

**FIBERGLASS REINFORCED PLASTIC (FRP) PIPING SYSTEMS**  
**A COMPARISON OF TWO FABRICATION METHODS**  
**SHOP FABRICATION VS LOOSE PIPE & FITTINGS**

Enclosed on the following pages is one in a series of papers written by the Engineering Department of EDO Specialty Plastics on fiberglass reinforced plastic (FRP) piping systems. This paper, on the comparison of Shop Fabricated Piping Systems and Loose Supplied Pipe & Fittings, is one in a line of papers written on the basic principles involved in the selection, specification, and design of the components involved in fiberglass piping systems.

EDO Specialty Plastics, as a designer, manufacturer, and installer of fiberglass pipe systems with two decades experience in the advanced composites industry, provides this paper as a service to its customers involved in the design and selection of fiberglass reinforced plastic piping systems.

The intention of this report is to present a wide range of data on two fabrication methods available to the purchaser of fiberglass pipe systems and to provide the interested reader with information necessary to compare and contrast these two methods. The information is presented as independent data, thus allowing the user to make his own independent conclusions and to select his preferred manufacturing process.

The guidelines drawn in the report are based on the history and experience of EDO Specialty Plastics in the fiberglass composite pipe industry. These guidelines, however, are intended to be just that - guidelines. Each application of an FRP pipe system is unique and must be treated as such. Furthermore, because of certain intangibles involved with FRP pipe systems, a "pre-engineered" system is not recommended. A detailed design of each pipe system is necessary to achieve the full potential of the FRP pipe system. By doing so, the customer is ensured of a "custom-designed," "custom-manufactured," and "custom-installed" system to his specifications and needs.

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## **Introduction**

When investigating the use of fiberglass reinforced plastic (FRP) pipe in the chemical, petrochemical, marine, and other industries, several decisions have to be made early on in the design of the piping system. These include the pipe fabrication technique (filament winding vs hand-lay up, for example), the method of installation (flanged pipe vs plain end pipe, and field-fabricated vs shop fabricated spools), and the joining system (adhesive-bonded vs butt and strap, for example), to name a few.

The selection of the system fabrication method affects the entire scope of the project from pipe manufacture to system installation, thus making this selection process one of the more critical ones that has to be made in the design and specification of fiberglass pipe systems. The two fabrication methods that are available to the purchaser of fiberglass pipe systems is the shop fabricated pipe system and the loose supplied pipe and fittings system. Each of these fabrication methodologies has its advantages and disadvantages. This report will first give a description of each type of fabrication method, tabulate the advantages and disadvantages, and outline potential applications.

The purpose of this report is to provide the interested reader with independent information comparing the methodology behind shop fabrication and the supply of loose pipe and fittings and to provide a set of guidelines for the fabrication method decision making process. This is but one of the many aspects of FRP pipe systems that must be investigated before a successful design can be completed. Fabrication materials, pipe flexibility, and pipe strength, are but a few of the additional aspects that should be considered. By reading and understanding the information in this report, one step of many is taken toward the successful design of a fiberglass pipe system.

