thermoplastic piping systems

CHEMLINE PLASTICS
SUPERIOR FLOW SOLUTIONS

Storage • Handling • Tool Selection • Training
Welding • Installation • Testing • Repair

ISO 9001:2015 CERTIFIED

STORAGE, HANDLING, WELDING + QUALITY ASSURANCE

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Storage + Quality Assurance *page*

GENERAL

When pipe, fittings, and fabrications arrive on site, they should be inspected to ensure that the proper components have arrived and that no damage has occurred during shipment. Chemline Plastics goes to great lengths to ensure that pipe and fittings are properly packaged for shipment. If damage occurs, the freight company should be notified immediately.

STORAGE

Preferably, pipe should be stored inside or in a trailer. Care should be taken to properly support pipe during storage. Use the hanging criteria for the proper support distance for storage. Pipe can be stacked during storage. Heavier pipes of larger dimensions should be stored at the bottom. However, it may prove more practical to segregate by size for easier access during the project. Pipe should not be stored above the recommended maximum height of 4 feet. If material is stored outside, it is preferable to cover with a tarp in case of rain. PVDF is UV resistant, but polypropylene will degrade over time when exposed directly to UV. Depending on the size of the pipe and the wall thickness, it could cause physical damage that could reduce the allowable pressure rating. In all cases, the UV will cause a color change over time that may not be acceptable for aesthetic reasons. In general, covering polypropylene during storage is recommended. Fittings are best kept in their boxes or bags, as they are shipped in separate containers by size, style, and material. This will allow for simplified picking and inventory control throughout the project.

ALIGNMENT

Dual containment piping contains spider clips to center the inner pipe within the outer pipe. These clips are snugly fixed onto the inner pipe at roughly 1-metre distances, with the end clips approximately ½-metre from each end of a 5-metre length. No spider clips are used in dual containment fittings. The spider clips should not move during storage and handling but you should verify and correct their spacing before installation, if possible.

On systems using the same materials for the inner and outer pipe, end supports are added inside each end and are welded in place on both pipes to prevent movement between the inner and outer pipe. If, during assembly, you need to cut a pipe to a shorter length, ensure that the spider clip spacing is maintained, and that end supports are welded onto the shorter pipe length before installation.

HANDLING

Preferably, piping systems should be built at the site of use to simplify installation. Care should be taken to properly support and align pipe and fittings during installation/welding. If a system must be built away from the site of installation, care must be used when moving the assembly into place, such as lifting to install at a height above assembly level. Use the hanging criteria for the proper support distance for lifting. Straight pipe runs can be pulled along its length over soft ground that contains no rocks or hard objects that can scratch the outer surface. Complex systems should never be pulled over any surface or lifted, and should be installed as a series of simpler assemblies moved/ lifted into place individually to avoid twisting or bending that could cause damage to the system.

Dual containment pipe runs can be pulled lengthwise but bending and lifting should be minimized since the inner pipe is difficult to check for breaks. Again, straight pipe runs can only be pulled over soft ground that contains no rocks or hard objects that can scratch the outer surface. The bending capability of the outer pipe is lower than that of the inner pipe so it will dictate how much dual containment systems can bend. Use the hanging criteria for the proper support distance for lifting applicable to outer pipe. Plastic piping will allow some flex to compensate for ground unevenness or rolling/dragging a pipe run into a ditch from the end or from the side. Avoid sharp bends in the piping, and spread the bend along the longest possible length of pipe to minimize chances of damage to the system.

TOOL SELECTION

The selection of the type of welding method conducted on a double wall industrial piping project should be based on the following criteria:

- Material
- Sizes to be installed
- Welding location
- Type of installation
- Similar to dissimilar material
- Available expertise

For assembling double containment piping systems made from PVDF, PP, E-CTFE, and HDPE, there are many choices of equipment available, each having its advantages and disadvantages. On all Chemline's standard double wall containment systems, butt fusion is the only joining system offered due to its ideal functionality in this application. Tables contain data on available welding equipment. There is no one right piece of equipment that can handle all sizes and materials. It is absolutely critical to have the right equipment on site for proper installation.

