CHEMICAL SINGLE WALL SYSTEMS

Installing any piping system properly requires preplanning. The installation is more than the welding of components. It requires the proper environment, material inventory, welding equipment, tools, and thorough training. This guide is to assist in the planning and installation of a chemical pipe system either in a pipe rack or trench. This guide is aimed at industrial applications and not high-purity installations.

This guide will concentrate mainly on materials such as PVDF, polypropylene, and E-CTFE, as supplied by Asahi/America, Inc. The practices outlined in this guide are also applicable to other materials such as PVC and C-PVC, with the exception of joining techniques. Asahi/America's recommended steps to plan and complete a successful installation follow.

Step 1. Welding Environment
Step 2. Tool Selection
Step 3. Material Handling
Step 4. Training and Preparation
Step 5. Tool Commission and Daily Checks
Step 6. Pipe Cutting
Step 7. Weld Inspection
Step 8. Hanging
Step 9. Trenching and Burial
Step 10. System Testing
Step 11. Repair Procedures

Step 1. Welding Environment

Asahi/America does not set requirements for proper welding environments. It is necessary for the installer 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 types, consult the Asahi/America Engineering Department.

Table F-10. Sample Welding Data (time-sec)

Pipe Size (inches)	A	B	C
	Heat Soak Time	Change Over Time	Cooling Time
1" Pro 150	8	6	240

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. Table F-11 provides information on the various welding systems available.

Table F-11. Equipment Selection

Description	Polypropylene		PVDF		E-CTFE/Halar	
Shop 4*	1/2"–4" Pro 150 4" Pro 45	A A	1/2"–1" 1 1/2"–4"	B A	1/2"–4"	X
Shop 12	1 1/2"–8" Pro 150 10" Pro 150 12" Pro 150 4"–12" Pro 45	A B X A	1 1/2"–12"	A	1 1/2"–6"	A
Field 6	1 1/4"–6" Pro 150	A	1 1/4"–6"	A	Does not apply	
Field 12	3"–12" Pro 150 4"–12" Pro 45	A A	3"–12"	A	Does not apply	
Field 20	8"–20" Pro 150 8"–20" Pro 45	A A	Does not apply		Does not apply	
Socket 2 Hand Held	1/2"–1 1/4" Pro 150 1 1/2"–2" Pro 150	A B	1/2"–1 1/4" 1 1/2"–2"	A B	Does not apply	
Socket 4 Bench	1/2"–4" Pro 150	A	1/2"–4"	A	Does not apply	
UF 2000/1	1/2"–2" Pro 150	C	1/2"–2"	C	1/2"–2"	C
UF 2000/2	2 1/2"–10" Pro 150	C	2 1/2"–10"	C	2 1/2"–10"	C
SP 110	1/2"–4" Pro 150	C	1/2"–4"	C	1/2"–4"	C
SP 250	2 1/2"–10" Pro 150	C	2 1/2"–10"	C	2 1/2"–10"	C
HPF	Does not apply		1/2"–2"	A	Does not apply	
Polymatic	1/2"–9" Pro 150	A	Does not apply		Does not apply	

A: Recommended
B: Will work, but better solution is available
C: Recommended, special requirements apply, consult factory
X: Not recommended
* Hand planer on this tool. For large amounts of welds 3" and 4", a larger tool with electric planer is more suitable

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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.

Step 2. Tool Selection

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

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

For assembling industrial grade piping systems made from PVDF, PP, or E-CTFE, there are really three choices for assembly: butt fusion, socket fusion, and electro fusion. Each method has its advantages and disadvantages. A discussion on each method for assistance in choosing the best method for each project follows.

Butt Fusion

During the butt-fusion process, components are forced against a flat heating element or plate to melt the ends for the fusion. Figures F-68, F-69 and F-70 show some of the systems available for this process.

