D

DOUBLE WALL SYSTEM DESIGN

Double containment piping systems are one of the most economical and reliable methods for protecting against primary piping leaks of corrosive or hazardous fluids. The Duo-Pro and Fluid-Lok systems offered by Asahi/America are the original and flagship products of the industry. When designed and applied correctly, the system can be expected to have a long service life often exceeding 50 years. Double contained systems constructed from thermoplastic materials offer significant cost savings and superior chemical resistance over their metal counterparts. A combination of government regulations, increased concern over environmental and personal safety, and a growing fear of litigation has hastened the development and improvement of double contained piping components into highly engineered systems. With over 15 years of experience in thermoplastic double containment piping, no other company can match Asahi/America's experience and quality.

Use this guide to assist in the design and layout of a double wall pipe system for multiple applications. This guide highlights the areas of consideration that an engineer should take when designing a system. This section should be used in conjunction with Section C, *Engineering Theory and Design Considerations*, to achieve a proper design.

Cost, reliability, and ease of installation can all be improved by careful planning in the conceptual and design phase of any piping project. Specific to double containment systems, the following items must be given careful consideration:

- When to Use Double Containment Piping
- Materials of Construction
- System Selection
- System Sizing
- Specialty Fittings
- Double Contained Valves
- Thermal Expansion
  (particularly important in thermoplastic systems)
- Hanging
- Burial
- Welding Methods
- UV Exposure and Weatherability

Leak detection is an important part of double containment systems. Leak detection of some sort is required on all underground double containment systems. The type of leak detection, the installation method, and the system set up are very different from system to system. For this reason, leak detection will be discussed in the next section separately.

When to Use Double Containment Piping

Underground EPA Requirements

The U.S. Environmental Protection Agency (EPA) has adopted regulations on underground storage tanks (USTs) and related piping. The EPA states these systems pose threats to the environment. EPA regulation 40 CFR 280 spells out the minimum requirements for USTs that contain petroleum or hazardous chemicals.

A summary of the EPA's requirements that affect double-containment piping follows.

This is a brief overview. A project engineer needs a thorough understanding of the regulations prior to designing a system.

EPA's Regulations Cover

Media: All chemicals listed under Subtitle 1 of 40 CFR 280.

Systems: All USTs and related piping.

System requirements: All USTs and pipes must be installed so that a release from the product pipe is contained or diverted to a proper collection system. Containment may be done via a trench, dike, or double containment pipe and tanks. The containment materials must be able to hold the leaking product for a minimum of 30 days. By then, scheduled inspections and periodic monitoring should identify the failure and correct the situation.

Leak detection: Drainage and suction lines require monthly manual inspections for product line leaks. Pressurized systems require automatic monitoring for product failure. In case of a leak, the system must automatically restrict flow of the product.

Compliance dates: The EPA has set requirements for the date of compliance for both new and existing systems. Contact Asahi/America for the latest standard, or visit the EPA's website at www.epa.org.

Above ground: In addition to the EPA requirements for below grade systems, many companies have adopted policies for overhead piping to protect personnel from a possible leak of a harmful chemical.

Materials of Construction

The majority of double containment systems installed worldwide are thermoplastic due to the ease of joining and chemical resistance to hazardous media, as well as underground moisture. Asahi/America offers several materials to handle a wide range of applications. Materials include:

- Polypropylene
- PVDF
- E-CTFE: Halar®
- HDPE: High Density Polyethylene

P.O. Box 653 • 35 Green Street, Malden, MA 02148 • Tel: (800) 343-3618, (781) 321-5409
Fax: (800) 426-7058 • Internet: http://www.asahi-america.com • Email: asahi@asahi-america.com

The carrier pipe (the inner pipe also known as the product pipe) material is selected based on common piping practices using variables such as:

- What is the chemical(s) to be in contact with the system?
- What are the chemical(s) concentrations?
- What temperature will the system operate at?
- What pressure will the system operate at?
- What is the flow of the media in the system?

