

COMPRESSED AIR PIPING 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 compressed air/gas pipe system, either in a pipe rack or trench. This guide is aimed at industrial applications and not high-purity installations.

For compressed air piping, Asahi/America recommends only the use of manufacturer approved materials for this application. In particular, the Air-Pro system from Asahi is the only system recommended for use in this application due to safety concerns. Air-Pro has been specifically designed and tested for the application of compressed air and gases. All other materials such as PVC, C-PVC, PVDF, and polypropylene are not recommended for compressed air and are not warranted by Asahi/America for that service.

Asahi/America's recommendations for project management 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. 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 extremely 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 advised. For specific recommendations by tool type, consult the Asahi/America Engineering Department.

When conducting field welds in a pipe rack or in a trench, it is important to have the location of the welding planned. Vertical welds in any location will prove more 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 Asahi/America for the use of double containment flanges.

Step 2. Tool Selection

The selection of the type of welding method conducted on an Air-Pro piping project should be based on the following criteria:

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

Socket Fusion

The majority of Air-Pro systems are 1/2" to 4". In these sizes, the weld method available is socket fusion. Asahi/America offers two styles of socket fusion equipment: a small hand-held tool capable of welding up to 2" and a larger bench style tool capable of welding up to 4". Figure F-118. shows a brief pictorial of the socket fusion method. For further explanation of the socket fusion method, see *Socket Fusion Welding Methods* in the beginning of Section F.

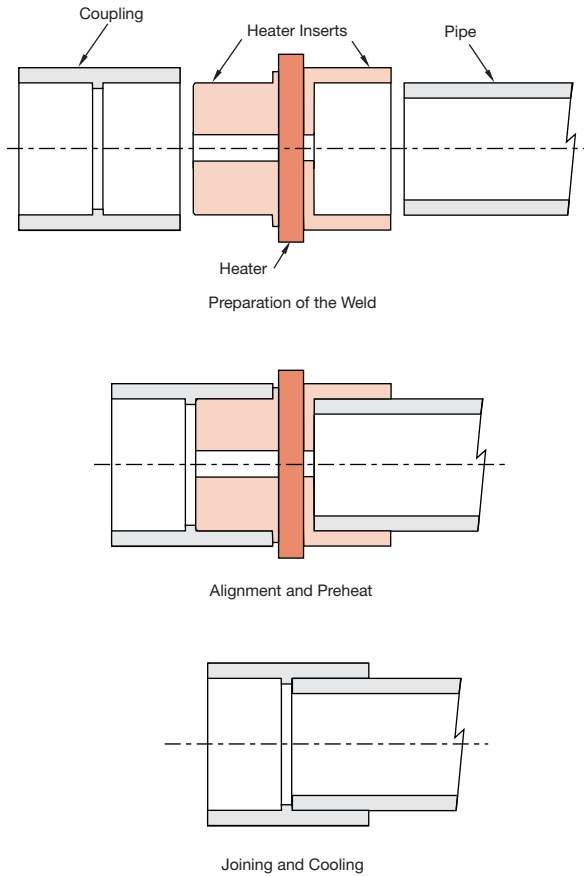


Figure F-118. Socket fusion welding process

Two Inch Hand-Held Socket Fusion Heater

This tool, depicted in Figure F-119, is a hand-held heating plate that accepts two sizes of socket fusion heater inserts. The tool is ideal for welding smaller dimensions and works very well in sizes 1/2"-1". While the tool can hold inserts in 1 1/2" and 2", it does prove to be more difficult due to the heavy wall of Air-Pro, requiring more force from the operator to push the pipe and fittings into the heating inserts. For projects that are primarily 1" and below, the hand-held tool is recommended. If only a few welds in the larger dimensions are necessary, the project can be accomplished completely with the hand-held tool.



Figure F-119. 2" hand-held socket fusion heater

The hand-held tool also has the practical use of working in tight locations. Due to its compact size, it is recommended for use in pipe racks, trenches, etc. where larger bench style equipment may prove too bulky and cumbersome. The hand-held tool is also ideal for repairs and additions to existing systems.

Bench Socket Fusion

The bench socket fusion machine is just that; it sits on a bench in order to be operated. The tool, depicted in Figure F-120, is provided with a heating element for the socket inserts to be attached. It also has a set of clamps and moving beds to force the pipe and fittings in and out of the heater inserts.



Figure F-120. Bench socket fusion heater

The advantage of the bench tool is the ease of operation. Fixing pipe and fittings into the clamps provides good alignment. The gear operation greatly assists in providing the required force to heat and join the components. If a system is made up primarily of 1 1/2" and larger, the bench tool is recommended. In smaller systems that are prefabricated, the bench tool may also provide a higher quality system in terms of weld aesthetics and alignment.

The bench tool is ideal for welding on a bench top, where the tool remains stationary. However, the tool can be placed on rollers and easily moved around if required. In trench applications, where a lot of welding may be required of straight runs of pipe, the bench tool can still be used. Each site condition is different, so experimentation with keeping the tool on the bench, rollers, or placement close to the ground will help find the fastest installation for a project.