Figure F-68. Shop 4 ($\frac{1}{2}$" – 4")

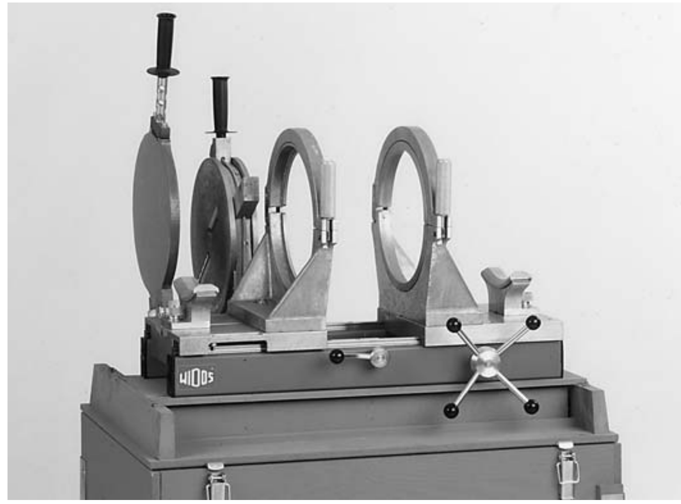

Figure F-69. Shop 12 ($1\frac{1}{2}$" – 12")

Figure F-70. Field (3" – 12")

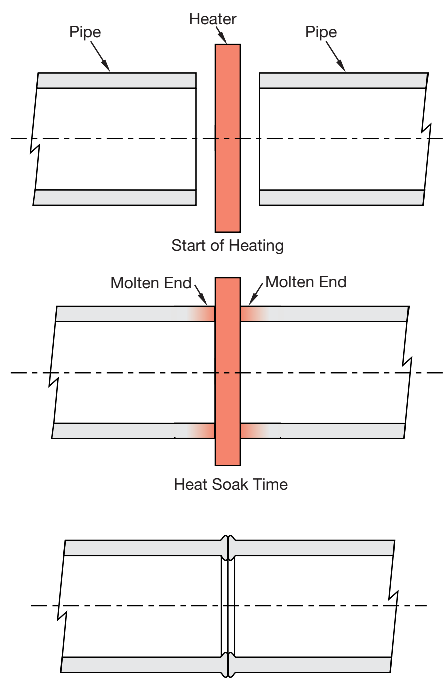

Figure F-71. Butt-fusion welding process

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The material is in contact with the heat source for a specified amount of time to allow the material time to soak in the heat and melt the pipe ends. At the end of the heat soak time, the heating plate is removed and the pipes are joined together at a force. Figure F-71 shows a brief detail of the process.

The advantage of butt fusion is its weld strength. When properly conducted, it is a strong, reliable joint. Butt fusion can be done in any size range, reducing the training time at the job start-up. In addition, butt fusion is fairly weather tolerant. This does not mean it can be conducted in any environment, but it will work in conditions other methods will not.

Socket Fusion

Socket fusion is the oldest method for assembling thermoplastic materials. Socket fusion is available for welding PVDF (SDR 21) and PP in sizes 1/2"–4". Similar in nature to butt fusion, the material is in direct contact with the heat source. However, instead of melting the component ends, the pipe is forced inside a mandrel and the fitting is forced over a mandrel. After proper heat soak time has been accomplished, the two components are forced together until they bottom-out. Figure F-72 illustrates a brief outline of the process.

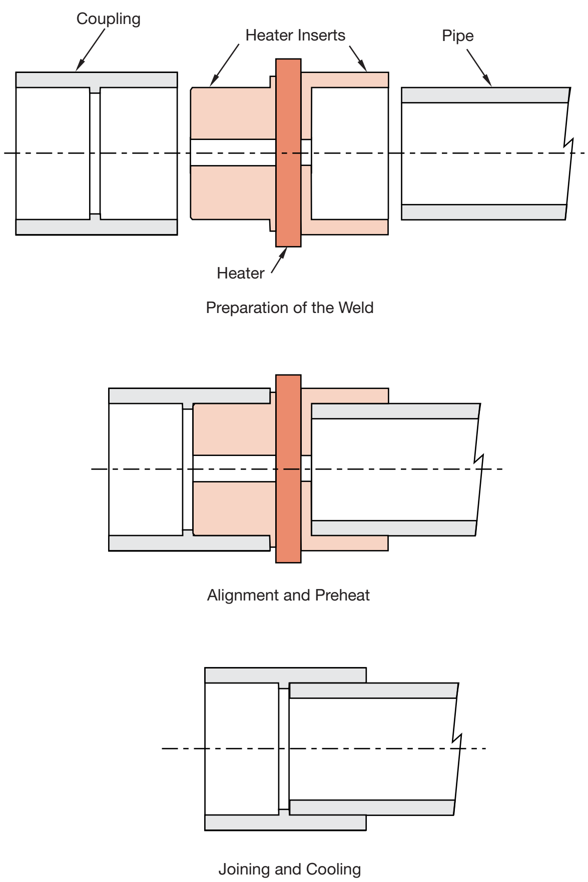

Figure F-72. Socket fusion welding process

Socket fusion is fairly tolerant to weather conditions and is simple to do. Untrained personnel can be trained in a short period of time to make consistent and reliable joints. Mechanically the welds are reliable, and fairly easy to inspect.