By answering these questions, the proper materials of construction for the carrier can be selected for the project. To assist in the material selection, refer to the chemical resistance table in Section E, *Chemical Resistance*. A thermoplastic system's ratings for temperature and pressure are based on water. The addition of certain chemicals will add stress to the system and may reduce the recommended operating parameters. For less aggressive chemicals, the use of printed resistance tables is perfectly suitable. For more aggressive chemicals or mixtures of chemicals, the manufacturer of the pipe system should be consulted.

After verifying the standard operating conditions, it is necessary to examine other operations that might affect the piping. The following is a sample of items to investigate prior to specifying a material.

- Will there be spikes in temperature or pressure?
- Is there a cleaning operation that the piping will be exposed to?
- If yes, what is the cleaning agent? What temperature will the cleaning be conducted at?
- Will the system be exposed to sunlight or other sources of UV?

Each of the above questions should be answered and the desired material should be checked for suitability based on the above factors, as well as any others that might be special to the system in question.

Finally, in addition to verifying the temperature, pressure, and media with the thermoplastic pipe material, it is also necessary to verify other components in the system, such as valves, gaskets, valve seat and seals, etc. These should be examined in the same manner as the pipe material.

Once the product pipe has been selected, the containment pipe must be selected. In most cases, the containment pipe is the same as the carrier pipe, such as in polypropylene and HDPE systems. Using the same material internally and externally yields many time-saving advantages on a project. However, in many systems where the product pipe required is a more expensive material, such as PVDF or E-CTFE, a polypropylene outer shell is often used.

Sizing the containment pipe requires consideration of many factors that are different than those used to size the carrier. These include:

- Static and live burial loading
- Leak detection requirements
- Hanging requirements for above-ground applications
- Physical space constraints
- Manufacturability and availability
- Operating pressure

When a double contained system is buried, the containment pipe bears the static soil load and the dynamic loading imposed by traffic, equipment, etc. Section C provides a detailed discussion for calculating static and dynamic loading to determine required wall thickness.

Leak detection requirements must also be considered. Depending on the type of leak detection chosen, there may be minimum requirements for the amount of annular space necessary for successful installation and operation. As a general rule of thumb, a minimum of 3/4 inches annular space is required for installation of a continuous cable system. Leak detection options are discussed in detail later in this section.

Hanging requirements and physical space constraints are also important considerations. Often, trenches or pipe racks are crowded with other systems, so the containment must not be too large. Hanging criteria including support, restraint, and guide spacing are discussed in Section C. The designer of a system should specify the exact hanger location and not leave this portion up to the installer.

Manufacturability and availability can also influence the selection of containment pipe. There must be adequate clearance between the carrier and containment to facilitate efficient manufacturing. This is especially important for the manufacture of fittings. Asahi/America has spent several years improving fabrication techniques to offer the widest variety of sizes in the marketplace. The designer should also be careful to design with standard pipe sizes to avoid costly delays due to lack of availability.

Operating pressure parameters may be quite different for the containment pipe than for the carrier. Often, systems are designed so that any leaks into the annular space drain directly into a manhole or sump. In these open-ended systems, it is virtually impossible to build up significant pressure. As a matter of economy, the containment pipe often has a lower pressure rating and thus a higher dimensional ratio than the carrier pipe.

The final consideration when choosing the containment pipe is the environment in which it will be installed. Outer UV exposure is not ideal for polypropylene systems and protection of the pipe may be required. If surrounding temperatures are extremely low, then certain materials will become brittle in the cold. Consult Asahi/America for specific recommendations in these cases.

P.O. Box 653 • 35 Green Street, Malden, MA 02148 • Tel: (800) 343-3618, (781) 321-5409
Fax: (800) 426-7058 • Internet: http://www.asahi-america.com • Email: asahi@asahi-america.com

D

System Selection

As stated in the previous section, the material must be selected based on the media to run through the system, as well as the operating conditions such as pressure, temperature, and media concentration. In a double containment system, the selection of pipe and associate pipe pressure ratings can be complex, as any combination of material can be used. Table D-1 lists possible pipe ratings that can be used for both the inner and outer pipe wall.