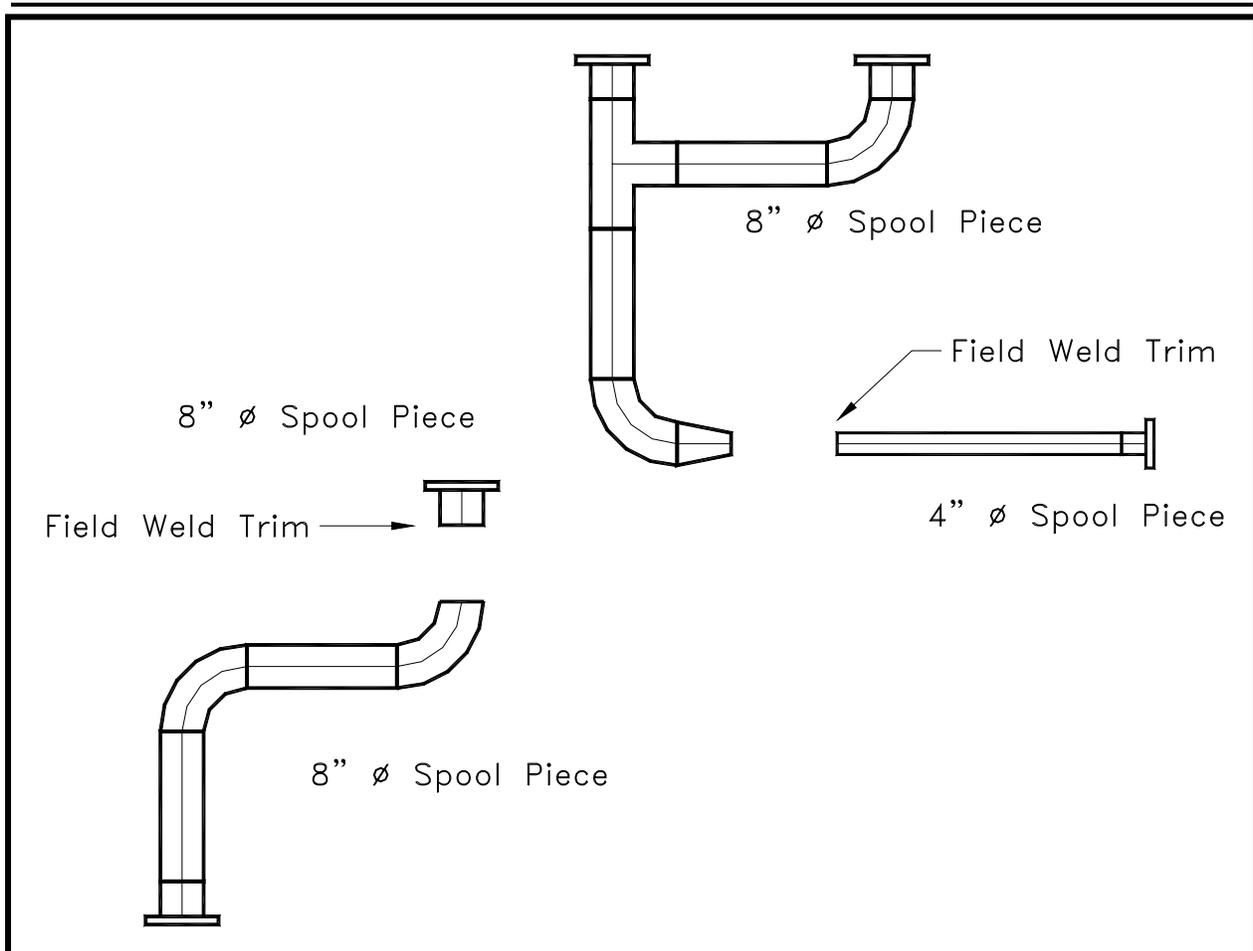
## **A Description of the Two Manufacturing Methods**

### **Shop Fabricated Piping Systems**

A shop fabricated (also called pre-fabricated) piping system is delivered to the customer as assemblies or "spools" of pipe and fittings joined together by shop welds. A typical set of fiberglass spools is shown in Figure 1. Fittings, such as flanges, elbows, reducers, tees, etc. are welded to the pipe in the shop forming these spools that match the routing of the pipeline in the field. The ends of the pipe spools are left with additional trim for final installation in the field. The end result is a more cost effective fabrication and erection of the piping system. Often 50-90% of all welds can be performed in the shop.

For an example of the number of welds that can be performed in the shop, refer to Figure 3. In this figure is a short 8" header system feeding three 4" inch lines and an 8" inch line. In this system the total number of welds are thirteen (13) 8" butt welds, three (3) 4" butt welds, and three (3) 4" tee welds.

In a shop fabricated piping system, only four 8" Butt Welds would be required to be performed in the field to allow for handling and to make up any field trim. All of the other welds could be performed in the shop. Thus, 79% of all of the welds would be shop welds leaving only 21% to field installation.