Butt Fusion

In the Air-Pro Compressed Air Piping system, the majority of systems are joined using socket fusion. However, larger systems in 6"–12" are available upon request. For these systems, butt fusion is the recommended welding method. Figure F-121 displays a brief pictorial of the butt-fusion welding method.

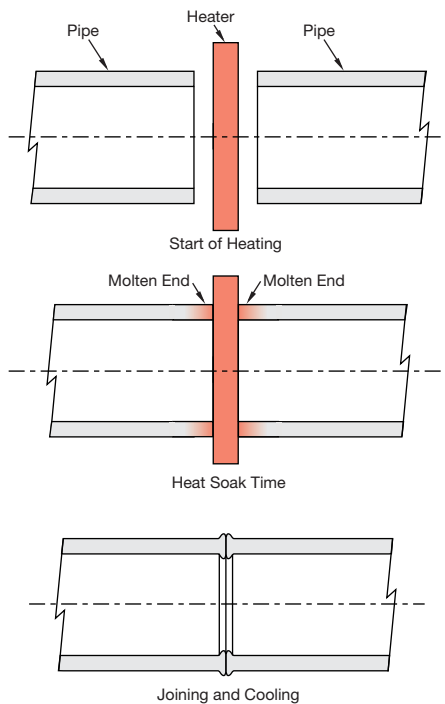


Figure F-121. Butt-fusion welding process

Depending on the size to be joined, the style of butt-fusion equipment will vary from manual operation to hydraulic style equipment. For an Air-Pro System being joined using butt fusion, Table F-22 provides the recommended tool for the application.

Table F-22. Butt-Fusion Equipment for Air-Pro Material

Size	Shop 10/12	Field 6	Field 12
6"	A	A	A
8"	B	X	A
10"	X	X	A
12"	X	X	A

A = Recommended
 B = Recommended, but better choices are available
 X = Not recommended

Butt fusion offers many advantages in an Air-Pro installation. When joining pipe to pipe, a coupling is not required. The two pipes are welded directly to each other. This reduces the amount of required fittings, as well as the amount of welds to be conducted. In the instance of Air-Pro being buried, the trench equipment proves ideal. It is designed to be pulled and dragged in a trench bottom. It is hydraulically operated, eliminating the need for bulk pull arms and gearing on equipment.

In many systems below 6" that are primarily made of pipe, butt fusion is used. For these installations, it proves cost effective to reduce fittings and welds. This is highly recommended if the system is mostly straight runs of pipe. In 4" and below, Air-Pro is not available with butt-fusion fittings. Therefore, two types of welding equipment will be required on the job site to attach pipe and fittings.

F

Step 3. Material Handling

When pipe, fittings, and valves arrive on site, they should be inspected to ensure the proper components have arrived and that 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.

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. 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.

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

An Air-Pro system is a straightforward installation and training requirements are minimal. Hand-held fusion can be learned in a period of one hour by most installers. Installations requiring bench style or butt-fusion equipment may require more training. In all cases, contact your distributor for proper training support prior to the job start, or even prior to ordering material. Training can then be planned and provided when the project is ready to begin.

Proper welding is critical in any piping system. 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 ensure all installers are trained and approved to use the equipment. Untrained personnel will not speed up a project's completion.

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.

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. Consult with the factory or distributor at the time of tool ordering.
- 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.

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 a 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 or welding errors will occur.

Step 6. Pipe Cutting

Cutting plastic pipe can be handled in a variety of methods. In small dimensions, 1/2" through 4", roll wheel pipe cutters are commonly available and work well. These types of cutters are similar to a tube cutter, but only larger. For an Air-Pro system using a roll cutter, 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.

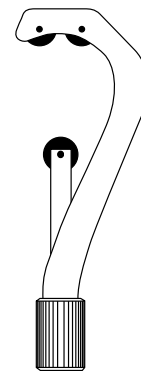


Figure F-122. Roll cutter

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 the band saw to avoid having the blade bend and create an angled cut. For smaller pipe sizes, a circular blade chop saw will 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. Reciprocating saws are generally acceptable as long as the blades are long enough to cross the entire diameter of the pipe. If too fine a blade is used, the material will become quite 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 this Section F. Use the recommendation of this weld inspection guide in conjunction with the equipment manual to achieve the best project results.

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 123 shows a detail of a standard butt-fusion bead formation.

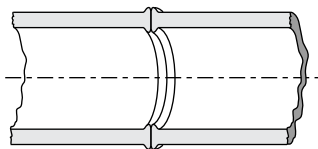


Figure F-123. Typical butt-fusion weld bead

Butt-fusion beads will vary in size depending on the outside temperature, the diameter welded, and the operator. With Air-Pro, there will be a pronounced double-bead formation that will be simple to identify. 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 for each tool on how to correct the problem. If problems persist, contact Asahi /America or your local distributor 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.