Table D-1. Pressure Ratings and SDR Values

System Name	Material**	Pressure Rating (psi)	Standard Dimensional Ratio
PRO 150	Polypropylene	150	SDR 11
PRO 90*	Polypropylene	90	SDR 17
PRO 45	Polypropylene	45	SDR 33
PVDF 230	PVDF	230	SDR 21
PVDF 150	PVDF	150	SDR 11
HDPE 150	High Density PP	150	SDR 11
HDPE 90	High Density PP	90	SDR 17
HDPE 45	High Density PP	45	SDR 33
Halar®	E-CTFE	Non-Standard	

* Available, but less common. ** Not all materials are available in every diameter size.

In addition to all the choices in material, Asahi/America offers three systems for double containment piping.

- Duo-Pro
- Poly-Flo
- Fluid-Lok

Each system has its ideal purposes and advantages. A description of the three systems follows.

Duo-Pro

The Duo-Pro system is the flagship of the Asahi/America double containment piping system offerings. Duo-Pro is available in polypropylene, PVDF, and E-CTFE, and in any combination of the three. Duo-Pro is available in systems ranging from 1"x 3" to 18"x 24". In addition, larger systems have been made available on request.

Duo-Pro is a fabricated system made from extruded pipe and primarily molded fittings. It has a complete range of molded pressure fittings that are fabricated at the factory into double containment fittings. In addition, Duo-Pro is ideal for drainage applications, having a complete compliment of fittings for drainage applications. It can be assembled using simultaneous butt fusion or staggered butt fusion.

The Duo-Pro system is assembled using a support disc on each end of a pipe or fitting. The support disc centers the carrier inside the containment and locks the two pipes together for simultaneous fusion. On pipe runs, the spider clip fitting is used to support the pipe inside the containment piping. Spider clips are spaced based on hanging criteria by size and material and are designed to avoid point loading of the pipes.

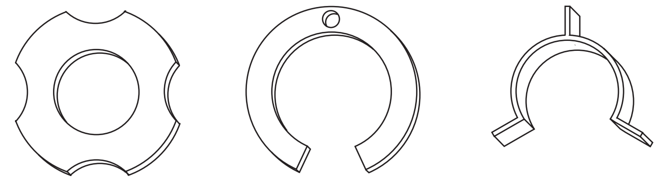

Figure D-11. Support discs and spider clip fittings

Per the EPA's requirements, any double contained system needs to have leak detection. The methods of leak detection include manual inspection, low point sensors, and continuous leak detection cable. Leak detection cable is installed in between the annular space between the inner and outer pipe. Duo-Pro is designed to provide sufficient space for the installation of leak detection cable. Contact Asahi/America technical staff for an exact recommendation.

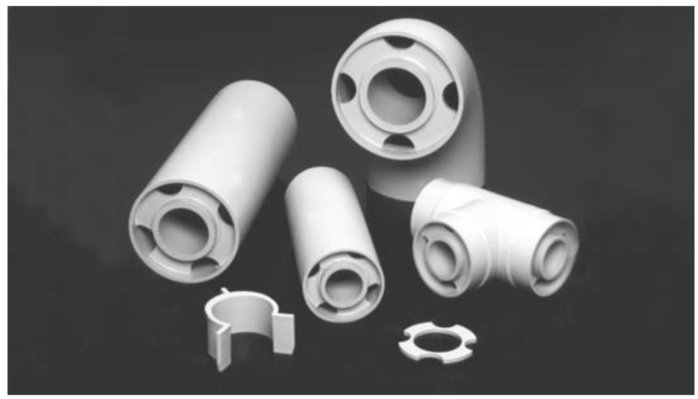

Figure D-12. Duo-Pro piping system

Poly-Flo

The Poly-Flo system is a unique dual extruded and molded system. In all other double containment pipe systems, the inner and outer components are made separately and then assembled into a double wall configuration. This adds time and labor to each project. The Poly-Flo system produces both the inner and outer piping at the same time. Asahi/America's patented extrusion process locks the pipe together by use of continuous support ribs. In addition, most fittings in the system are molded as one piece components. The only deviation is HDPE material, where many fittings are fabricated from double wall pipe.