materials / welding machines		Contact Butt Fusion								Contact Socket Fusion		
		Manual		Hydraulic[6]						Manual		
pipe type	material & wall thickness	Miniplast	Maxiplast	W4400	W4600	W4900	W5100	W5500	W6100	HSOC1[7]	HSOC2[7,8]	W3511 Bench[7]
single pipe	PP SDR11	1/2″ – 4″	1-1/2″ – 6″	1-1/2″ – 6″	2-1/2″ – 10″	3″ – 12″	8″ – 18″	8″ – 20″	12″ – 24″	1/2″ – 2″	2-1/2″ – 5″	1/2″ – 5″
single pipe	PP SDR33	1/2″ – 4″	1-1/2″ – 6″	1-1/2″ – 6″	2-1/2″ – 10″	3″ – 12″	8″ – 18″	8″ – 20″	12″ – 24″	1/2″ – 2″	2-1/2″ – 5″	1/2″ – 5″
single pipe	AirPro® PE100 SDR7	–	1-1/2″ – 4″[5]	1-1/2″ – 4″[5]	2-1/2″ – 4″[5]	3″ – 4″[5]	–	–	–	1/2″ – 2″	2-1/2″ – 5″	1/2″ – 5″
single pipe	AirPro® PE100 SDR11	1/2″ – 4″	1-1/2″ – 6″	1-1/2″ – 6″	2-1/2″ – 10″	3″ – 12″	8″ – 18″	8″ – 20″	12″ – 24″	1/2″ – 2″	2-1/2″ – 5″	1/2″ – 5″
single pipe	PVDF SDR21	–	–	–	–	–	–	–	–	–	–	–
single pipe	ECTFE[1] SDR21	1/2″ – 4″	1/2″ – 4″	1-1/2″ – 4″	2-1/2″ – 4″	3″ – 4″	–	–	–	–	–	–
single pipe	PTFE	–	–	–	–	–	–	–	–	–	–	–
single pipe	Backwelding	–	–	–	–	–	–	–	–	–	–	–
dual containment simultaneous welding	PE/PP SDR11 x 33	3″ x 1″ to 4″ x 2″	4″ x 1-1/2″ to 6″ x 3″	4″ x 1-1/2″ to 6″ x 3″	6″ x 3″ to 10″ x 6″	6″ x 3″ to 12″ x 8″	12″ x 8″ to 18″ x 14″	12″ x 8″ to 20″ x 16″	16″ x 12″ to 24″ x 20″	–	–	–
dual containment simultaneous welding	PE/PP SDR33 x 33	3″ x 1″ to 4″ x 2″	4″ x 1-1/2″ to 6″ x 3″	4″ x 1-1/2″ to 6″ x 3″	6″ x 3″ to 10″ x 6″	8″ x 4″ to 12″ x 8″	12″ x 8″ to 18″ x 14″	12″ x 8″ to 20″ x 16″	16″ x 12″ to 24″ x 20″	–	–	–
dual containment simultaneous welding	PVDF x PVDF SDR21	–	–	–	–	–	–	–	–	–	–	–
dual containment simultaneous welding	ECTFE[1] x ECTFE[1] SDR21	–	–	–	–	–	–	–	–	–	–	–
dual containment staggered welding	PE/PP SDR17 x PVDF SDR21	3″ x 1″ to 4″ x 2″[2]	4″ x 1-1/2″ to 6″ x 3″[4]	4″ x 1-1/2″ to 6″ x 3″[4]	6″ x 3″ to 10″ x 6″	6″ x 3″ to 12″ x 8″[4]	12″ x 8″ to 18″ x 14″[4]	12″ x 8″ to 14″ x 10″[4]	–	–	–	–
dual containment staggered welding	PE/PP SDR17 x ECTFE[1] SDR21	3″ x 1″ to 4″ x 2″[2]	4″ x 1-1/2″ to 6″ x 3″[4]	4″ x 1-1/2″ to 6″ x 3″[4]	6″ x 3″ to 8″ x 4″	6″ x 3″ to 8″ x 4″[4]	–	–	–	–	–	–

welding machines / materials		Non Contact (Infrared) Butt Fusion				Beadless Butt Fusion		Electro Fusion	Hot Air Fusion
		Manual	CNC			CNC			
pipe type	material & wall thickness	SP63M	SP110/.10S	SP250S	SP315S	SP110B	SIB – 2	HPF	HA30 – 400
single pipe	PP SDR11	1/2" – 2"	1/2" – 4"	4" – 10"	4" – 12"	1/2" – 4"	3/4" – 2"	1/2" – 4"	–
single pipe	PP SDR33	1/2" – 2"	1/2" – 4"	4" – 10"	4" – 12"	1/2" – 4"	3/4" – 2"	1/2" – 4"	–
single pipe	AirPro® PE100 SDR7	–	–	–	–	–	–	–	–
single pipe	AirPro® PE100 SDR11	1/2" – 2"	1/2" – 4"	4" – 10"	4" – 12"	1/2" – 4"	–	–	–
single pipe	PVDF SDR21	1/2" – 2"	1/2" – 4"	4" – 10"	4" – 12"	1/2" – 4"	3/4" – 2"	1/2" – 2"	–
single pipe	ECTFE[1] SDR21	1/2" – 2"	1/2" – 4"	–	–	–	–	1/2" – 4"	–
single pipe	PTFE	–	1/2" – 2"[3]	–	–	–	–	1/2" – 2"	–
single pipe	Backwelding	–	–	–	–	–	–	–	1/2" – 24"
dual containment simultaneous welding	PE/PP SDR11 x 33	3" x 1" to 4" x 2"	3" x 1" to 4" x 2"	4" x 2" to 10" x 6"	4" x 2" to 12" x 8"	–	–	–	–
dual containment simultaneous welding	PE/PP SDR33 x 33	3" x 1" to 4" x 2"	3" x 1" to 4" x 2"	4" x 2" to 10" x 6"	4" x 2" to 12" x 8"	–	–	–	–
dual containment simultaneous welding	PVDF x PVDF SDR21	3" x 1" to 4" x 2"	3" x 1" to 4" x 2"	4" x 2" to 10" x 6"	4" x 2" to 12" x 8"	–	–	–	–
dual containment simultaneous welding	ECTFE[1] x ECTFE[1] SDR21	3" x 1" to 4" x 2"	3" x 1" to 4" x 2"	4" x 2"	4" x 2"	–	–	–	–
dual containment staggered welding	PE/PP SDR17 x PVDF SDR21	3" x 1" to 4" x 2"[2]	3" x 1" to 4" x 2"[2]	8" x 4" to 14" x 10"[2]	8" x 4" to 12" x 8"[2]	–	–	–	–
dual containment staggered welding	PE/PP SDR17 x ECTFE[1] SDR21	3" x 1" to 4" x 2"[2]	3" x 1" to 4" x 2"[2]	8" x 4"[2]	8" x 4"[2]	–	–	–	–

WELDING ENVIRONMENT

Chemline does not set requirements for proper welding environments. As the installer, it is necessary to choose the environment based on the installation type, timing or quality goal. In most systems, pipe is either going into a pipe rack, beneath a floor or wall, or buried underground. In all these cases, conducting welds in the actual final location may not always be the most convenient location for welding. In fact, in most cases, it is preferable to prefabricate spool piece components and conduct final welds or hook-up in the pipe rack.

If possible, set up a welding area to build the spool pieces. The weld area should be situated in an area that has reduced exposure to wind, possible rain, and extreme cold temperatures. Building spool pieces inside a weld shop may prove advantageous. A fairly controlled environment and organized work space will improve efficiency and quality of the system to be installed.

Not all welding can be conducted in a shop and eventually field welds will need to be done. Some systems will be installed completely outside, with all the welds perhaps conducted in place.

When welding outside, several factors have to be considered. It is always important not to weld in the rain. Rain will damage equipment and improperly influence the weld. For rainy days, a shelter or tent should be constructed over equipment. In addition to rain, high winds and cold temperatures, below 40° F, will negatively influence the welding process. If these conditions are not avoidable, a heated tent structure is recommended. For specific recommendations by tool type, consult Chemline.

