IntegriFuse L -1 *INSTALLATION INSTRUCTIONS*
Electrofusion Fittings 1/2" THROUGH 12 DIPS"

L -1 Training Requirements

It is important to read and understand all instructions before attempting a fusion. Permanent field installations should be done only by operators who have been properly trained by an authorized instructor that has knowledge of polyethylene Electrofusion installation procedures, and by going through an Electrofusion training course which combines classroom discussion on the installation procedures with hands on training. The training class should include the operator making an Electrofusion joint and doing a destructive test on the fitting in accordance with D.O.T. 192.283.

For IntegriFuse Electrofusion fittings in the size range of 12" DIPS and below (Couplers, Elbows, Tees, Reducers, Branch Saddle, and Tapping Tee) under standard pressure applications (240 PSI and below), Integrity Fusion products will accept a valid certificate from a recognized US manufacturer (e.g.: Central Plastics, IPEX Friatec), or the installer may attend and complete Integrity Fusion Product's IntegriFuse L-1 training class. Participants will be issued an IntegriFuse L-1 certificate.

Safety Procedures

Always follow these procedures while performing electrofusion;

- Keep distances of at least 3 feet from the electrofusion fitting and the fusion site during the fusion process as electrical shock could occur.
- Always remain at the fusion site and observe the fitting during the fusion process and during the cooling time as a general safety practice.
- Always let the fitting go through the entire cooling process before refusing the fitting.
- Never fuse the electrofusion fitting during rainy or wet conditions in which the fusion area can't be kept dry.
- Discontinue the fusion process immediately if any smoke is observed. It is a good general safety practice to have a fire extinguisher nearby during the fusion process.

• IntegriFuse EF couplers are produced from PE100 and can be fused with pressure pipes made of PE3408, PE4710, PE80, and PE100. They cannot be fused with any other materials such as PP, PVC etc.
• It is recommended to use pipes with close tolerances, grade B (EN 1555-2:2002)
• Working Temperature: IntegriFuse EF Coupler could be fused at ambient temperatures of between -4°C (+40 F) and +45°C (+115 F) Special care should be taken to provide a balanced temperature level of both pipes and fittings before fusion operation
• IntegriFuse EF standard pressure couplers 39.5 volts and below for SDR 11 and 1 HDPE wall thicknesses can be fused with standard universal fusion machines.
• IntegriFuse EF fittings must be fused in dry conditions. Do not perform any fusion if the pipe or couplers are wet or contain moisture.

Recommended Installation Equipment

1. **Pipe cutting tool** - for making a square cut on the pipe. For smaller pipes, use a blade type pipe cutter or cutting saw. For larger pipes, use a chain saw without bar oil (chain saw oil will contaminate the pipe and permeate into the pipe wall).
2. **Pipe scraping tool** - for removal of the oxidation layer from the pipe. Use either a manual scraper tool with a tungsten carbide steel blade or a mechanical scraper tool.
3. **Pipe cleaning material** – use 90% or greater isopropyl alcohol as a cleaning agent. Use a clean lint free wipe to clean the pipe.
4. **Pipe rerounding tool** – for use on oval pipe. Rerounding tools are required on all IntegriFuse couplers larger than 24". PPI recommends for all sizes above 8".
5. **Pipe restraint and alignment equipment** – for limiting movement and maintaining proper alignment of the pipe during the fusion and cooling process, use alignment clamps.
6. **Pipe Beveling equipment** – for putting a bevel on the pipe ends to prevent damage to the wires and facilitate ease of installing the coupler on the pipe. Use a router with a 22.5 degree angle bit or a power planer.
7. **Electrofusion Processor** – IntegriFuse I Fuse 105 is required on all IntegriFuse fittings requiring over 40 volts. For IntegriFuse fittings requiring 40 volts or lower, use the IntegriFuse processor or a universal Electrofusion processor with 4.0 MM adaptor tips.
8. **Adequate Power Supply** – For all IntegriFuse large OD couplers, use a 6500 watt continuous output generator with a 240 volt, 30 amps, 4 prong twist lock receptacle. Do not use a pigtail adapter on any fittings larger than 2".
9. **Pipe measuring tools** – Use a measuring tape for determining pipe ovality. Use a pipe diameter or "PI" tape to determining overall pipe diameter.
10. **Flashlight** – use for checking for gaps and determining proper melt
11. **Electrical Tie** – Use 7" long electrical tie for checking for gaps prior to fusion of coupler. Use 4" electrical tie for checking for gaps and adequate fusion melt after fusion and cooling process is complete.
12. **Ratchet Straps** – for use on IntegriFuse thin wall couplers. Straps must be wide enough to cover the fusion zone. For IntegriFuse large OD couplers, use two, 2" wide ratchet straps capable of 1500 lbs strength on each side of the coupler to cover the fusion zone. When fusing to SDR 32.5 call Integrity Fusion Products for special instructions.
13. **Pipe Markers** – Use a permanent pipe marker similar to a silver "Sharpie" permanent marker pen. Do not use a "grease pencil" or other type of petroleum based marker that will leave contaminate behind.