Poly-Flo is available in 1"x 2", 2"x 3", and 4"x 6". (Consult Asahi/America for the availability of 6"x 8".) Poly-Flo is available in three materials: black polypropylene (UV stabilized), PVDF, and HDPE. It is a unique system, where the carrier pipe has an OD consistent with IPS pipe, while the outer pipe is a jacket not corresponding to an IPS dimension.

Poly-Flo is assembled using simultaneous butt fusion only. The system is available with manual and low point leak detection sensors only. The use of leak detection cable is not possible due to the limited annular space.

P.O. Box 653 • 35 Green Street, Malden, MA 02148 • Tel: (800) 343-3618, (781) 321-5409
Fax: (800) 426-7058 • Internet: http://www.asahi-america.com • Email: asahi@asahi-america.com

Figure D-13. Poly-Flo piping system

Fluid-Lok

The Fluid-Lok system is an all HDPE system. It is manufactured in a similar process to the Duo-Pro system. Fluid-Lok is available in many sizes ranging from 1"x 3" to systems as large as 36"x 42".

Besides being an all HDPE system, Fluid-Lok is different than Duo-Pro in that most fittings are fabricated and not molded. Fabricated fittings are ideal for the application of long sweep 90's and 45's, often required in these systems. Fluid-Lok is designed to accommodate leak detection low point sensors or cable. In addition, HDPE manholes are available and can be directly welded to the pipe system to avoid unnecessary fittings and provide more consistency and leak protection.

Figure D-14. Fluid-Lok piping system

The availability of many materials and three piping systems creates many choices. Each system is designed for specific applications and assembly techniques. To assist in the proper selection of the system, answer the following questions.

Question/Answer

Q: Are you operating under pressure or drainage?

A: Pressure systems may need to have consistent pressure rating fittings on both the carrier and containment pipe. DWV fittings are not allowed in pressure systems.

Q: Do you require consistent pressure ratings on the carrier and containment?

A: If not, cost can be saved by using 150 psi carrier piping and 45 psi containment piping.

Q: What material are you using?

A: Material requirements may determine the system you can choose.

Q: Do you require continuous cable leak detection?

A: Only the Duo-Pro and Fluid-Lok systems can accommodate cable systems.

Based on knowing the operating parameters and the desired material, one of the following systems can be chosen for the installations.

Table D-2. Double Containment Systems

Product Name	System Name**	Material	Size Range (inches)
PRO 150 x 150	Duo-Pro	Polypropylene	1 x 3 to 16 x 20
PRO 150 x 45	Duo-Pro	Polypropylene	2 x 4 to 18 x 24
PRO 45 x 45	Duo-Pro	Polypropylene	4 x 8 to 18 x 24
PVDF x Pro 150	Duo-Pro	PVDF x Polypro	1 x 3 to 12 x 16
PVDF x Pro 45	Duo-Pro	PVDF x Polypro	2 x 4 to 12 x 16
PVDF x PVDF	Duo-Pro	PVDF x PVDF	1 x 3 to 8 x 12
Poly-Flo BPP	Poly-Flo	Black Polypropylene	1 x 2, 2 x 3, 4 x 6
Poly-Flo PVDF*	Poly-Flo	PVDF	1 x 2, 2 x 3
Poly-Flo HDPE	Poly-Flo	HDPE	1 x 2, 2 x 3, 4 x 6
HDPE SDR 21x21	Fluid-Lok	HDPE	1 x 3 to 16 x 20
HDPE SDR 17x17	Fluid-Lok	HDPE	3 x 6 to 18 x 24
HDPE SDR 17x33	Fluid-Lok	HDPE	3 x 6 to 18 x 24
HDPE SDR 33x33	Fluid-Lok	HDPE	3 x 6 to 18 x 24

* Consult factory for availability.
** Fluid-Lok is available in other SD ratios, as well as larger dimensions.

System Sizing

In Section C, *Engineering Theory and Design Considerations*, there is a detailed discussion on fluid dynamics and determination of flow rates and pressure drops. It is recommended when using any thermoplastic with a hazardous chemical to maintain flow rates below a velocity of 5 ft/second. High velocities can lead to water hammer in the event of an air pocket in the system. Water hammer can generate excessive pressures that can damage a system. For safety reasons, high velocities should be avoided.