Socket fusion is ideal for smaller systems and is quite simple and practical for welding 1/2"–1". Systems consisting primarily of 3" and 4" are better suited for butt fusion, as the equipment is smaller and easier to use in tight locations.

Electro Fusion

HPF is a portable, electro-fusion process for welding PVDF in sizes 1/2"– 2". HPF is the brand name for the PVDF equipment and provides the added benefit of a bead-free weld. In addition to HPF, standard electro-fusion welding for polypropylene and polyethylene are available as well. Contact Asahi/America for more information on equipment types.

The HPF system for PVDF is ideal for welding in tight locations such as in pipe racks, walls, or under floors. The process works by placing the components to be welded in an electric socket fitting. The socket is electrified and the resistance of the wire heats the material and fuses it all together to make one component. Tools are supplied with computer control. Parameters are selected via a bar code system on each weld, making the process extremely reliable and exactly repeatable. Because the entire welding process takes place inside the socket, the required equipment to actually fuse the joint is small and compact.

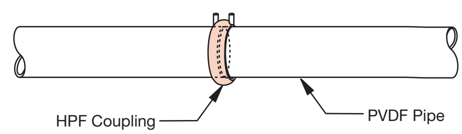

Figure F-73. HPF weld

For conducting beadless fusion, HPF is provided with two options: with balloon and without. For beadless and seam free, weld balloons are available. This ensures a smooth weld and no crevice. Joints welded with balloon will have a small wave in the joint due to the weight of the coupling and the outward force of the inflated balloon. Sometimes it is not possible to place a balloon in the weld area and then be able to remove it after, such as in the case of a repair or addition. For this reason, HPF can also be conducted without a balloon. These joints will also be beadless, but will have a small seam around the joint.

HPF is recommended for welding in or outside of a cleanroom environment. During the weld process, HPF is closed to the external environment, so issues of wind, temperature, and contamination are greatly reduced. HPF is the tool of choice for repairs or additions to an existing system. HPF is only available for PVDF in sizes 1/2"– 2".

HPF systems for harsh chemical transport should be approved by Asahi/America and called out as the welding method when conducting a chemical resistance verification.

Asahi/America has also introduced electro fusion in polypropylene (HDPE on special request) in 1/2"– 9". This new system works in a similar fashion to that of HPF, but does not provide a bead free and seamless weld. However, electro fusion does prove extremely convenient in tight locations.

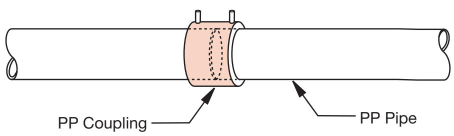

Figure F-74. PP weld

Polypropylene electro-fusion couplings are significantly larger than that of HPF and do require extended leg fittings. All systems to be assembled using electro fusion must be approved by Asahi/America if they are to be used in a chemical application. The welding material should be called out at the time of a chemical resistance verification.

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Step 3. Material Handling

When pipe, fittings, and valves arrive on site, they should be inspected to ensure the proper components have arrived and no damage has occurred during shipment. Asahi/America 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.

Preferable, 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. 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 stacked above the recommended 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, it is recommended to cover polypropylene during storage.

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.

Step 4. Training and Preparation

A chemical system is a critical utility within a plant's operation. An unplanned shutdown can prove to be more costly than the piping construction itself. One bad weld can cause hours of repair and frustration, as well as significant 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.

All of the above topics are discussed during Asahi/America's certified training sessions. For the installation of a single wall pipe system, the following training sessions are available:

- Tool Operator Training
- Quality Control Inspection

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

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

Consult with Asahi/America's Engineering Department for dates and availability of corporate programs.

During the on-site training process, Asahi/America 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 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 used, 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,

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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.

Formal training can be the key factor in starting a project off in the right direction. Take advantage of this service while on site. Asahi/America also offers field technicians for hire to oversee project welding and training for any specified amount of time. Contact Asahi/America for more information. This is a service many customers take advantage of to ensure a smooth, trouble-free installation.