When conducting field welds in a pipe rack or in a trench, it is important to have the location of the weld well planned. Vertical welds in any location will prove difficult to conduct and should be avoided. The field weld that connects up prefabricated spool pieces should be a pipe-to-pipe weld whenever possible. Pipe-to-pipe welds are easier to align and level, making the weld easier to conduct in possibly tight quarters.

In all field welds, in the rack or in a trench, it is important to have ample room for welding equipment and to choose the proper welding equipment. In some underground installations, it may be necessary to increase the width of the trench in weld locations. Many underground systems are welded above ground and then lowered down into the trench to avoid placing equipment in narrow trenches. The same is true in crowded pipe racks. Many times it will prove more efficient to prefab spools and use flanges or unions to connect them together in the pipe rack. Consult Chemline for the design and use of a double contained flange.

TRAINING AND PREPARATION

A repair to a system can prove difficult and costly. One bad weld can cause hours of repair and frustration, as well as lost revenue. For these reasons, it is critical to receive training at the time of job start-up and use certified personnel throughout the course of a project.

Tool operation is only one of several factors in a thorough training course. Operators, inspectors, and managers need to understand the physical nature of the material, how to properly handle it, how to inspect welds, how to identify potential problems, how to properly maintain equipment and finally, how best to tie into a line and test it.

During Chemline's certified training sessions, all of the above topics are discussed. For the installation of a double containment system, the following training sessions are available:

- Tool Operator Training
- Quality Control Inspection

Both of these can be conducted on site during the time of the start-up. The depth of training in a double containment piping system is based on the system type to be installed. Systems that require staggered fusion are more involved to install and may require the operation of different equipment.

In addition to the above on-site training, Chemline also offers courses that are held at the corporate office for the following topics:

- Certified Maintenance and Repair
- Certified Trainer (prerequisites apply)

Consult with Chemline for dates and availability of corporate programs.

During the on-site training process, Chemline certified trainers will set recommendations for the class size based on the tool type. In general, groups of four are recommended for the welding operation portion of the training. Typically, two groups can be certified in one day on the welding portion of the seminar. On simple installations, it may be faster; and on more complex installations, it may be longer. To reduce the distraction within the class, it is important that only personnel who will be conducting the weld operation during the project participate in the training. It is also recommended that if a third party QC is to be used that they also attend the full training course to fully understand the welding process and QC parameters.

PREPARATION

To best use training time, preparation should be made prior to the trainers' arrival on site. A recommended list of preparations follows.

- Ensure that project material is on site. It is not critical to have all material, but enough to start the project. Once training is complete, it is practical for the trainer to oversee the beginning portion of the installation. Many times new questions and challenges arise once the actual installation starts. In addition, if there is a significant period of time between the training and actual installation, operators may forget portions of the training or different operators may now be slated for the welding operation. Both scenarios require additional training.
- Ensure required tools are on site. Do not open the tools until a certified trainer is present. If more tools are ordered during a project, this is no longer required as proper unpacking and set up of the equipment is covered in the training process.
- Ensure that the correct power is available. Many pieces of equipment require 220 Volt single or three phase power supply. Consult with the factory or distributor at the time of tool ordering.
- If possible, have a conference room with an overhead projector available for the classroom portion of the training. If this is not available, select an area where all personnel will be able to see and hear the trainer for this portion of the discussion.
- Ensure that pipe samples are available for the training session. Asahi/America does not normally provide samples for the training.
- Ensure extra components such as welding rod, support discs, and hot air welders are ordered and available at the time of training. Such components.will be required throughout the project.

Formal training can be the key factor in starting a project off in the right direction. Take advantage of this service while on site. Chemline also offers field technicians for hire to oversee project welding and training for any specified amount of time. Contact the Chemline for more information.

TOOL COMMISSION AND DAILY CHECKS

Checking equipment and welding technique daily is recommended. This is particularly important on larger projects where there are many welders on site. This daily check will allow QA to ensure all welders are up to speed on tool operation, welding technique, and inspection. Most problems in the field occur due to improper usage of equipment, rather than equipment failure.

During the initial training of the project, many welds are produced in the presence of a qualified trainer. These welds should be kept and used for the daily checks. Each welder should conduct one coupon test weld and submit it to QA. The coupons should be compared to initial samples. Inspection should include bead formation, sizing, and weld label.

Conducting preventive maintenance to the equipment at the beginning of each day is also required. The maintenance recommended aries on each weld tool type. Consult the Operation Manual for items to be checked daily.

By keeping equipment in good operating condition and ensuring all operators are up to speed, tool problems or welding errors are less likely to occur.

PIPE CUTTING

In most sizes, band saws, vertical or horizontal, will work very well for plastic. Since plastic pipes can have a very heavy wall thickness, it is important to travel slowly through the band saw to avoid the blade from bending and creating an angled cut. For smaller pipe sizes and Poly-Flo pipes up to 2 x 3, a circular blade chop saw will also provide neat and accurate cuts. A miter box chop saw is also very useful if angled welds are to be done in the field.

If only manual saws are available, a hack saw will certainly cut through small dimensions, but avoid using a fine blade as it will take considerable time. In addition, reciprocating saws are generally not the best choice as the blades are only long enough to cut one wall at a time. If too fine of a blade is used, the material will become hot and can fuse itself back together partially behind the blade travel.

WELD PREPARATION

The type of material and system will dictate welding method and tool selection. One important factor in welding a dual containment system is the alignment of the support discs. To allow the pulling of cable, it is necessary to have the disc openings aligned at the pipe bottom.

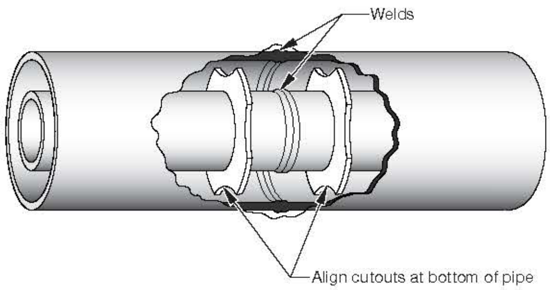

Figure A: Support Disc Aligment

In a dual containment system, it is important to rotate the pipe ribs. Since a dual containment system cannot accommodate leak detection cable, rotating the ribs is recommended to allow a possible leak to make its path to the bottom annular space.