Recommended Installation Equipment

Critical Installation Procedures:

It is of the upmost importance to pay close attention to the following key installation procedures. Failure to do so could result in improper fusion. See installation instructions for a more details.

1. **Pipe Cutting** – make sure that the ends of the pipe are cut with a square or right angle cut. Mark the pipe with a pipe wrap and mark a square cut with a marker pen before cutting the ends. Failure to cut square ends could result in a "short stab" in which the pipe ends are not together in the cold zone and would cause exposure of the EF wires and create excessive melt and heat.
2. **Pipe Scraping** - proper pipe scraping is necessary to obtain proper melt characteristics of the pipe. It is recommended that a minimum of .007" to .010" of the pipe's surface material be removed during the scraping process in order to expose a clean virgin material. This is approximately the thickness of 2 sheets of paper. Do not use a grinder, metal file, wood file, sandpaper, or emery cloth. These materials create grit or grit like residue that will imbed into the pipe area being scraped, which acts as a barrier between the pipe and fitting.
3. **Pipe Cleaning** –the pipe must be clean, dry, and free from any contaminants such as dirt or oil in order to create a proper fusion. Use 90% or greater Isopropyl Alcohol to clean the pipe surface after scraping the pipe. Denatured Alcohol or any other chemicals should not be used.
4. **Rerounding Oval Pipe** – use rerounding tools to round the pipe to facilitate the pipe insertion process and to reduce the gaps between the pipe and coupler surface. A gap that is too large will result in insufficient melt to close the pipe/coupler interface.
5. **Eliminating Water-** Never fuse the electrofusion fitting during rainy or wet conditions in which the fusion area can't be kept dry. All valves should be shut off and no water can be present during the time of the fusion. If there is inclement weather, the work area must be tented off during the preparation and fusion. If the water cannot be stopped or the work area cannot be kept dry, work may need to be temporarily suspended until conditions improve.
6. **Pipe Alignment** – use alignment clamps or make sure the pipe is in proper alignment with the coupler. If the pipe is not properly aligned with the pipe, it will result in a stress on 1 side of the coupler and a gap on the other side of the coupler resulting in an improper fusion.
7. **Pipe support and restraint** – support the pipe and coupler underneath during the fusion and cooling process. Restrain the pipe to avoid any movement during the fusion and cooling process. Movement or lack of pipe support will cause pipe movement and a stressed condition that could result in an improper joint.
8. **Check and Eliminate Gaps before Fusion** – determine gap areas prior to fusion. Eliminate gaps with a pre-warming cycle or by heating the inside area of the pipe with a 2400 watt or less infrared heater. Close the end of the pipe and the area approximately 2 feet back to contain the heat. Measure the pipe with a pi tape to determine when pipe is in proper dimensions.
9. **Examine the Fused Coupler** – examine the fused coupler with a flashlight and electrical tie after the cooling time to determine if the fusion cycle was sufficient to produce enough melt to close the gaps.

Fitting Storage/Handling

Electrofusion fittings should remain in their original packaging whenever possible prior to fusion to protect the fitting from contamination or degradation from UV effects. Fittings should be stored indoors in their original packaging. Fittings stored properly indoors in their original packaging have an unlimited shelf life. Fittings that have been stored outside in direct sunlight and weather conditions should be evaluated by destructive testing to determine if surface oxidation has occurred. Oxidation can't be removed by cleaning and will prevent proper bonding between the pipe and fitting during fusion. Integrity Fusion Products will not accept the return of any fittings that have been stored outside!