Step 5. 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 required. The maintenance recommended varies 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, it is less likely tool problems and welding errors will occur.

Step 6. Pipe Cutting

Cutting plastic pipe can be handled in a variety of methods. In small dimensions, 1/2"– 4", roll wheel pipe cutters are commonly available and work well. These types of cutters are similar to a tube cutter, but only larger. If using a roll cutter on PP or PE, it is important to ensure the wheel has a larger radius than the wall thickness of the pipe so it will cut all the way through.

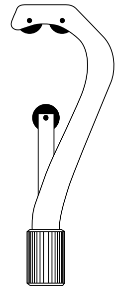

Figure F-75. Roll cutter

If you are not concerned about particle generation, then 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 with the band saw to avoid the blade from bending and creating an angled cut. For smaller pipe sizes, a circular blade chop saw will also provide neat and accurate cuts.

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.

Step 7. Weld Inspection

To ensure a safe and on-time system start-up, initiating a standard inspection process on each project is recommended. This quality assurance measure can be conducted by third party QC or can be done by each individual operator after each weld. A recommended inspection report for recording quality assurance on each weld is attached at the end of Section F. Use the recommendation of this weld inspection guide in conjunction with the equipment manual to achieve the best project results.

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Butt Fusion

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

Figure F-76 shows a detail of a standard butt-fusion bead formation.

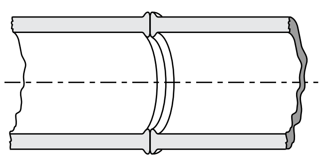

Figure F-76. Typical butt-fusion weld bead

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 is recommended. 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 on each tool on how to correct the problem. If problems persist, contact Asahi/America for assistance. Many times these issues can be cleared up quickly over the phone, avoiding wasted time and material. Never continue welding if proper fusion cannot be accomplished. This will only add to problems at a later time.

Socket Fusion

With socket fusion, beads are also present on the outside that should be used for inspection. With a socket weld, it is important to ensure that the bead on the pipe and the bead on the fitting are in contact. If the two beads are not in contact, or the bead from the pipe is not up against the socket, the proper insertion depth has not occurred. If beads do not meet, the weld will not be full strength and should be rejected. With socket fusion weld inspection, look for the following items:

- Bead formation on pipe in full contact with fitting 360° around the joint.
- Consistent bead 360° around the joint.
- Free of any burrs or foreign material.
- Proper alignment. Pipe needs to be inserted straight into the fitting without angle.

Figure F-77 is an example of acceptable and non-acceptable socket fusion joints.

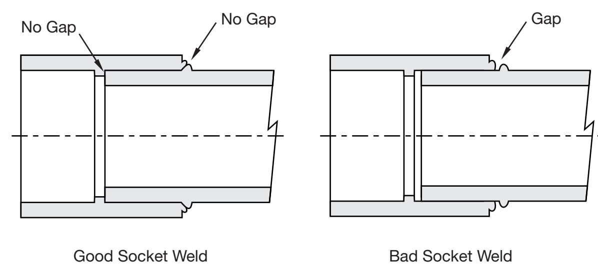

Figure F-77. Good and bad socket fusion welds

Electro Fusion

HPF welds can be inspected, as well as data on each weld and stored in the memory if desired. This information can be printed any time on 8 1/2" by 11" paper. Consult the HPF Operation Manual for details on printing weld data. It is important to specify the need for data retrieval at the time of job start-up, as all HPF equipment is shipped with the memory function turned off.

HPF is a non-bead forming weld process. The inspection on HPF is simplified since the socket coupling itself covers the weld. When welding with balloon, the indicator on the side of each fitting can identify proper fusion. The plastic indicator will push out from the HPF coupling due to the heat from the weld. This device, Figure F-78, much like a turkey timer, indicates that the fitting has been properly heated. When welding without balloon, the indicator will not necessarily push out.

The HPF equipment shows the weld count on the screen of each weld. This number should be logged on the supplied charts. In addition, the data from each weld can be printed using a standard dot matrix printer. The tracking of the joint on the pipe, the log, and the tool printout allows quality assurance to track each weld to ensure welds in the system were conducted properly. In addition, the printout will indicate the method of welding on each joint, balloon or without balloon.