In addition, high velocities also mean added pressure drop, which, in turn, increases demand on the pump. If the flow velocity is not required, it is recommended to size a system with

ASAHI/AMERICA
Rev. EDG–02/A
P.O. Box 653 • 35 Green Street, Malden, MA 02148 • Tel: (800) 343-3618, (781) 321-5409
Fax: (800) 426-7058 • Internet: http://www.asahi-america.com • Email: asahi@asahi-america.com

minimal pressure drop. It is also recommended to oversize a design to allow for future expansion or chemical demand. Once a system is in place, it is difficult to add capacity to it.

Specialty Fittings

Double containment systems, for the most part, can be thought of in the same manner as single wall piping systems with a few exceptions. In a double wall system, the issue of thermal expansion is more complicated (see next page), welding is similar but not the same, and finally, the outer containment pipe must have a start and stop.

D

The major fitting that sets Asahi/America systems apart from all other double wall systems is the patented Dogbone force transfer fitting. The Dogbone fitting can be used in many ways to assist in the design of a proper double containment piping system.

The Dogbone is used for:

- Locking the inner and outer pipes together
- Compartmentalizing pipe section
- Termination of the containment pipe
- Sensor installation
- Control of thermal expansion

Figures D-15 through D-18 depict a few uses of the Dogbone.

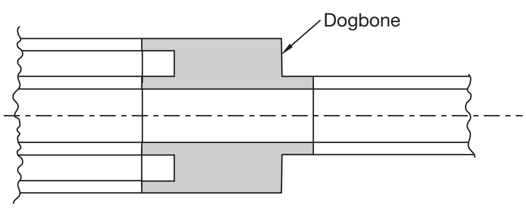

Figure D-15. Outer containment termination

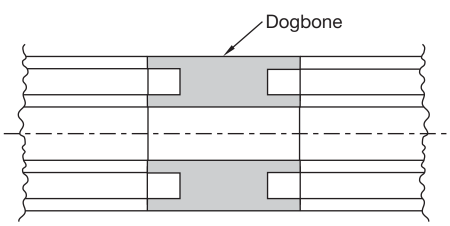

Figure D-16. Locking inner and outer pipes

Dogbones are available in solid and annular forms. A solid Dogbone does not allow the passage of fluid in the annular space to pass through, while annular Dogbones will allow the passage. The placement and purpose of the fitting will determine the style required.

Dogbone fittings are available in the Duo-Pro and Fluid-Lok system. The Poly-Flo system does not require the fitting, as the pipe is continuously supported and locked together.

Finally, the Dogbone can be used for connecting in low point leak detectors, ventilation, and drainage. When designing a double wall system, it is important to incorporate high point vents to eliminate air from the system. In addition, in the event of a leak, a drainage method for the containment pipe is required. Connection methods for these valve requirements are shown in Figures D-17 through D-20.

