. Again, it is amazing how many specifications and inquiries come through without any requirement for flange gusseting. The quality fabricator, that as a routine gussets all of his flanges, is at a competitive disadvantage to the fabricator that is willing to "cut corners" and quote these nozzles, as allowed by the specifications, un-gusseted. But the real "loser" is the end user. Our standard gussets are conical - which we believe provide the best overall service. *Obtaining Your Best Buy:* For your lowest cost per year of service life make sure that the specifications clearly call for all flanged nozzles 6" diameter and smaller to be conically gusseted.

### **DRAIN NOZZLES:**

The preferred drain nozzle would be a flanged and gusseted sidewall-mounted siphon drain. This is the least costly nozzle to install. With FiberSystems' method of standing the tank up vertically for fitting, a sidewall siphon drain does not present the problems caused by a full or side bottom drain. *Obtaining Your Best Buy:* For your lowest cost per year of service life specify sidewall-mounted siphon drains whenever possible.



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### **PAD TYPE NOZZLES:**

A flange pad is a very effective and useful way of providing a tank inlet or outlet that is not as susceptible to damage as is a projecting flange nozzle. However, a pad-type nozzle should never be specified with studs. Any damage to the studs becomes very difficult to repair or replace. The preferred method for a flange pad is by the use of a pad with inserts. The insert can always be drilled out and replaced with a new insert if damage or stripping does occur. *Obtaining Your Best Buy:* Specify flange pads when they make sense; and with inserts rather than with studs.

### **FLANGES:**

All of FiberSystems' standard flanges for nozzles and manways will be filament wound. The filament wound flange gives superior strength, and is used as the "premium grade" flange by all of the commodity pipe manufacturers. There is more than an even chance that the pipe flange mating up to the tank flange will be filament wound. For a filament wound tank, it only makes sense to use a filament wound flange. *Obtaining Your Best Buy:* You will gain the strongest flanged nozzle, and your lowest cost per year of service life, when specifying filament wound flanges for all nozzles and manways. Also, most knowledgeable customers exclude the so called "gunk molded" or compression molded flanges. These highly filled press molded flanges do not have the toughness or strength needed in a tank application.

FiberSystems' filament wound pipe flanges are all rated for 150 psi service. (As mentioned earlier, sidewall manway flanges are rated for 25 psi service.) In most cases the pipe, fittings and accessories running to and from the tanks are for 150 psi service. *Obtaining Your Best Buy:* Take advantage of the savings and strengths offered by standard flanges and have the specifications call for 150 psi rated pipe flanges for all flanged nozzles.

### **FLANGE HARDWARE AND GASKETS:**

We would prefer that the customer provide their own hardware and gaskets. Most knowledgeable customers do this as a standard practice in order to save the extra markup required if the tank fabricator has to buy and resell these items. *Obtaining Your Best Buy:* The specifications should clearly call for all flanges (other than manways) to be furnished without hardware and gaskets.

### **PIPE GUIDES AND SUPPORTS:**

Guides and supports for external and internal downpipes should be clearly specified and shown on the drawings. This is another area that often gets "forgotten" in the specifications and leads to wide differences in quoted prices. The preferred guide would be one which allows the pipe to move freely. *Obtaining Your Best Buy:* To insure that you receive a "complete" vessel, make sure both the specifications and drawings fully detail these requirements for pipe guides and supports. Drawings of standard pipe supports and guides are available from FiberSystems for inclusion in the drawings and specifications.



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### **LADDERS, PLATFORMS, AND CAGES:**

FiberSystems sees entirely too many specifications coming through that do not clearly specify whether the tank manufacturer is to provide the ladder, safety cage, and platform; or if these items will be customer supplied. Many times the drawings will show such ladders, cages, and platforms - but no mention is made of them in the specifications. We then don't know whether to quote on the basis of providing ladder support lugs for customer-supplied ladders. Or, are we to provide the ladder and platform accessories, and if so, of what materials of construction?