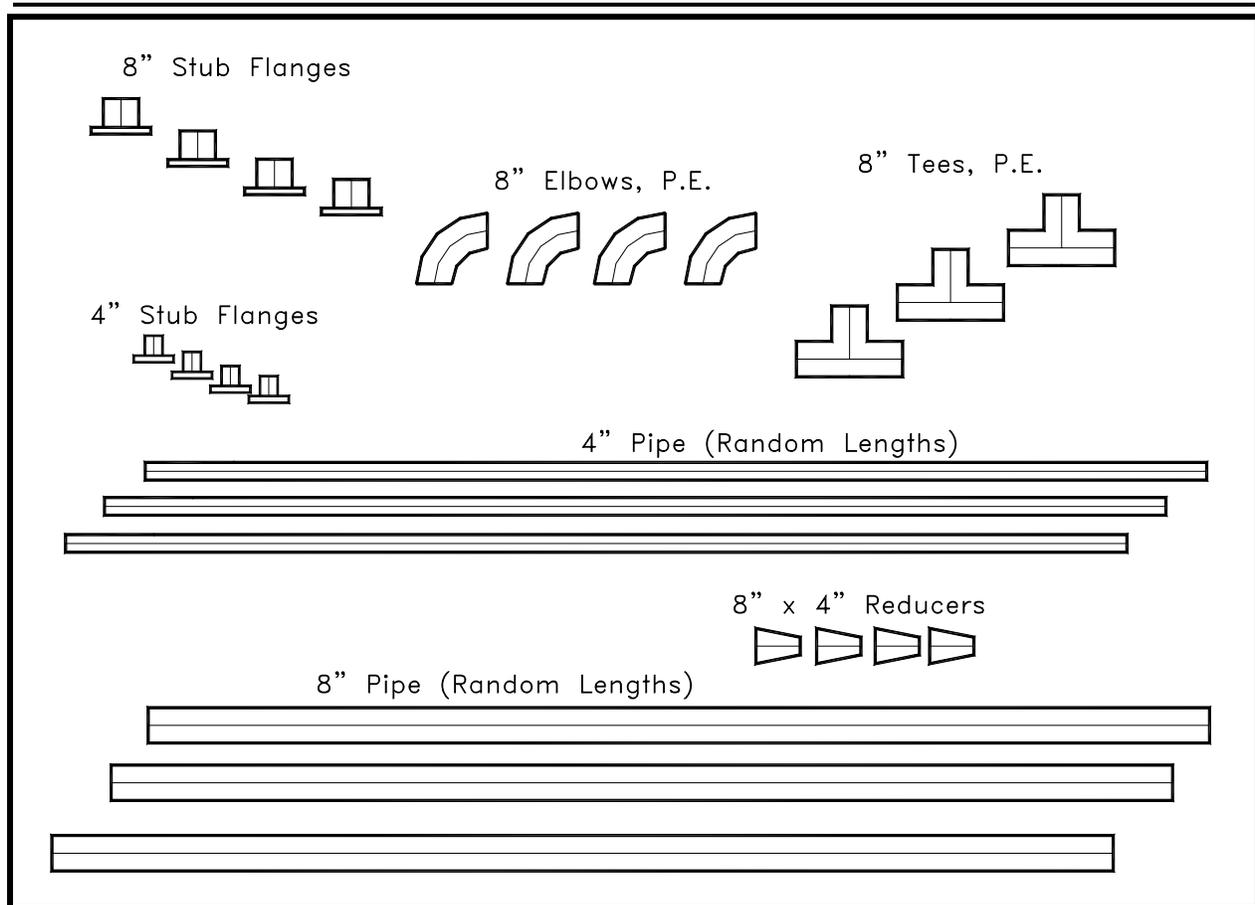


**Figure 1.** Shop fabricated piping systems are prefabricated as assemblies (or "spools") of pipe and fittings in a shop prior to shipment in the field. A minimum number of field weld kits are sent as well to join the assemblies and make up for any field trim.

Another advantage specific to the plain end butt weld system is the elimination of couplings. The plain end butt system is welded similar to steel butt welding in that the pipe, fittings, and flanges are "butted" end to end when welded. No additional parts, such as a coupling, are required. A socket weld system can not mate fitting-to-fitting. These systems require the use of couplings for welding. For example, in Figure 1, the 8" x 4" assembly would require couplings for 1) the 8" tee to flange weld, 2) the 8" elbow to reducer weld, and 3) the 8" elbow to flange weld. A system using plain end butt welds would require no such couplings.

### Loose Supplied Pipe and Fittings

Loose pipe and fittings are supplied just as they are described. Pipe is shipped in random lengths to the



**Figure 2.** Loose pipe and fittings are supplied just as they are described. Pipe is shipped in random lengths along with fittings. Field weld kits are shipped as well, all of which have to be performed in the field.

field along with loose flanges, elbows, tees, reducers, etc. Field weld kits for all of the joints are shipped as no pre-fabrication is performed. Thus all of the welding has to be performed in the field. The typical components of a loose pipe and fittings shipment is shown in Figure 2. A shipment like this would have to be made to install a piping system such as that in Figure 3. When loose pipe and fittings are shipped, 100% of the welds would have to be performed in the field. No welds would be shop welds.