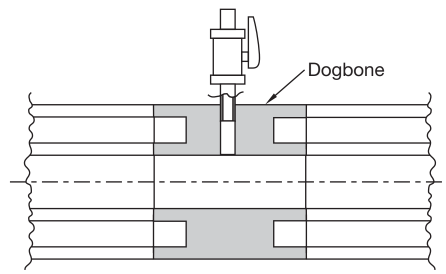

Figure D-17. Ventilation of inner pipe: Duo-Pro and Fluid-Lok

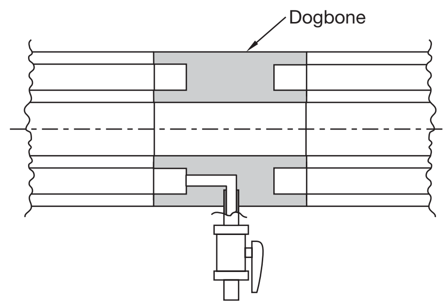

Figure D-18. Drainage of containment pipe: Duo-Pro and Fluid-Lok

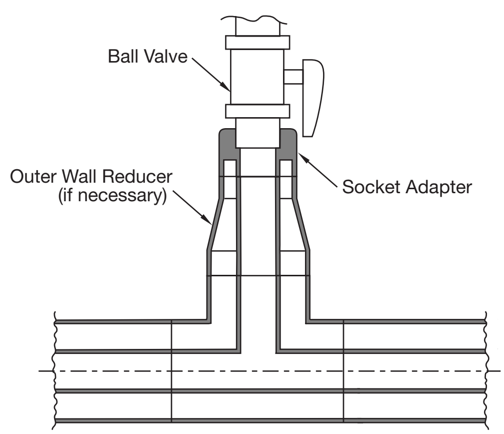

Figure D-19. Ventilation of inner pipe: Poly-Flo system

P.O. Box 653 • 35 Green Street, Malden, MA 02148 • Tel: (800) 343-3618, (781) 321-5409
Fax: (800) 426-7058 • Internet: http://www.asahi-america.com • Email: asahi@asahi-america.com

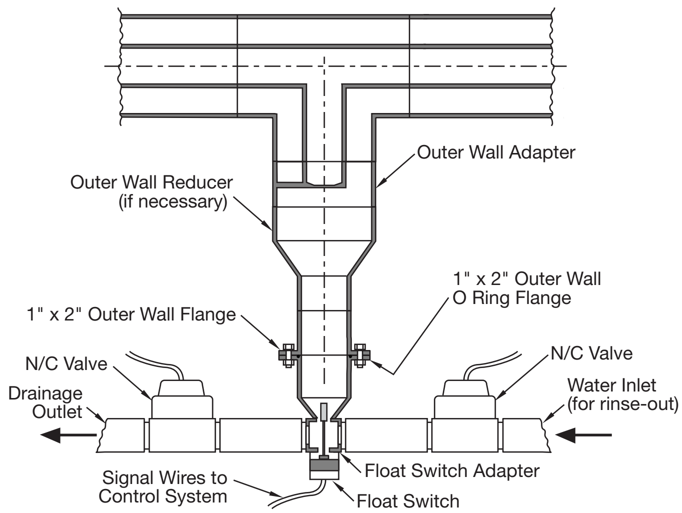

Figure D-20. Drainage of containment pipe: Poly-Flo system with low point sensor

Double Contained Valves

In pressurized systems, the necessity of valves can be accomplished without interrupting the integrity of the double containment system. Double contained valves are available in many shapes and forms. Double contained valves are available in any style valve such as ball, butterfly, diaphragm, check, and gate. The valve selected, based on the application, determines the shape of the outer containment.

The following figures demonstrate a few valve configurations that are available from Asahi/America, Inc. Other options are readily available on request.