Re-Fusion of IntegriFuse Electrofusion Fittings

IntegriFuse electrofusion fittings can be refused up to 3 times. If another fusion is needed, contact Integrity Fusion for approval. IntegriFuse fittings must be allowed to cool for the complete fusion time before re-fusing! Failure to wait the full cooling time before refusing could result in excessive heat being created and could result in a fire. It is often necessary to re-fuse the IntegriFuse fittings in manual input mode with the IntegriFuse processor after the complete cooling time due to the wire still being hot and the resistance out of tolerance

for barcode or manual barcode mode. Visually examine the gap areas after the fusion/cooling time with a flashlight and use a small electrical tie to determine if the tie stops at the first wire. This will determine if sufficient melt has occurred to close the pipe/coupler interface.

Hydrostatic Testing Electrofusion Fittings

Most HDPE pipe manufacturers have adopted the hydrostatic pressure test recommendations listed in the Plastic Pipe Institutes (PPI) technical report TR31. Wait 24 hours to allow the electrofusion fitting to cool. Test pressures should not exceed 1.5 times the rated operating pressure of the pipe or lowest rated component of the system for an average of 1 to 3 hours. The total time under test should not exceed 8 hours. The fitting should be visually examined for leakage when possible. If pressure monitoring is used to determine if leakage exists, allowances should be made for pipe expansion by adding water until equilibrium is established. Allowable amount of "make up" water are show in PPI TR31. Pneumatic pressure testing, cue to safety reasons, is not recommended.

Weather Guidelines

In Cold Temperatures down to 40°F, it is recommended that a temporary wind barrier be set up around the operator and fusion equipment. It is also recommended that the pipe ends be capped off to prevent cold air from flowing through the pipe. In Cold Temperatures below 40°F, in addition to the above recommendations, pipe ends should be pre-heated using a heating blanket or warm air device to elevate the temperature to improve the heat cycle. Make sure the OD of the pipe ends are clear of moisture due to possible frost. Make sure there is no water inside the line from condensation. In warm/hot conditions up to 115°F, elevated temperature conditions can be improved by shading the operator and the equipment when applicable. The Fusion Area must be tented to stop any precipitation from reaching the fusion area if there is any present.

IntegriFuse L-1 INSTALLATION INSTRUCTIONS for ELECTROFUSION Fittings 1/2" THROUGH 12 DIPS"

The information and instructions included in this document should be read & sequence of installation instructions must be strictly followed.

IntegriFuse EF couplers are produced from PE100 and can be fused with pressure pipes made of PE3408, PE4710, PE80 & PE100. They cannot be fused with any other materials such as PP, PVC etc.

It is recommended to use pipes with close tolerances, grade B (EN 1555-2:2002)

Working Temperature: TEGA EF Couplers could be fused at ambient temperatures of between +40°F and +115°F. If jobsite conditions are such that the pipe and fitting temperature is below 40 degrees F, the installer should use a tent and heater to warm the pipe and EF fitting to allowable temperatures.

Special care should be taken to provide a balanced temperature level of both pipes and fittings before fusion operation

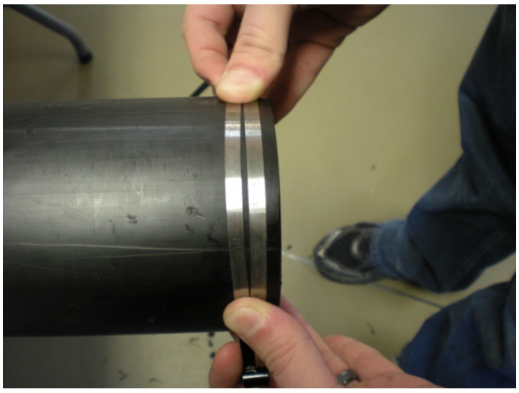
IntegriFuse EF standard pressure couplers that are labeled 40 volts and below for SDR 11 and 17 HDPE wall thickness could be fused with standard universal fusion machines.

IntegriFuse EF Couplers requiring voltages greater than 40 volts require use of the IntegriFuse I Fuse 105 universal processor. Use a generator with an output no less than 6500 continuous watts with a 240 volt, 30 amp, 4 prong twist lock input.

IntegriFuse EF fittings must be fused in dry conditions. Do not perform any fusion if the pipe or coupler is wet or contains moisture.