### Advantages and Disadvantages of Each Fabrication Method

Each fabrication method, shop-fab and loose pipe & fittings, has its respective pluses and minuses, and it is these characteristics that should be remembered when selecting the preferred fabrication method. Tabulated below are the advantages and disadvantages of each fabrication method.

**Shop Fabricated Pipe Systems:**

**Advantages:**

- 50 - 90% of all welds can be performed in the shop
- More economical in the long run; the end user only pays for what he/she gets
- Shop fabrication is more efficient than field fabrication (by as much as 5 to 1); installation time is greatly reduced
- Pipe systems can be custom designed and manufactured to customer specifications
- Shop fabrication labor rates are much more economical than field labor rates
- With the plain end butt weld system, no couplings nor nipples are required. Fittings and flanges can be mated to each other without couplings. Field welding of long straight runs of piping do not require couplings. This reduces the total number of welds, both shop & field, in the system.

**Disadvantages:**

- Requires drafting services of either the purchaser or fabricator
- Has higher up-front expenses
- May require a longer delivery time to the jobsite

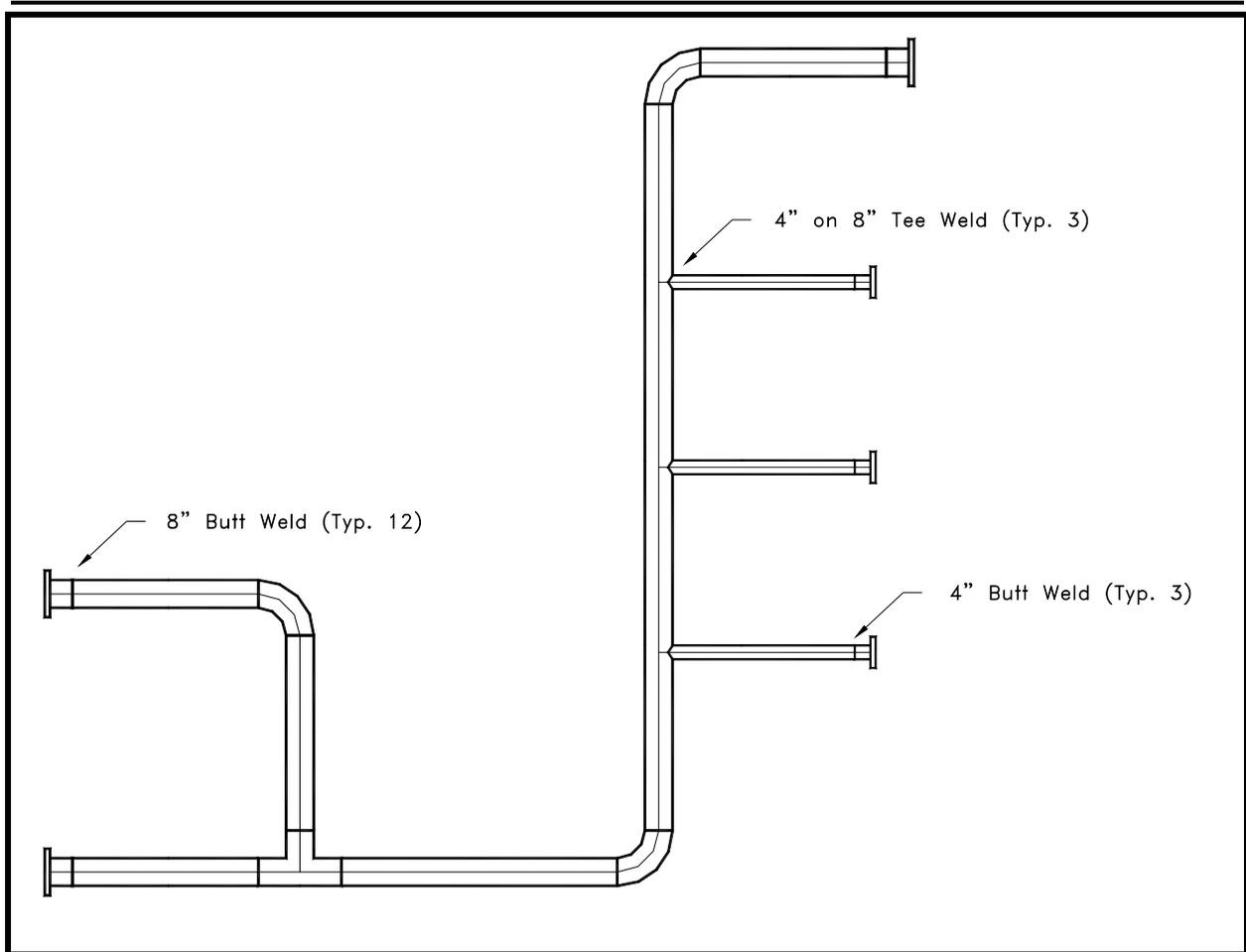
**Loose Pipe and Fittings:**

**Advantages:**

- Fewer up-front costs such as layout design, drafting, etc.
- In the short run, it is more economical
- Has a shorter delivery time to the jobsite
- No drafting services required