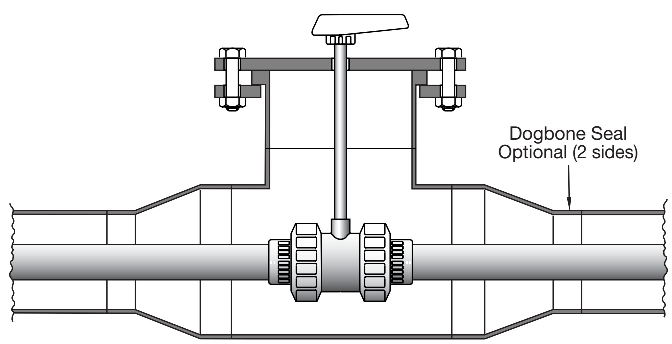

Figure D-21. Double contained ball valve with stem extension: Duo-Pro system

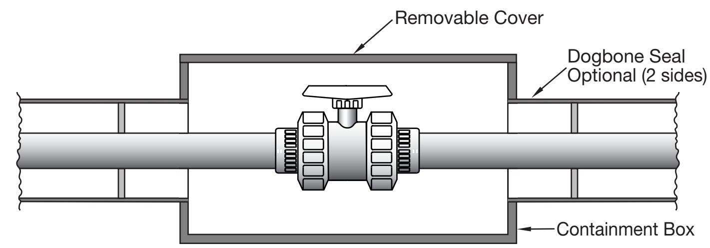

Figure D-22. Double contained ball valve without stem extension: Poly-Flo system

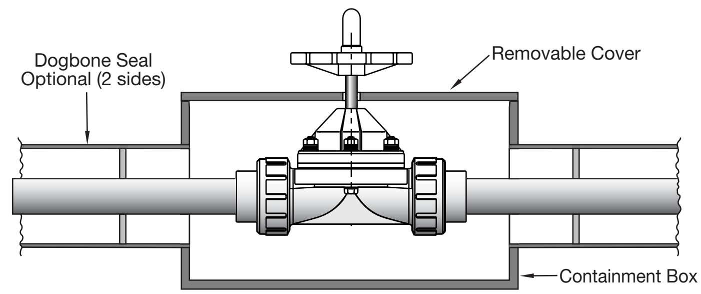

Figure D-23. Double contained diaphragm valve with stem extension: Poly-Flo system

More than valves can be installed. Items such as flow meters, and temperature and pressure monitors can also be incorporated into the internal containment portion of the system. Contact Asahi/America's Engineering Department to discuss your particular needs. It is important to specify and design in the need to access valves for maintenance purposes.

Thermal Expansion

Based on your operating criteria, thermal expansion must be considered. For systems maintained at consistent temperatures, compensation for thermal effects may not be required. In a double contained piping system, three types of expansion can occur:

- Carrier pipe exposed to thermal changes, while containment remains constant. Typically possible when carrier pipe is exposed to liquids of various temperature, while outer containment is in a constant environment such as in buried applications.
- Containment piping experiences thermal changes, while carrier remains constant. Typical application is outdoor pipe racking with constant temperature media being transported in carrier.
- Both inner and outer experience temperature changes.

The Dogbone fitting is a proven and effective way to control thermal expansion where a restrained system is acceptable. It can also be used to direct the growth of a flexible system. For systems maintained at consistent temperatures, compensation for thermal effects may not be required. It is, however, impor-

P.O. Box 653 • 35 Green Street, Malden, MA 02148 • Tel: (800) 343-3618, (781) 321-5409
Fax: (800) 426-7058 • Internet: http://www.asahi-america.com • Email: asahi@asahi-america.com

tant to review all aspects of the operating environment such as:

- Is it outdoors where it will be exposed to changing weather?
- Is the system spiked with a high temperature cleaning solution?
- Will the system run at a significantly higher or lower temperature than the installation temperature?

The occurrence of any thermal change in a plastic system will cause the material to expand or contract.

Thermoplastic systems can be used in hot applications and applications where the temperature is cyclical; it just requires analysis of the thermal expansion effects. Section C, *Engineering Theory and Design Considerations*, walks through the steps of calculating thermal expansion, end loads, and expansion compensating devices. In most cases, the use of expansions, offsets, and proper hanging techniques are all that is required to ensure a proper design.

Hot systems also reduce the rigidity of thermoplastic piping, which, in turn, decreases the support spacing between hangers. In smaller dimensions, it is recommended to use continuous supports made of some type of channel or split plastic pipe.

Finally, the use of hangers as guides and anchors becomes important. As the design procedures in Section C indicates, certain hangers should be used as guides to allow the pipe to move in-line, while other hangers should be anchoring locations used to direct the expansion into the compensating device. The anchors and hangers should be designed to withstand the thermal end load.

In a buried system, the standard Dogbone fitting will lock the inner and outer pipe together. The surrounding ground and fill should eliminate the movement of the outer pipe. In systems that are hung, the outer pipe hanger must withstand the thermal end load. To properly hang these systems, a special Restraint Dogbone is recommended at the hanger locations.