1. Determination of the pipe dimensions.

Determine Pipe Tolerance-with a tape measure or a Pi tape, measuring the circumference of the pipe area to be fused (Figure 1). Use the HDPE Pipe Tolerance table below to determine if the pipe is within tolerance. These measurements should be taken in the fusion zone on the pipe and at the end to check the end of the pipe to see if a neck-down is present. At this time the technician must also check the condition of the pipe. Check to see if any flat spots are present. If the pipe has gouges or a texture exceeds 10% of the minimum wall thickness required for the operating pressure, it they exceed 10%, contact Integrity Fusion Products to proceed. A section of the pipe may need to be removed to eliminate these issues. If the pipe is out of tolerance in anyway and the issues are not addressed, the manufacturer's warranty on the couplers is no longer effective. If pipe is not within minimum tolerance, call Integrity Fusion Products, Inc. before proceeding. If the pipe measures towards the lower end of the tolerance, you will need to take care to check for excessive gaps. Do not over scrape pipe. Do not use a plainer to scrape as this may remove too much material and create too large a gap. You will need to utilize the preheat cycle to close any gaps larger than 2MM (between wires and pipe surface).



Measure pipe with a pipe diameter tape

Figure 1

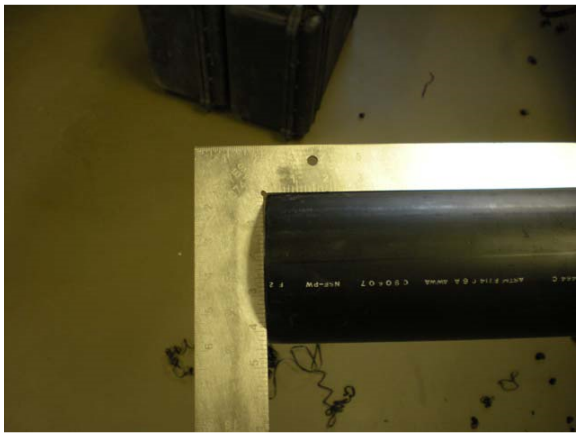
HDPE Pipe OD Tolerance Guide

Pipe Size	OD	Min. OD	OD Circumference	Min. Circumference	Max Gap (mm)
2" IPS	2.375 "	2.369"	7.460"	7.430"	0.95
3" IPS	3.500 "	3.492"	10.990"	10.960"	1.15
4" IPS	4.500 "	4.491"	14.130"	14.100"	1.25
6" IPS	6.625"	6.614"	20.800"	20.770"	1.40
8" IPS	8.625"	8.612"	27.080"	27.040"	1.63
10" IPS	10.75"	10.735"	33.760"	32.570"	1.93
12" IPS	12.75"	12.733"	40.040"	39.980"	2.18
3" DIPS	3.960"	3.944"	12.430"	12.380"	1.30
4" DIPS	4.800"	4.778"	15.070"	15.000"	1.63
6" DIPS	6.900"	6.869"	21.660"	21.570"	1.93
8" DIPS	9.050"	9.009"	28.420"	28.290"	2.36
10" DIPS	11.100"	11.050"	34.850"	34.690"	2.83
12" DIPS	13.200"	13.141"	41.450"	41.260"	3.33

2. Cutting Pipe Ends

Cut the pipe ends at right angles to the pipe axis. Do not allow the use of any lubricant on the cutting tool. Oil on the cutting tool will create a non-fusible barrier between the pipe and coupling which will lead to joint failure. For the pipe cutting, a suitable cutter for plastics must be used. An improper cut can lead to the pipe ends being outside the cold zone in the coupler which will result in excessive melt of the coupler. If possible, a saw with a right-

angled guide is recommended as shown in Figures 2. If it is not possible to provide a cutting device with a guide, the cutting lines should be marked on whole circumference of pipe to achieve a right-angle cut-off pipe. It is recommended to use an electric planer to face of the rough ends of the pipe to make them flat and smooth. Use of mechanical scraper tools which use the pipe ends as a guide will operate much easier with pipe ends that are flat and smooth. Note: Do not bevel pipe ends at this time, as this will make it difficult to measure pipe and determine pipe ovality.



Cut pipe at right angles

Figure 2

3. Marking the Fusion Zone

Fusion Zone: The fusion zone is the half-length of the coupler. The fusion zone must be measured and marked with a marker on the pipe as shown in Figure 3 and Figure 4 below.