**Disadvantages:**

- In the long run, it is not as economical as shop fabrication
- Has a much higher field installation cost
- Requires a greater number of field weld kits
- Pipe, fittings, and welds are wasted because of the need to purchase extras



**Figure 3.** A typical short piping system header. A shop fabricated system or loose pipe and fittings could be supplied to fabricate and install this piping. There are a total of 18 welds in this pipe system.

### **Potential Applications for Each Fabrication Method**

It is not the intent of this report to draw conclusions from the information presented above. Rather, the decision on which fabrication method to choose is left up to the user. There are, however, certain applications that merit the use of one fabrication method over the other.

In general, shop-fabricated pipe systems are preferred over loose pipe and fittings where an investment has already been made in the design of the piping system. In these situations, piping isometrics, plans, and elevations are often already available and can be used for shop-fabrication spool drawings. There is little additional investment required on the customer's part as only the drafting of these spool drawings is required. Shop-fabricated pipe systems are also preferred in installations when 1) there is a quick turnaround on the installation of the piping system, 2) field conditions are adverse, 3) field installation costs need to be kept to a minimum, and 4) where contractors installing the piping system are unfamiliar

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with the piping material. Loose pipe and fittings can be advantageous on projects where routing of the piping system will be done in the field and where no time is dedicated to drafting. However, these projects prove to be less economical than shop-fabricated systems.

**\*\*\* Although each fabrication method has its advantages and disadvantages, no fiberglass pipe system can be successful without proper engineering design. Any system that is not engineered will be subject to detriment over its service life. It has become commonplace to treat fiberglass pipe systems as a custom product, not a "commodity" or "pre-engineered" product. \*\*\***

**\*\*\* While both systems can be manufactured to precise standards, the reliability of a manufacturer's product is only as good as its quality control. Both shop-fabricated and loose pipe & fittings systems can be made to high standards of reliability only if there is a dedication to quality control on the manufacturer's part. \*\*\***

### **Selection Process Guidelines:**

To summarize the information presented in this report, a set of criteria has been tabulated below. These criteria make up many, but not all of the considerations that need to be taken into account during the selection process. By answering each of the questions, the user can have a better idea of which fabrication method to choose.

#### **Is installation of the project critical?**

Shop fabricated pipe systems greatly reduce the number of welds needed to be performed in the field, thus reducing the amount of field labor involved in the project. Field fabricated jobs require less up-front planning and layout design time.

#### **What type of environment will be encountered during field installation?**

Installation conditions can often be adverse, thus making field installation timely and expensive. The shop-fabricated system, with its minimal number of field welds, leaves less to chance during field installation of the project.

#### **How much of the project can be dedicated to shop fabrication and how much to field fabrication?**

Shop fabrication is a much more efficient process than field fabrication. Typically three shop welds can be performed in the same time it takes to perform a single field weld. This ratio, of course, is dependent upon a number of factors, however, the high ratio is primarily due to the planning and scheduling behind shop fabrication.

**Will the installation be performed during a shutdown or on a quick turnaround?**

By minimizing the number of field welds, a shop fabricated system requires a much smaller amount of time dedicated to field installation. Thus shorter turnarounds can be achieved and shutdowns can be minimized.

One aspect of the selection process that should be seen as an advantage is the wide variety of custom products that can be offered in the fiberglass pipe industry. This is an advantage in the sense that it allows the designer to specify a product that best fits its purpose. Among the variables open to the designer is pipe construction (including resin, reinforcement type, helix angle (for filament winding), liner reinforcement, liner thickness, and exterior corrosion barrier.), pipe manufacturing method, joining method, and installation method.

These variables, however, are often seen as a disadvantage to the selection process due to the non-standardization of the products. This is true only to those unfamiliar with the fiberglass industry. As one becomes more and more familiar with the composites industry and sees the advantages of fiberglass, it becomes apparent that flexibility in design is one of its greatest advantages.