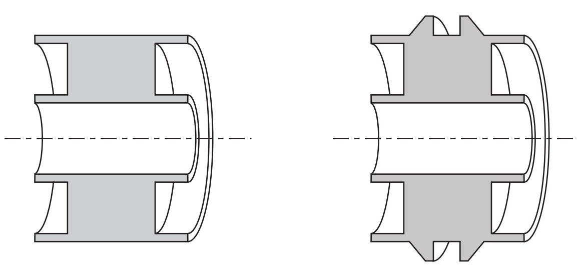

Figure D-24. Dogbones

For calculation of allowed stresses and design of expansion compensation devices, refer to Section C, *Engineering Theory and Design Considerations.*

Hanging

See Appendix A for proper hanging distances by size and material. As in any thermoplastic system, the selection of hangers is an important decision. Hangers that scratch or create point loads on the pipe are not recommended. The ideal hanger is a thermoplastic component. In many cases an all plastic hanger may not be available. In these cases a metal hanger is acceptable, but precautions should be taken. Any sharp edges on the hanger should be removed. A cushion made of rubber is recommended in the event that the pipe shifts, thus preventing scratching.

Section C provides detailed recommendations on hanging double containment pipe. Please consult this section prior to specifying the hangers.

Burial

Due to EPA requirements, burial of double containment piping is a common practice. In most cases, the burial of double wall pipe is the same as that of a single wall pipe system. Careful consideration of the soil type, compaction, trench detailing, back fill, load, etc. are necessary to consider in the proper design. Section C, *Engineering Theory and Design Considerations*, provides a step-by-step detailed process of how to properly bury the system.

Live loads also pose the added complication when burying a system. It is important to look at the possibility of the pipe system being driven over, as well as the type of vehicle that would be creating the live load.

In the design it is imperative to call out the recommendations of the burial in the details of the drawing set. By calling these details out, the contractor will be in a better position to properly install the pipe as required.

Welding Methods

All double containment systems offered by Asahi/America, Inc. are available for butt-fusion assembly. Butt fusion provides reliable fusion, but is also ideally suited for the double wall system. By properly aligning the carrier and containment piping with the support disc, both the inner and outer pipe can be welded at the same time. This reduces the assembly time, as well as the need for extra fittings such as couplings. What can be accomplished in one weld can take up to 4 welds in other systems (weld the inner and outer separately on either side of a coupling).

When building a system that is made of dissimilar materials (example: PVDF x Pro 45), the pipes cannot be welded simultaneously due to different heat and joining force requirements. For these systems staggered welding is required, where the inner pipe is welded first and the outer pipe welded second using a special annular heating element. Staggered fusion does take more time due to the extra welds, but still proves econom-

P.O. Box 653 • 35 Green Street, Malden, MA 02148 • Tel: (800) 343-3618, (781) 321-5409
Fax: (800) 426-7058 • Internet: http://www.asahi-america.com • Email: asahi@asahi-america.com

ical when compared to using like materials such as PVDF on both the carrier and containment pipe depending on pipe size, project requirements, and installation environment.

See Section F, *Installation Practices*, for detailed information on double containment welding methods.

UV Exposure and Weatherability

All thermoplastic materials react to the exposure of UV differently. PVDF and E-CTFE materials are completely UV resistant over the course of its design life. However, certain chemicals containing Cl anions exposed to UV light can create a free radical Cl that will attack the PVDF pipe wall. For more information on these chemicals, refer to Section F, *Good Installation Practices,* on weatherability and UV exposure of the piping.

Polypropylene is not UV stable. In direct exposure to sunlight it will break down. The effect can be seen in a noticeable color change in the pipe. In pigmented PP systems, the color change will actually create a protective shield on the outer layer of the pipe and prevent further degradation. For PP pipes with a wall thickness greater than 0.25", the effect of UV is normally reduced and can be used outside. However, it is still recommended to protect it from UV exposure for added safety.

The Fluid-Lok HDPE material is UV stabilized. Fluid-Lok pipes contain carbon black to make the material UV stable and acceptable for use in outside applications. Other HDPE materials made by other manufacturers may require protection. Be sure to consult a manufacturer prior to selecting a pipe system.

P.O. Box 653 • 35 Green Street, Malden, MA 02148 • Tel: (800) 343-3618, (781) 321-5409
Fax: (800) 426-7058 • Internet: http://www.asahi-america.com • Email: asahi@asahi-america.com