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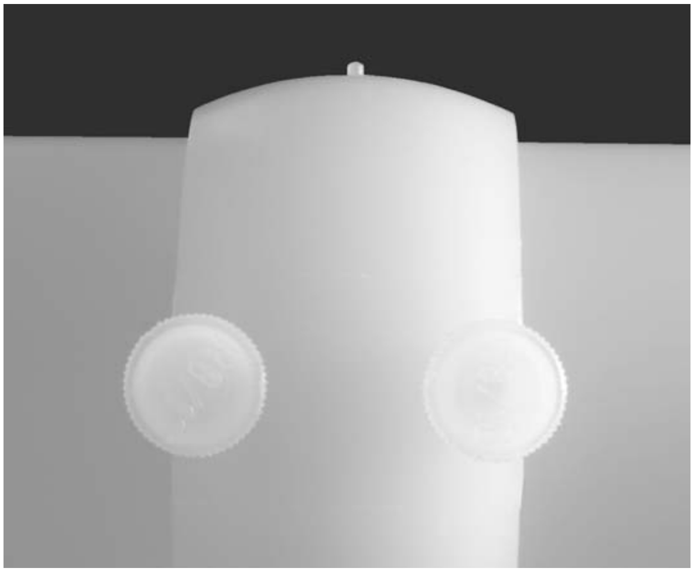


Figure F-78. HPF indicator

Other techniques employed with HPF to ensure proper insertion depth is the marking of the depth. When setting a component into the clamp and centering it, mark the side of the component up tight against the clamp. This mark will allow inspectors to verify the pipe was properly installed into the clamp after the weld is completed. The distance of the mark to the side of the coupling will be identical for each dimensional size. Marks that are too close or too far to the coupling should be rejected. Most problems with HPF come from not carefully inserting the fitting and centering it into the coupling. Since the process is controlled with bar coding the parameters and computer control of the heating and cooling, the welding process itself is extremely reliable. The proper set up is the main variable that is the responsibility of the operator.

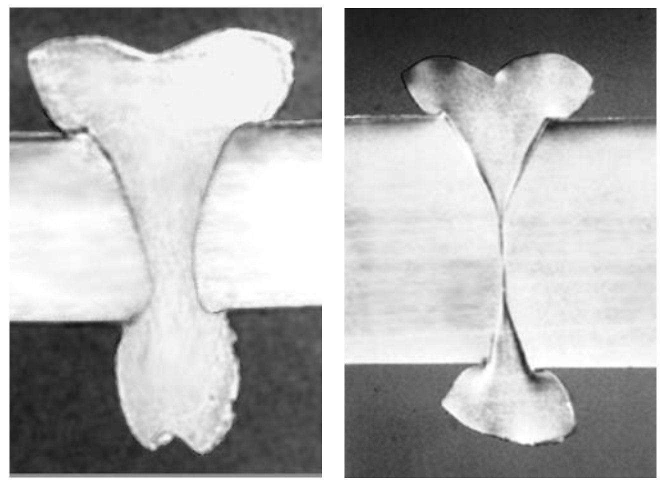
Bubbles in the Joint

In the fusion process, it is possible to find tiny bubbles trapped in the welded region. This may be most noticeable with PVDF, for its clear nature allows it to be visible. These bubbles are a common occurrence in non-contact butt fusion, but can also be present in conventional butt-fusion systems. The bubbles are from one of two sources: either air has been trapped in the weld during the joining process, or small vacuums appear due to material shrinkage during the cooling down time. In either case, the bubbles are not an area of concern and there is no specification for the size of a bubble that would cause a joint failure. The combination of the welding parameters and the melt flow index of the Solef PVDF resin help to ensure against tiny bubbles affecting the quality of the joint.

Limitations of Inspection

Following proper weld procedures, in conjunction with thorough inspection, 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.

The cold weld is more difficult to identify, and virtually impossible to detect with the naked eye. Two cross-sectional views of a pipe wall that has been welded are shown in Figure F-79. Weld 1 is a good fusion joint, while Weld 2 is a cold weld. Notice in the cold weld there is very little material joined together in the pipe wall area. The molten material has been forced to the outer and inner bead and the unheated sections of the pipe have been forced together in the pipe wall region. In the proper Weld 1, you can see there is material joined together in the pipe wall, as well as in the inner and outer beads.



Weld 1 – Standard IR joint   Weld 2 – Cold weld

Figure F-79. Cross-sectional view of pipe wall with weld

The problem with inspecting a cold weld is that the outer bead is the same as a good joint. In Figure F-79, the top bead represents the outer look of the weld. It can be seen very clearly that both welds look the same according to the bead formation.