Our standard ladders, cages, and platforms will be carbon steel with an epoxy primer coating. It is our preference that FiberSystems furnish only FRP support lugs for attaching customer supplied ladders, platforms and cages. Again, this is standard practice with our more knowledgeable customers. It saves them money, since they do not have to pay for FiberSystems' "markup" for handling the purchasing of these items. *Obtaining Your Best Buy:* The specifications must clearly detail what is required in the way of fabricator-supplied ladder accessories, along with very specific details on the materials of construction - so that all fabricators are quoting on the same basis. To obtain your lowest cost, plan on purchasing these items direct.

Because of the practically flat profile of the standard FiberSystems shallow cone top, typically a platform should not be required. Where frequent top access to the tank is required, we suggest the use of either handrails to the center manway or a circumferential handrail around the entire tank top. This could be combined with an anti-slip walkway material, when required. *Obtaining Your Best Buy:* For shallow cone and flat tops, a top platform may not be necessary, saving you costs. However, for safety considerations the specifications should require an entire top platform and top handrail for tanks using a dished top. You should need only top handrails for those tanks using a reinforced shallow cone or flat top.

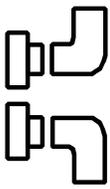
### **AGITATION ACCESSORIES:**

Agitator bridges, sidewall support brackets, etc. are all fairly standard outside purchases. Again, the specifications should clearly detail the specific design and type of agitation accessories required. If carbon steel is specified for these accessories, the type of protective coating required should also be specified. For all agitation accessories our standard will be carbon steel with an epoxy primer coating. *Obtaining Your Best Buy:* Since these are outside purchases that a fabricator must mark up, your lowest cost will be for you to purchase these agitation items on a direct purchase basis.

### **AGITATION BAFFLES:**

Unless the agitator is sidewall-mounted or top offset angle-mounted, internal FRP agitation baffles should be specified. Again, we often find that the specifications are vague or silent on this particular point. This can make a big difference when comparing competitive quotes.

Most FRP tank manufacturers use a flat plate baffle supported by plate gussets on one or two sides. The FiberSystems standard baffle is a wedge-shaped baffle that is continuously welded or supported to the



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tank walls along its entire length. Because of its sloped rear face, it tends to prevent material from hanging up behind the baffles or getting wedged between the baffle and the wall. It is also a much stronger baffle. Torque and agitator design considerations are much less critical with FiberSystems' standard wedge baffle. *Obtaining Your Best Buy:* For your lowest cost per year of service life, and the most trouble free baffle, specify the standard wedge baffle for all agitated tanks. (The rule of thumb of one inch of baffle width per foot of tank diameter applies.)

### **HYDROTESTING:**

Hydrotesting each vessel before shipment, especially with vessels having a large number of fittings, is cheap insurance for "peace of mind". Many years ago, FiberSystems set up a standard vertical hydrotesting station for routine testing as an ongoing plant quality control procedure. We can carry out a hydrotest at a very nominal and reasonable cost. *Obtaining Your Best Buy:* Have the specifications call for plant hydrotesting at the time of final customer inspection. This requirement will allow you to install the vessel, knowing it has already passed one critical quality control procedure.

### **OVEN POST CURING:**

There are many service applications that would greatly benefit from a controlled post cure of the entire vessel. Severe chemical service environments, food applications, distilled and deionized water storage, sodium hypochlorite storage, furan and epoxy composite tanks, etc. all require the tank to be oven post cured.

As with hydrotesting, FiberSystems is set up to conduct such post curing operations (because of its furan and epoxy technology) on a full vessel basis. We have controlled temperature convection ovens 16 ft. square by 40 ft. long that were specifically installed for this purpose. The circulating gas "dry" heat gives a much better cure than injection steam post curing with the attendant "hot spots". *Obtaining Your Best Buy:* Have the specifications call for post cure of all critical fabrications in a circulating hot air "dry" oven with recording charts to be provided to the inspector. The specifications should specifically prohibit internal steam injection curing of tanks and vessels. Again, this requirement of post curing can often provide you a far superior vessel, having your lowest cost per year of service life.