HANGING

Hanging any thermoplastic double wall system is not that much different than hanging a metal system. Typically, the spacing between hangers is shorter due to the flexibility of plastic. In addition, the type of hanger is important.

Hangers should be placed based on the spacing requirements provided in Appendix A. Since thermoplastic materials vary in strength and rigidity, it is important to select hanging distances based on the material you are hanging. Also, operating conditions must be considered. If the pipe is operated at a higher temperature, the amount of hangers will generally be increased. Finally, if the system is exposed to thermal cycling, the placement of hangers, guides, and anchors is critical In these cases. The hanger locations should be identified by the system engineer and laid out to allow for expansion and contraction of the pipe over its life of operation.

When selecting hangers for a system, it is important to avoid using a hanger that will place a pinpoint load on the pipe when tightened. For example, a U-bolt hanger is not acceptable for high-purity thermoplastic piping systems. See Figures B and C.

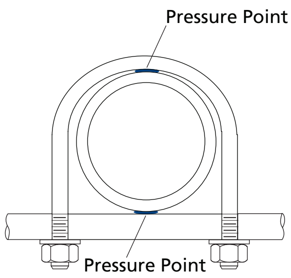

Figure B: Effects of U-bolt on pipe–not recommended

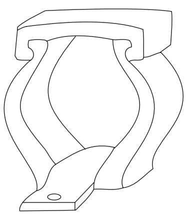

Figure C: Recommended hanger

Hangers that secure the pipe 360° around the pipe are preferred. Thermoplastic clamps are also recommended over metal clamps, as they are less likely to scratch the pipe in the event of movement. If metal clamps are specified for the project, they should be inspected for rough edges that could damage the pipe. Ideally, if a metal clamp is being used, an elastomeric material should be used in between the pipe and the clamp. This is a must for PVDF and E-CTFE systems, which are less tolerant to scratching.

TRENCHING AND BURIAL

Proper trenching and burial of a pipe system requires engineering prior to an installation. Chemline's Piping System Application Worksheet (page 2) provides a comprehensive guide to burial calculations load tolerance of thermoplastic pipe. This information should be supplied and be specified prior to installation. Refer to Chemline's manual for the burial calculations.

For installation purposes, it is important to look at several factors as the installer of underground piping.

- Soil conditions should match that of the specification and/or drawings.
- Trenches should be dug according to plan.
- Pipe should be surrounded by specified soil type and compaction.
- Accommodations for welding in the trench should be made.
- Safety issues of being in a trench should always be observed.

For each underground installation, burial designs will specify depth of trench and width of trench. The wider the trench, the more load the pipe will see upon compaction. Therefore, it is important to follow trench design closely to avoid excess load on the pipe. In addition to the trench details, the type of soil becomes important. Different types of soils have differing densities and will create differing loads on the buried pipe. If the soil does not match that of the design, it needs to be rechecked or different top fill may be required.

The surrounding material of the pipe is also important. Items such as large rocks may cause pinpoint loads on the pipe that could eventually damage the pipe. Figure D depicts a recommended cross section of a trench and proper fill material and compaction.

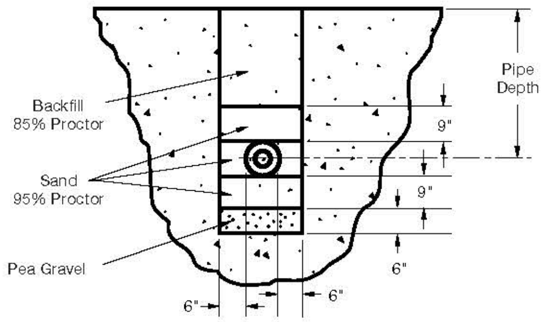

Figure D: Trench Detail

Welding in a trench should also be preplanned. It is common that all welding is done above ground, and then, the welded components are all lowered into the trench. In many instances it may be necessary to weld in the trench. For conducting welds in a trench, it is important to allocate space for the machine as it will be wider than the pipe itself. Widening of the trench may be required to accommodate the machine.

LIMITATION OF INSPECTION

Following proper weld procedures in conjunction with a thorough inspection process will lead to a safe and reliable system. However, a weld cannot be 100% judged by viewing it after the fusion is complete. Bad welds with obvious problems can be identified, such as missing beads, small beads, and misalignment, but other problems may not be easily found. A cold weld occurs when an operator either maintains too high a force during the heat soak time or joins the material together at too high a force. Molten material is then pushed to the outer bead and cooler material is forced together inside the weld. The problem with inspecting a cold weld is the outer bead is the same as a good joint. Since the occurrence of a cold weld is difficult to find and inspect, it is important to use proper welding procedures when joining the material. The issue of inspecting and avoiding a cold weld is no different than a PVC joint that has not been primed prior to cementing. You cannot tell after the weld is made, but if you correctly follow procedures, it will not occur. Cold welds can be avoided with the following operating techniques on all butt fusion and socket fusion equipment.

- Ensure proper heating element temperature throughout the project.
- Use the correct welding parameters by pipe size, wall thickness, and material.
- Do not delay between removal of heating element and joining of material.
- Do not slam material together after heating. Material should be joined quickly, but the pressure build up should be smooth and even.
- Do not join components together above the joining force.

When welding the inner and outer pipe and fitting simultaneously on dual containment piping, the outer bead will provide an accurate depiction of the inner weld. If the outer pipe appears improperly aligned, the inner pipe will also be out of alignment. For simultaneous fusion, it is necessary to ensure the carrier component is flush in length with the containment component. Check on each part with a straight edge after the planing and prior to the heating step of welding. Other methods include marking the ends of the carrier in four locations 90° apart prior to planing. If planing on the containment pipe is complete and all the original marks on the carrier have been removed by the planer, then both parts are flush. The figure below shows a detail of a standard butt-fusion bead formation.