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 always 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.

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- 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.

Step 8. Hanging

Hanging any thermoplastic 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 Tables F-12 thru F-14 . Since thermoplastics 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 recommended for thermoplastic piping systems. See Figures F-80 and F-81.

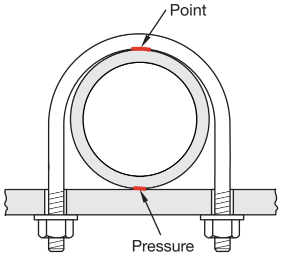

Figure F-80. Effects of U-bolt on pipe–not recommended

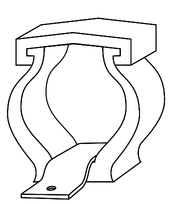

Figure F-81. Recommended hanger

Table F-12. PVDF Support Spacing Recommendation (feet)

Nominal Size (inches)	68° F 20° C	86° F 30° C	104° F 40° C	122° F 50° C	140° F 60° C	158° F 70° C	176° F 80° C
1/2	3.0	2.5	2.5	2.0	2.0	2.0	2.0
3/4	3.0	3.0	2.5	2.5	2.5	2.5	2.0
1	3.5	3.0	3.0	3.0	3.0	2.5	2.5
1 1/2	4.0	3.5	3.0	3.0	3.0	3.0	3.0
2	4.5	4.0	4.0	3.5	3.0	3.0	3.0
2 1/2	5.0	4.5	4.0	4.0	3.5	3.0	3.0
3	5.5	5.0	4.0	4.0	4.0	3.5	3.5
4	6.0	5.0	5.0	4.0	4.0	4.0	4.0
6	7.0	6.0	6.0	5.0	5.0	4.5	4.5
8	7.5	7.0	6.0	6.0	5.5	5.0	5.0
10	8.5	7.5	7.0	6.5	6.0	6.0	5.5
12	9.5	8.5	8.0	7.0	7.0	6.5	6.0

Table F-13. Polypropylene SDR II Support Spacing Recommendation (ft)

Nominal Size (inches)	68° F 20° C	86° F 30° C	104° F 40° C	122° F 50° C	140° F 60° C	158° F 70° C	176° F 80° C
1/2	3.0	2.5	2.5	2.0	2.0	2.0	2.0
3/4	3.0	3.0	2.5	2.5	2.5	2.5	2.0
1	3.5	3.0	3.0	3.0	3.0	2.5	2.5
1 1/2	4.0	3.5	3.0	3.0	3.0	3.0	3.0
2	4.5	4.0	4.0	3.5	3.0	3.0	3.0
2 1/2	5.0	4.5	4.0	4.0	3.5	3.0	3.0
3	5.5	5.0	4.0	4.0	4.0	3.5	3.5
4	6.0	5.0	5.0	4.0	4.0	4.0	4.0
6	7.0	6.0	6.0	5.0	5.0	4.5	4.5
8	7.5	7.0	6.0	6.0	5.5	5.0	5.0
10	8.5	7.5	7.0	6.5	6.0	6.0	5.5
12	9.5	8.5	8.0	7.0	7.0	6.5	6.0
14	10.0	8.5	8.0	7.5	7.0	6.5	6.5
16	10.5	9.5	8.5	8.0	7.5	7.0	6.5
18	11.5	10.0	9.0	8.5	8.0	7.5	7.0

Table F-14. E-CTFE Support Spacing Recommendation (feet)

Nominal Size (inches)	68° F 20° C	248° F 140° C
1	3.60	2.50
2	5.00	3.00
3	5.75	3.75
4	6.00	4.00

Notes:
1. Supports must be spaced according to the highest possible temperature the pipes will encounter even if the extreme condition is only temporary.
2. Support spacing is based on a liquid with a specific gravity of 1.0. Spacing should be reduced by 10% for liquids having 1.5 specific gravity, 15% for 2.0 s.g., and 20% for 2.5 s.g.

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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. For more details on hanging Asahi/America systems, consult Section C, *Engineering Theory and Design Considerations.*

Step 9. Trenching and Burial

Proper trenching and burial of a pipe system requires engineering prior to an installation. Section C 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 Asahi/America'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 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 F-82 depicts a recommended cross section of a trench and proper fill material and compaction.