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 of 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-124 shows an example of acceptable and non-acceptable socket fusion joints.

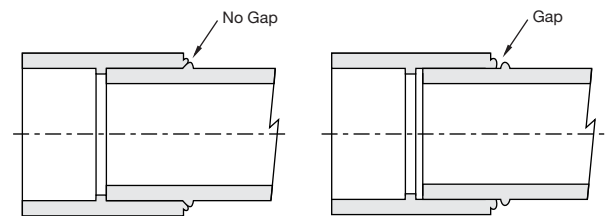


Figure F-124 Good weld Bad weld

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 with the naked eye. In a 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 a proper weld, there is material joined together in the pipe wall, as well as in the inner and outer beads.



The problem with inspecting a cold weld is that the outer bead may be 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.

F 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 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 ideal for hanging thermoplastic piping systems. While Air-Pro is most likely the most tolerant system to mishandling, improper hanging, scratching, and impacts, it is still best to avoid poor metal hangers when possible. Figure F-125 depicts the negative effect of a U-bolt hanger on a system.

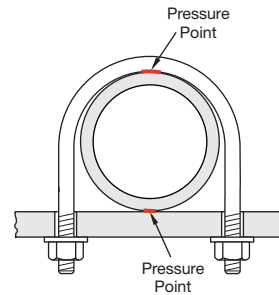


Figure F-125. Effects of U-bolt on pipe

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.

Step 9. Trenching and Burial

Proper trenching and burial of a pipe system requires engineering prior to an installation. Asahi/America's *Engineering Manual* (Section C) provides a comprehensive guide to the 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 be checked.

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 different densities and will create varying 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 F-126 depicts a recommended cross section of a trench and proper fill material and compaction.

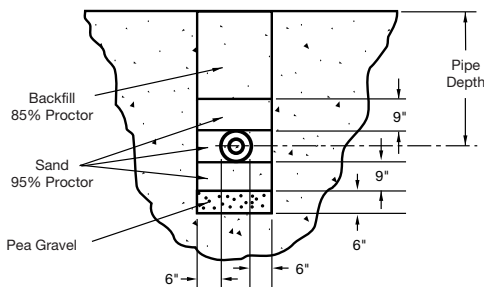


Figure F-126. Trench detail

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 to accommodate the machine may be required.

Step 10. System Testing

Prior to pressure testing, the system should 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 procedure above.

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

Pressure Test

The Air-Pro system can be tested using compressed air.

1. Begin pressurizing the system in increments of 10 psi. Bring the system up to 100 psi 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.
2. 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 in the environment.
3. Test is to be witnessed by quality control engineer, and certified by the contractor.
4. Obvious leaks can be found by checking each joint individually using a soapy water solution or an ultrasonic leak detection gun. Leak detection guns are available from Asahi/America. Consult factory for usage of U.S. leak detection guns. Some limitations do apply.

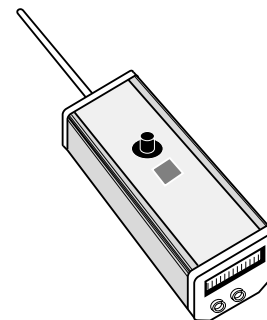


Figure F-129. Ultrasonic leak detection gun

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 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 on stressing the pipe.
4. Conduct standard butt-fusion weld per operating procedures. It may be necessary to flex one end of the pipe out of the way of existing pipe.
5. Conduct final weld using the flexible side of the pipe system in the moving clamp.

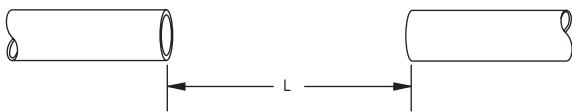


Figure F-128. Remove damaged section

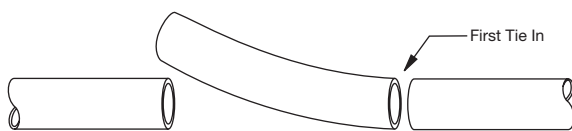


Figure F-129. Install new spool

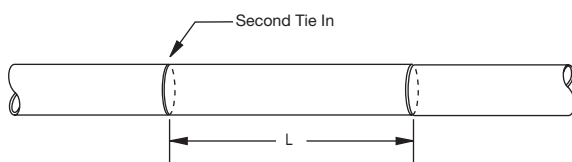


Figure F-130. Butt weld spool to existing pipe line

Non-Flexible Pipe System

Depending on the size and material, repairs can also be made to systems without any movement. If 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 true union ball valves.

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-131. Remove damaged section



Figure F-132. Weld flanges or unions into place

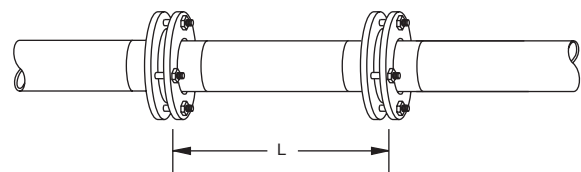


Figure F-133. Place spool into place