### **DESIGN CONSIDERATIONS:**

The specifications should fully define the specific gravity for which the vessels are to be designed and fabricated. Failure to include design specific gravities in an inquiry can often make a major difference in competitive quotations. Generally speaking, the higher the specific gravity to be used for design and fabrication, the greater the need for a dual angle wound vessel. Tied with this specific gravity requirement should be the specification of the design temperature for the laminate or vessel operating environment. *Obtaining Your Best Buy:* To make sure your vessel will provide you many years of trouble free service, have the specifications clearly call out the specific gravity and service temperatures - not only for the present service, but also for all future anticipated tank usage.



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The specifications should require the tank to fully meet all minimum requirements of ASTM D-3299. Additionally, the specifications should call for all tanks installed outdoors to be able to sustain a minimum wind load of 100 mph. All tanks, regardless of where they are installed, also should contain a specification requirement for the tank wall to be able to sustain an impact of 200 ft-lbs. without failure or leakage, as measured by means of a falling ball impact test. The ability of a tank to withstand impact is a very important consideration. It seems that in service someone is always scraping a tank with a fork lift, swinging a piece of pipe, dropping a wrench, etc., FiberSystems can provide certification that your tank will meet these wind and impact tests! *Obtaining Your Best Buy:* To make sure your tanks keep providing low cost service, year after year, have the specifications call for the supplier to furnish certification that the equipment you are purchasing has been successfully tested for 100 mph wind loads and 200 ft-lb. impact.

### **LAMINATE PHYSICAL PROPERTIES:**

Laminate strengths at ambient temperature should be limited to a .001 in./in. strain in the hoop or circumferential direction. The tank shell thickness shall also be designed for a minimum ultimate axial stress of 9000 psi in the longitudinal direction. This requirement, without exception, should be clearly called for in the specifications.

Many customers have found, to their great expense and sorrow, that the so-called "hoop-wind and chop" method of fabricating filament wound tanks does not give adequate axial strength. This was the reason that Owens Corning Fiberglass developed their "High Performance Series" fiberglass tanks. Large customers for FRP tanks forced this change because of plant failures of tanks that had been accidentally pressurized. Catastrophic failures followed. As the result of subsequent investigations by these customers they now insist that additional axial strength be obtained by adding additional layers of chopped strand fiberglass mat to the laminate of all "hoop-wind and chop" tanks.

With FiberSystems' unique dual circumferential and helical interlocking filament winding, we obtain the required strength in both directions without having to add extra wall thickness and cost to your vessel. *Obtaining Your Best Buy:* To provide yourself the strongest possible vessel and the lowest cost per year of service life, make sure your specifications clearly call for minimum laminate properties based on limiting strain in the hoop direction to .001 in./in., and requiring the tank design to be based on a minimum axial stress of 9000 psi. Perhaps even better would be to also include the requirement that these physical properties be achieved by the use of helical and circumferential interlocking filament winding as part of the structural composite wall.

### **VERIFICATION OF LAMINATE PROPERTIES:**

The requirements for minimum laminate strengths are meaningless if the customer has no way of determining that the vessel, as built and shipped, meets his requirements. Therefore we also recommend that the specifications call for submittal, at the same time the drawings are submitted for approval, of design calculations showing that the tank meets both the requirements of ASTM D-3299 and the minimum laminate properties shown above. These design calculations should be certified as being based on data obtained by full tank strain gage tests. (Copies of the tests are to be made available for review by



## **FiberSystems**

521 Kiser Street  
Dayton, OH 45404-1641  
Tel: 937-222-9000  
Fax: 937-222-9020

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the inspector at the time of plant inspection.) Most quality fabricators can provide this kind of engineering capability and test data to substantiate their vessel fabrications. *Obtaining Your Best Buy:* To insure the integrity of your equipment have the specifications call for design calculation submittal and strain gage data substantiation from all fabricators.