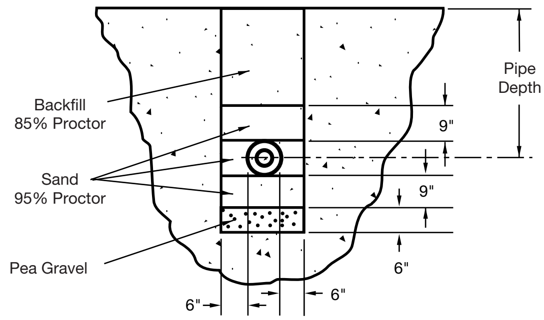

Figure F-82. Trench detail

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 the trench may be required to accommodate the machine.

Step 10. System Testing

Prior to pressure testing, the system shall be examined for the following items:

1. Pipe should be completed per drawing layout with all pipe and valve supports in place.
2. Pipe, valves, and equipment should be supported as specified, without any concentrated loads on system.
3. Pipe should be in good condition, void of any cracks, scratches, or deformation.
4. Pipe flanges should be properly aligned. All flange bolts should be checked for correct torques.
5. All joints should be reviewed for appropriate welding technique. See Weld Inspection, Step 7.

If any deficiencies appear, the quality control engineer should provide directions/repair.

Pressure Test

Test fluid should be water. In all cases, tests must be done hydrostatically. Air is not acceptable.

1. Filling the system: Open the valves and vents to purge the system of any air. Slowly inject the water into the system, making sure that air does not become trapped in the system.
2. Begin pressurizing the system in increments of 10 psi. Bring the system up to the test pressure and hold. Allow system to hold pressure for a minimum of two hours and up to a recommended 12 hours. Check pressure gauge after one hour. Due to natural creep effects in plastic piping, the pressure may have decreased. If drop is less than 10 psi, pump the pressure back up. At this time, the system may be fully pressurized to desired test pressure.
3. If after one hour the pressure has decreased more than 10%, consider the test a failure. Note the 10% value may need to be greater for larger systems. Also, note that Step 2 may need to be conducted several times if there are significant thermal changes.
4. If the pressure drops less than 10% after one hour, pump the pressure back up to the test pressure. This is normal due to creep. If after two hours the pressure does not drop, consider the test a success.
5. Test is to be witnessed by the quality control engineer, and be certified by the contractor.
6. Obvious leaks can be found by emptying the system and placing a 5 psi charge of clean, dry nitrogen on the system. Each joint should then be individually checked using a soapy water solution or an ultrasonic leak detection gun. Leak detection guns are available from Asahi/America. Consult factor for usage of U.S. leak detection guns. Some limitations do apply.

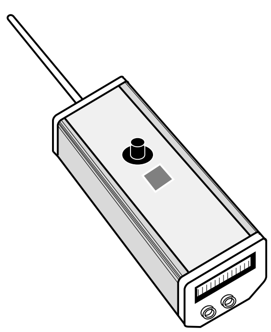

Figure F-83. Ultrasonic leak detection gun

Step 11. Repair Procedures

If a leak is found or an addition is required to an existing system, there are several options on how to make the repair. In most systems, socket or butt fusion, there is a requirement for pipe movement when making a weld. To conduct a butt or IR weld, one side of the tool moves in order to accommodate the planer, the heating element, and the final joining force. In a repair procedure, the need for movement of the existing pipe makes for the simplest repair.

Flexible Pipe System

If the pipe is in an area where it can be moved, standard butt fusion or socket fusion equipment can be used.

1. Cut out the section in need of repair. It is best to conduct new tie-in welds on straight runs of pipe for easier alignment.
2. If several welds are required, prefab a spool piece on a bench and conduct only a few tie-in welds in the pipe rack.
3. Attach the tool to the existing pipe and properly support the machine to avoid sagging or stressing the pipe.
4. Conduct standard butt-fusion weld per operating procedures. It may be necessary to flex the existing pipe out of the way of existing pipe.
5. Conduct final weld using the flexible side of the pipe system in the moving clamp.