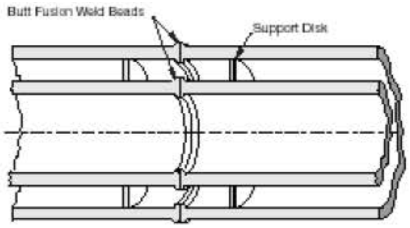

Figure E: Typical Butt-Fusion Weld Bead

WELD INSPECTION

To ensure a safe and on-time system start-up, initiating a standard inspection process is recommended on each project. This quality assurance measure can be conducted by a third party QC or can be done by each individual operator after each weld. Table 1 below shows the features to look for, while a recommended inspection report for recording quality assurance on each weld is attached to the end of this section. Use the recommendation of this weld inspection guide in conjunction with the equipment manual to achieve the best project results. To inspect butt-fusion joints, the inspector should look for the following characteristics on each weld.

- Welds should have two beads that are 360° around the pipe.
- Beads should be of consistent height and width.
- Beads should have a rounded shape.
- Beads should be free of burrs or foreign material.
- A bead on either side should not reduce greatly in width or disappear.
- Components welded should be properly aligned and cannot be misaligned by more than 10% of the wall thickness.

Butt-fusion beads will vary in size and a little in shape with different materials. In general, PP and HDPE will have larger bead formations in comparison to PVDF. With PP and HDPE, there will be a pronounced double-bead formation that will be simple to identify. With PVDF, there will also be a double-bead formation, but not as pronounced. The material will appear to flow more together, making what appears to be one single weld. However, upon examination, you will always see the seam where the components were joined. In addition, when butt welding PVDF pipe to fittings, the fitting bead will be larger than the pipe bead. This is normal as the resin used to produce PVDF fittings flows at a higher rate when melted compared to the resin used to extrude pipes. Mechanically, there will be no issues on strength of the joint, only the appearance of the weld. Since outside temperatures and conditions will have some effect on bead sizes, there is no formal specification for the size of the bead. Also, measuring each bead would be time consuming. During the training process, welding one of each size to use as a rough gauge for the project may prove useful. These sample coupons can be referred to on a regular basis to check welding throughout the project. If bead formations do not meet the inspection criteria, they should be rejected. Consult the operation manual for each tool on how to correct the problem. If problems persist, contact Chemline Plastics Ltd. for assistance. Many times these issues can be cleared up quickly over the phone, avoiding waste in time and material. Never continue welding if proper fusion cannot be accomplished. This will only add to problems at a later time.

WELD INSPECTION – FAILURE CATEGORIES

No.	Feature	Description	Evaluation Groups 1	2	3
External State of joint					
1	Cracks	Cracks running length-wise or cross-wise to weld · in weld · in base material · in heat affected zone	not permissible	not permissible	not permissible
2	Reinforcement notches	Continuous or local notches length-wise to weld with notch root in base material. Caused by, for example: · insufficient joint pressure · warming-up time too short · cooling time too short	not permissible	not permissible	not permissible
3	Notches and flutes	Notches in edge of base material, length-wise or cross-wise to weld. Caused by, for example · clamping tools · incorrect transport · fault in edge preparation	Locally permissible if ending flat and $\Delta s <= 0.1s$ but max 0.5 mm	locally permissible if ending flat and Δs (<= 0.1s but max 1mm	permissible if ending flat and $\Delta s <= 0.15s$ but max 2mm
4	Mismatch of joint faces	joint faces are misaligned relative to one another or thickness variations are not corrected	permissible if e <=0.1s but max 2mm	permissible if e <=0.15s but max 4mm	permissible if e <= 0.2s but max 5mm
5	Angular deflection	for example · machine fault · layout fault	permissible if e <= 1mm.	permissible if e <=2mm	permissible if e <= 4mm
6	Narrow, excessive reinforcement	Excessive and sharp-edged reinforcement over part or all of weld length due to wrong welding parameters, especially caused by excessive joint pressure with polyolefins only	not permissible	not permissible	not permissible
7	Reinforcement incorrectly formed	Reinforcement too wide or too narrow over part or all of weld length. Caused by, for example:	See diagram page 17	See diagram page	See diagram page

WELD INSPECTION – FAILURE CATEGORIES

		· incorrect heated tool temperature · incorrect joint pressure · incorrect warming up time	Value range A	Value range B	Value range C
8	Non-uniform reinforcement See note 2	Non angular joint planes, leading to variations in form of reinforcement over part or all of weld length. Caused by, for example: · edge preparation fault · incorrect welding unit	Permissible if b_1 > =0.7 B_2	Permissible if b_1 >=0.6 B_2	Permissible if b_1 > =0.5 B_2
9	Thermal damage	High-gloss reinforcement face with voids or nodules, usually associated with faulty reinforcement formation and marked bead notches	not permissible	not permissible	not permissible

1) Description and evaluation as per current state of knowledge on polyolefins. Amendments may be necessary after revision of guidelines DVS 2207, Part 1 and Part 2

2) Applies only to welds which are produced using equipment as per DVS 2008, Part 1

Internal state of joint

10	Lack of fusion	No fusion or incomplete fusion on joint faces, over part or whole of weld cross-section. Caused by, for example: · contaminated joint faces · oxidized joint faces · excessive reversal line · heated tool temperature too low	not permissible	not permissible	not permissible
11	Blowhole	Hollow space in joint planes. Caused by, for example: · insufficient joint pressure · insufficient cooling time	not permissible	not permissible	not permissible
12	Pores caused by inclusions of foreign matter	Numerous, dispersed isolated or locally concentrated pores or inclusions. Caused by, for example: · vaporization during welding (water, solvent) · contaminated heated tool	small isolated pores permissible if Δs <=0.05.s	pores and rows of pores permissible if Δs <= 0.10s	pores and rows of pores permissible if Δs <= 0.15s

SYSTEM TESTING – SINGLE + DUAL CONTAINMENT PIPE, PRESSURE

Procedures for testing installed sections of any system must take into account factors affecting all piping (carrier and containment pipes on dual containment systems). Basic recommendations may be given, but a comprehensive testing program should be developed for each and every system design. The program should be developed based on the needs and characteristics of the particular system at hand. All pressure tests must be conducted prior to backfilling a buried system. Testing should be witnessed by the quality control engineer and be certified by the contractor.