### **PRE-BID QUALIFICATION:**

Knowledgeable customers - such as DuPont, Monsanto, Union Carbide, etc. - all pre-qualify their suppliers before going out for bid. Historically, FiberSystems has done best with these more knowledgeable buyers that have taken the time to know the complete capabilities of their proposed FRP vendors. Many FRP tanks are handling some pretty nasty materials that could cause severe damage to a plant, as well as loss of life or permanent personal damage if a tank failure occurred. Yet many customers make no effort to pre-qualify their suppliers of these critical tanks and vessels. Many plants have also come to recognize that the cost of lost production caused by equipment failure is so great they can only afford to buy the very best.

### **PLANT INSPECTIONS:**

FiberSystems always welcomes a plant visit and inspection. We also urge our potential new customers to contact previous FiberSystems customers. The initial cost of the equipment fades in comparison to the possible liabilities from buying a "cheap" tank. *Obtaining Your Best Buy:* Insist on pre-order plant inspections and qualification of proposed fabricators. Ask for a list of similar equipment that has been built in the last three years. For all critical equipment establish a firm specification requirement for a minimum of five years prior experience on like equipment. (This prior experience requirement should be mandatory for furan and epoxy equipment.)

### **FINANCIAL STRENGTH:**

Also, we recommend you qualify your suppliers of FRP equipment on the basis of their financial strength, experience in the industry, and personal reputations. One recent major project had three out of the five tank suppliers solicited for quotes that were in such severe financial situations that it was questionable whether they would even be in business 60 days from then; and subsequently it was learned that two of the three had "closed up shop". These fabricators had been "cut off" by their suppliers, having owed some of them for over a year. *Obtaining Your Best Buy:* We recommend you obtain D & B reports on proposed fabricators. Also request the name, address, and phone number of the fabricator's major glass and resin suppliers. Then check with the suppliers for the fabricator's credit history.

### **AT WHAT RISK?**

As mentioned above, FRP tanks are usually specified and used because they are handling and storing hazardous materials. Frequently these are acids or highly alkaline materials that pose real hazards if tank failure were to occur in a crowded plant area; or where spillage could create hazards, downstream or downwind, for the environment. For example, what might happen to a community's water supply due to the failure of a tank and the loss of chemicals into the ground water or nearby stream?



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### **NATIONAL APPROVAL:**

One evidence of being able to purchase quality in FRP equipment is the ability of a supplier to furnish FRP tanks that have already been pretested and have passed national specifications. The premier national specifications for above ground vertical tanks is Factory Mutual, the research and testing arm of many insurance companies. Factory Mutual approval for FRP vessels calls for full scale testing of tanks for wind, roof loading, impact, and fire. For FiberSystems tanks these tests are fully detailed in a short movie, and written reports are available from Factory Mutual. (Ask your local FiberSystems Rep for a copy of this movie and the Factory Mutual reports.)

*Obtaining Your Best Buy:* For your lowest cost per year of service life, include in your specification the requirement that all tanks furnished must meet the requirements of Factory Mutual and carry a Factory Mutual approval label. Beside knowing you are obtaining the best possible tanks, when you buy tanks with the Factory Mutual approval many insurance carriers will provide you a lower insurance premium.

### **THE BOTTOM LINE - QUALITY PAYS:**

The utilization of each of the above *"Obtaining Your Best Buys"* will yield a specification that makes sure all FRP Tank Fabricators compete on a fully qualified basis. By including all these key points and requirements in your specifications for reinforced composite tanks and vessels, you will greatly increase your chance of getting your lowest cost per year of service life - and thus your "Best Buy". Quality doesn't cost - it pays!