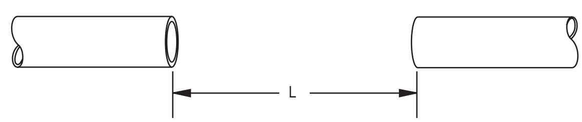

Figure F-84. Remove damaged section

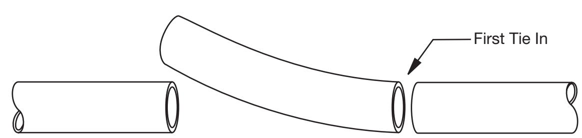

Figure F-85. Install new spool

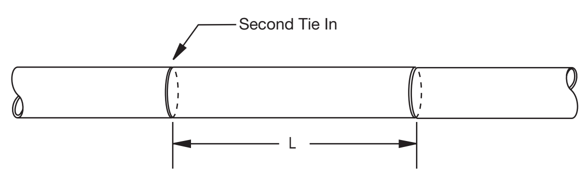

Figure F-86. Butt weld spool to existing pipe line

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Non-Flexible Pipe System

Depending on the size and material, repairs can also be made to systems without any movement. For Purad PVDF systems in sizes 1/2"–2", HPF welds can be conducted in place with minimal need for movement. In polypropylene in sizes 1/2"–9", electro-fusion welds can be accomplished.

1. Remove the damaged section of piping. For easier alignment, conduct new tie-in welds on straight runs of pipe.
2. If several welds are required, prefab a spool piece on a bench setup and conduct only a few tie-in welds in the pipe rack.
3. Using either the large or the small alignment rack, fix two wide clamps to the existing pipe line and to the new spool piece. Make sure all components are level and properly supported.
4. Plane the ends perfectly square. It is recommended to pre-plane both ends of the spool and both ends of the existing pipe line at this point. It is also necessary to slide the second coupling onto the spool at this point to avoid difficulty of placing it on the pipe after one weld is complete. For polypropylene, planing is recommended but not required, as long as cuts are straight and square.
5. Slide the coupling into place using the third wide clamp and center the existing pipe in the clamp using the mechanical stop. Now bring the spool piece into the clamp until it is up tight against the existing pipe line. For polypropylene, only one clamp is necessary.
6. Conduct the weld per procedure for the equipment.
7. Measure the thickness of the coupling. Take half of the thickness and mark this distance from the end of the pipe. This mark identifies the location of the end of the coupling and helps to center the coupling on the two final components to be joined. Lock in place using the wide clamp.8. Conduct the final weld according to procedure.

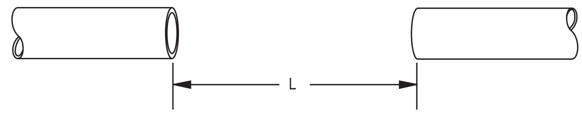

Figure F-87. Remove damaged section

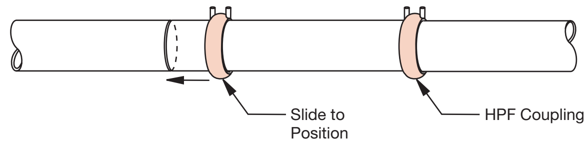

Figure F-88. Slide second coupling into place and conduct first weld at joint seam

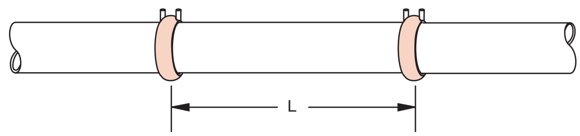

Figure F-89. Conduct final weld

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For systems where electro fusion is not available, and there is no flex for movement of the existing pipe in the region of the damaged pipe, the repair can be done using flanges or unions.

1. Remove the section to be repaired.
2. Weld flanges or unions on both ends of the existing piping.
3. Measure the distance from face to face and build a spool to fit into place.
4. Connect spool into place.

Figure F-90. Remove damaged section

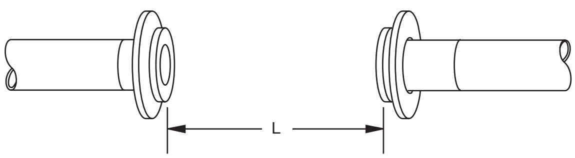

Figure F-91. Weld flanges or unions into place

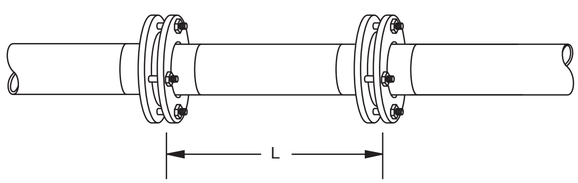

Figure F-92. Place spool into place

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