1. Single-Wall Piping and Dual Containment Carrier Pipe, Pressure System

If the carrier piping is intended for pressure service greater than 10 feet of head, a hydrostatic pressure test must be conducted. In any hydrostatic pressure test, provisions must be made to vent all air out of the inner pipe. If necessary, special highpoint vents should be installed to bleed any trapped air. Air pockets can create a dangerous situation if a cold weld exists and is found during a test. Compressed air pockets can contribute to extensive propagation of fault lines when a failure occurs. Compressed air or gas should not be used for pressure testing of any carrier pipe in excess of 10 psi. Pressure tests should be conducted at a maximum of 150 percent of the operating pressure of the lowest rated component of the system.

Filling the System

The piping should be capped off at the end of the spool section to be tested and fitted with an adapter to allow tie-in for testing. All flanges in the vertical position should be left open at this point. Bleed off air through the relief valves.

Introduce water very slowly into the system at the low point. In no instance should the water velocity exceed two feet per second. When the water fills all vertical risers, the flanges can be resealed. The relief valves should be left open until it is certain that all air is out of the system. The system can then be brought up to pressure through gradual steps using a hand pump or other similar equipment. Do not use city water pressure to accomplish this step if the water pressure in the city mains is greater than the pressure test to be conducted.

Conducting the Test

The test should be done in gradual steps of 10 psi for 150 psi systems, or 5 psi for 45 psi systems, until the desired pressure is achieved. There will be some gradual drop in pressure due to natural creep effects and elongation of the pipe wall. Also, there could be some drop occurring due to thermal expansion effects where there are sudden environmental temperature changes. After one hour, check the pressure gauge. If there is a decrease without an indication of leakage, pump the pressure back up to the test pressure. If the total pressure drops more than 10% after the second pressurization, the test can be considered a failed test. Check the system for leaks or other problems. Otherwise, continue the pressure test for a minimum of two hours up to a recommended duration of 12 hours or as required by local code requirements.

2. Dual Containment, Containment Pipe, Pressure Systems

If outer piping is designed and required to withstand the same pressure as the inside piping, then a hydrostatic pressure test should be conducted for both inner and outer pipes but an extremely long drying time will have to apply before using full leak detection cable (see "Drying the Annular Space" below). This is for situations where the inner pipe pressure is greater than 10 psi. It is important to remember that when the annular space is pressurized during this situation, two pipes are involved. A plastic pipe is always less capable of withstanding external pressure than internal pressure. The inner pipe should be kept full of water at a pressure equal to the pressure test of the outer pipe.

Equal pressure on the carrier and containment is necessary for the following reasons:

1. To prevent possible collapse of the inner piping during the test.
2. Both the inner and outer piping will elongate equally, thus minimizing any differential stress or stress buildup between the two pipes.
3. In the event of a carrier failure, the containment piping must handle the same pressure as the carrier. The inner pipe will continue to pressurize the outer pipe until the two reach equilibrium.

Filling the System

The outer piping can be filled after the inner test is conducted or at the same time as the inner pipe. The system should be filled in the exact same way as described for pressurized carrier pipe. Do not use city water pressure to accomplish this step if the water pressure in the city mains is greater than the pressure test to be conducted.

In many cases, it is not an advantage to conduct a hydrostatic test on the annular space, as it is very difficult to dry the space after the test. An air test can be used as an alternative. The pressure should be no higher than 10 psi, and extra safety precautions must be made for surrounding personnel. In all cases, the ambient temperature should be above 0° C. The carrier pipe should also be filled with water and pressurized any time a test is conducted on the annular space.

Conducting the Test

Testing is conducted on the containment in the same manner as the carrier. The test should be done in gradual steps of 10 psi for 150 psi systems, or 5 psi for 45 psi systems, until the desired pressure is achieved. There will be some gradual drop in pressure due to natural creep effects and elongation of the pipe wall. Also, there could be some drop occurring due to thermal expansion effects where there are sudden ambient changes. After one hour, check the pressure gauge. If there is a decrease without an indication of leakage, pump the pressure back up to the test pressure. If the total pressure drops more than 10% after this second pressurization, the test can be considered a failed test. Check the system for leaks or other problems. In larger systems and pipelines exposed to large changes in temperature, it may take several tries to get the pressure to remain constant. Otherwise, continue the pressure test for a minimum of two hours up to a recommended duration of 12 hours. A cyclic hydrostatic test as described above for the inner pipes may be used where appropriate.

Note: Do not use fabricated drainage fittings in pressurized systems where a pressure exceeding 10 feet of head is required. Use molded pressure fittings in these applications.

DUAL CONTAINMENT PIPE, DRAINAGE

Dual Containment, Carrier Pipe, Drainage Systems

Inner piping that is intended for drainage service (10 feet of head or less) should be tested by implementing a 10-foot standing water test. A 10-foot standing water test consists of welding or attaching in some manner a 10-foot riser to the upstream (high end) of the system. It is not unusual that there are several high points (branch connections) in a system. It is important that every riser or branch connection be affixed with a 10-foot riser in order to ensure that every point in the system will see 10 feet of head. In fact, at the low point, the system will see a pressure equal to 10 feet of head plus the value of the elevation change. A maximum of 20 feet of head must not be exceeded in a drainage system. To consider a standing water test acceptable, the water level after 12 hours should be at a level equal to the level at the start of the test, minus normal evaporation and expansion due to temperature fluctuations. Compressed air or gas should not be used for pressure testing of any carrier pipe in excess of 10 psi.

Dual Containment, Containment Pipe, Drainage Systems

Outer piping that is intended for drainage capability (10 feet of head or less) or that is flowing open-ended should be tested by implementing a 10-foot standing water test. It should be noted that the carrier pipe pressure must be maintained equal to the outer pipe pressure at all points in order that the inner pipe does not collapse. PP or PE 45 psi inside carrier pipe is common in some large-diameter systems such as drainage mains. In order to test these systems, special consideration must be given to ensure that the inner pipe is kept under equal pressure with the outer pipe. The standing water test should be conducted in the same manner as the inside pipes. A riser should be attached to every vertical riser equal to 10 feet, and the system filled with water. The level should be checked after 12-18 hours, and if no fluid has escaped (minus normal evaporative losses and expansion due to temperature fluctuation), the test should be considered successful. It should be noted that the total of the elevation change plus 10 feet should not exceed the sum of 20 feet. In order not to trap fluid in the annular space, a low-pressure compressed air or nitrogen test (<10 psi) may be used. Note that if this type of test is used, the carrier inner pipe must be filled with fluid and kept to at least the level of the pressure in the annular space to prevent collapse. If this type of test is used, it is required to "soap" each joint thoroughly to check for visual leaks. In addition, the pressure gauge must also be checked after 2-12 hours for indication. Again, any time compressed air is used, extra safety precautions should be taken. Air tests should be done at 0° C or higher ambient temperature.

Dual Containment Annular Test, Drainage Systems

The purpose of the annular test is to test both the carrier and containment simultaneously. For low-pressure drainage systems, an annular test can be conducted to reduce test time. This type of test can only be used on drainage systems using 150 psi carrier. Cap off the carrier and containment pipe, and provide a pressure gauge on each. Using low-pressure compressed air (< 10 psi), charge the annular space. In a tight system, the containment gauge should read 10 psi (minus losses due to creep), and the carrier gauge should be zero. If there is a leak in the containment piping, the containment gauge will begin to drop. If, however, there is a leak in the carrier piping, the inner piping will become pressurized. See Figure F below for typical test results. Pressure should be maintained on the system for 2-12 hours to ensure against a possible slow leak.

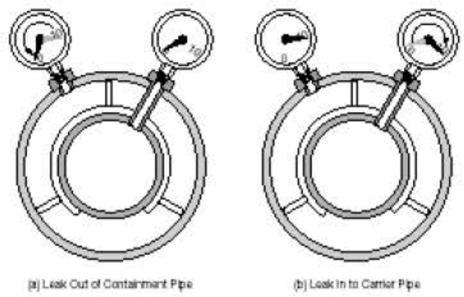

Figure F: Annular Pressure Test Leak Indications

Drying the Annular Space

If the annular space is contaminated with water due to the test procedures or other unforeseen events, it is essential that all moisture be removed thoroughly to minimize condensation that may cause false alarms in leak detection cables and low-point sensors. The installation of properly sized vents and drains will assist greatly with this process. It may be necessary to use blowers and/or clean dry air to remove all moisture completely. The greater the number of vents and drains, the higher the volume of air can be pushed through the system, thereby decreasing the drying time. As it is extremely difficult to remove moisture from the annular space, it may be appropriate to use compressed air (< 10 psi) for testing carrier and containment pipe where pressure requirements are low. Use of compressed air will not contaminate the annular space with moisture.

Locating a Leak

In the event of a leak in the carrier, the pressure should be relieved and the water drained to prevent flooding of the annular space. To determine the location of the leak, ultrasonic leak detection guns are capable of hearing disturbances in air flow (vibration) through the containment wall.

Cyclic Hydrostatic Testing

In critical applications, the inner piping should be tested hydrostatically for more than one cycle. To test for more than one cycle, do not empty the system and start all over. Instead, drop the system pressure down to below 5 psi, and then raise it back in gradual steps of 10 to 20 psi to the desired test pressure. Follow the same procedures as described above. Repeat this procedure for as many cycles as required up to a maximum recommendation of seven cycles

Note: Do not use fabricated drainage fittings in pressurized systems where a pressure over 10 feet of head is required. Use molded pressure fittings in these applications.

WELD INSPECTION TABLE

Project Name		
Date:	Company:	Page:

Joint Number:			Welder:
Material:	OD:	Wall Thk:	QC:
Serial Number:			Drawing Number:

Joint Number:			Welder:
Material:	OD:	Wall Thk:	QC:
Serial Number:			Drawing Number:

Joint Number:			Welder:
Material:	OD:	Wall Thk:	QC:
Serial Number:			Drawing Number:

Joint Number:			Welder:
Material:	OD:	Wall Thk:	QC:
Serial Number:			Drawing Number:

REPAIR PROCEDURES

A properly designed, installed, and maintained dual containment piping system will provide years of reliable service. The system, however, should offer the means to perform a repair in the event of a mishap, and this repair should be of such quality that the operating parameters, pressure, temperature, and safety factors are not reduced. The dual containment systems offer this capability for all pressure ratings with minimum disruption to site conditions.

The first step in a repair procedure is to isolate the leak source. The ease of finding a leak is determined by the leak detection method selected at the time of installation. The use of a leak detection cable will pinpoint the location of the leak to plus or minus three feet, and is possibly the most efficient system. The low-point sensors will identify a zone that has been contaminated. Further testing methods will be required to locate the actual leak source. Several methods are available for this, including the use of an ultrasonic test gun (Figure F-99), fiber optic cameras, and dye solutions. These methods, although more time consuming, are viable alternatives to leak detection cable.

The second step in a repair procedure is to flush the carrier and containment pipes to remove any hazardous chemicals that will create safety concerns for the workers doing the repairs. The ability to flush the system is determined by the initial design. The installation of high-point vents and low-point drains in the containment pipe will provide a safe means to perform the flushing. Attempts to install high-point vents and lowpoint drains during repair are costly and potentially dangerous.

To completely weld a system repair, the pipe must be flexible in movement in the axial direction. If movement is not present, then a double-wall flange repair may prove convenient. Doublewall flanges may have reduced pressure ratings. Consult factory prior to installation.

The third step is to expose the damaged pipe and perform the repair procedure with one of the following methods.

Repairs to Systems without Flexibility
Flange Repairs (similar materials)

Dual containment systems offer patented, double-wall flanges that permit the flow of fluids through the annular space, as shown in Figure G. (Consult factory for pressure rating.)

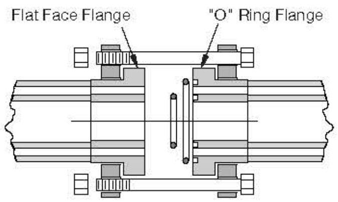

Figure G: Double Wall Flange

1. The damaged section of pipe is removed first (Figure H).

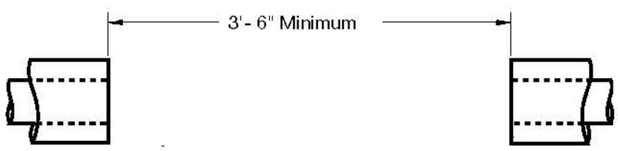

Figure H: Remove damaged section of pipe

2. Plane ends and install supports discs. Next, weld two flanges onto the exposed pipe ends.

Figure I: Install double-wall flanges

3. A flanged spool piece is fabricated and installed.

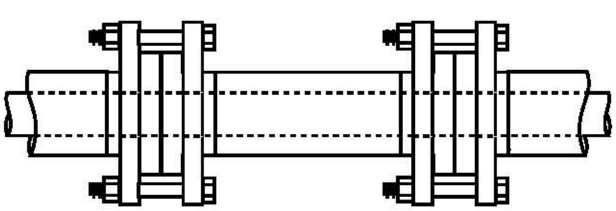

Figure J: Install flanged spool

4. The system is then tested and returned to working order.

For all repair methods, a minimum of 3'- 6" is required to facilitate use of welding equipment.

Repairs to Systems with Flexibility
Butt Fusion Repairs (similar materials)

The second method of repair is performed without the use of flanges but instead, only with thermal butt fusion. The use of butt fusion, as the repair procedure requires a larger excavation due to the requirement that the pipe be able to move at least three inches to perform the weld.

To perform the repair:

1. The damaged section of pipe is removed and the area cleared to allow the pipe to move in the radial direction. Note that only one end of the pipe needs this flexibility (Figure K).

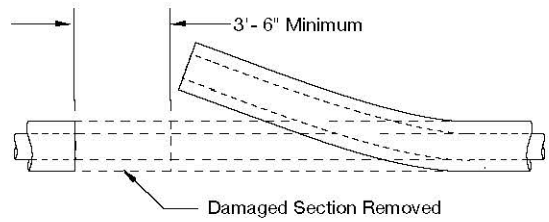

Figure K: Remove damaged section of pipe

2. The pipe in the ground is prepared for simultaneous fusion.
3. A spool of pipe is assembled and butt welded to the stationary pipe.

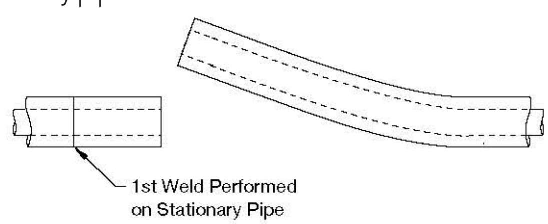

Figure L: Install new spool

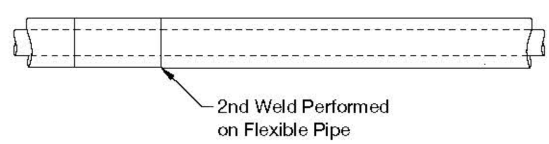

Figure L: Butt weld spool to remaining pipe

4. The second weld is then performed on the flexible side.
5. The system is then tested and returned to working order.

The repair procedures described above are appropriate for dual containment systems when the same material is used for the carrier and containment piping. To perform a repair on a system with a PVDF carrier and a polypropylene containment, the following steps should be followed.

Repairing PVDF Carrier/Polyproplyene Containment Flanged Repairs (dissimilar materials)

To perform the repair:

1. The damaged section of pipe is removed and prepared.

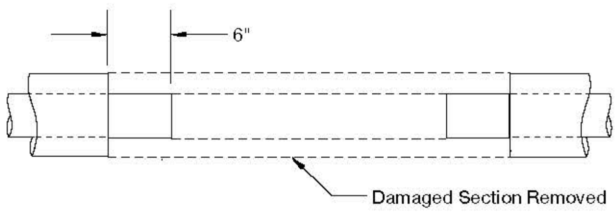

Figure M: Remove damaged section of pipe

2. Polypropylene flanges are welded to the containment pipe.

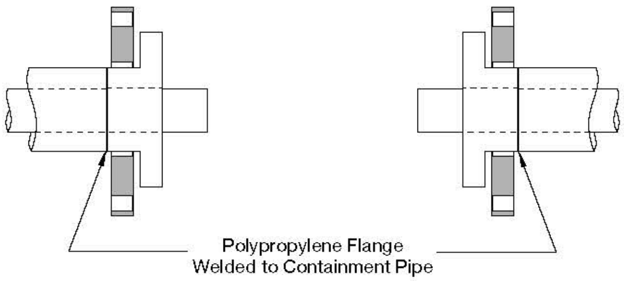

Figure N: Weld polypropylene flanges to pipe ends

3. PVDF flanges are bolted to the polypropylene flanges. Now both the inner and outer piping are similar material.

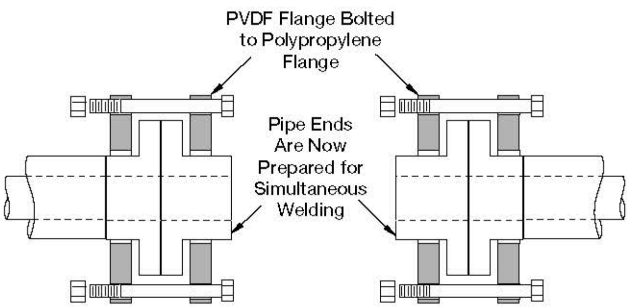

Figure O: Bolt polypropylene flanges to PVDF flanges

4. The repair procedure is now the same as for similar materials, as described above.

There are other repair options available that require the use of slip couplings, electro-fusion couplings, and use of hot-gas welding and extrusion welding. These repair options are adequate for drainage systems only and require well-trained technicians to perform the repair. Consult Chemline for assistance.

thermoplastic piping systems

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