Measure the fusion zone

Figure 3

Mark the fusion zone

Figure 4

4. Scraping the fusion zone

In order to remove the oxide layer completely, the pipe end must be scraped so that shavings are formed as shown in Figures 5 and 6. If the coupler is being inserted all the way onto the pipe, the full coupler length must be scrapped. Any area that the wires may come in contact with must be scraped to avoid contamination. This operation ensures removal of the oxidation layer, which will increase melt flow during the fusion process. **It is critical that the oxide layer be removed completely; otherwise it may cause cold welding resulting in leakage**. This can be accomplished with a manual scraper tool or a suitable mechanical scraper tool. Make sure that the scraper blade is sharp. It is recommended to use a tungsten carbide blade. It must be taken into account that the surface of pipe within the fusion zone must be smooth (i.e. without any grooves, gouges, etc). If there is any un-scraped area on the pipe surface, these areas must also be scraped (if the pipe is oval and a mechanical scraper is used, it is possible that some areas will remain un-scraped. These areas must be scraped with a manual scraper tool. The prepared surface must be protected against dirt, grease, and unfavorable weather conditions. After scraping do not touch the fusion zone again. Do not scrape the inside of the fitting. If the pipe has deep cuts, gouges or a texture exceeds 10% of the minimum wall thickness required for the operating

pressure, contact Integrity Fusion Products to proceed. A section of the pipe may need to be removed to eliminate these issues. If the pipe is out of tolerance in any way and the issues are not addressed, the manufacturer's warranty on the couplers is no longer effective. The deep cuts, gouges, or texture on the pipe's surface cannot not be repaired with extrusion welding guns; this will not restore the structural strength of the pipe.

Mechanical Scraper
Figure 5

Manual Scraper
Figure 6

5. Correct the pipe ovality

Measure for the pipe ovality as shown in Figures 7 and 8 below to determine if the area is out of tolerance. Mark the areas that are outside the standard tolerance for the OD of the pipe with a white marker. If it is determined that some of the areas have an OD that is too large, then you will need to utilize pipe rerounding clamps as shown in Figure 9 in order to install the coupler.

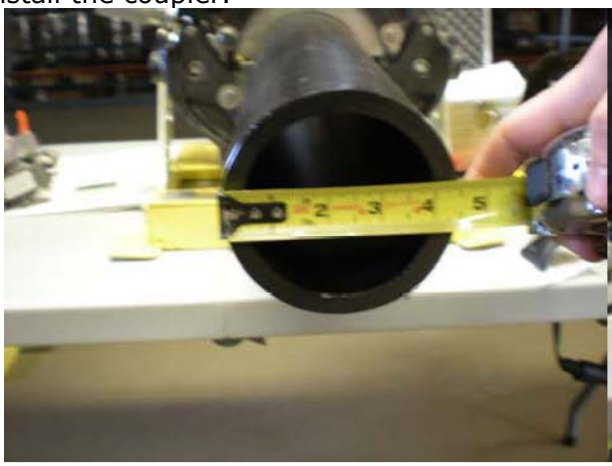


Figure 7

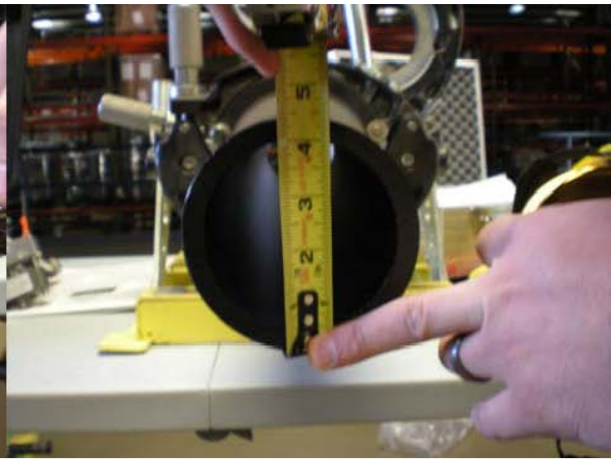


Figure 8

Measure to determine pipe ovality

Alignment Clamps
Figure 9

6. Correcting Flat Spots

If a flat spot is present, you must take care of the flat spot before you start the fusion. In order to correct the flat spot on the pipe, the technician should use at least a 5 ton bottle jack on the inside of the pipe to close up the gap. You may also need to use an infrared

heater to help close up the gaps. Refer to the maximum allowable gap chart to see if the gaps are in tolerance. If the flat spot is not eliminated, there is a high chance of leakage. Coupler will not be covered under warranty if the flat spots are not eliminated.

7. Deburring/Beveling Ends

The internal end of pipe must be deburred. Then round off the outer edge as shown Figure 10. Round off or bevel the outer edges of the pipe with a hand scraper, electric planer, or router.

Deburring or Beveling pipe ends
Figure 10

8. Cleaning the Fusion Zone

The prepared pipe end and internal face of EF fitting must be degreased with a suitable cleaning agent and a white absorbent and non-fibrous cloth as shown in Figures 12 and 13. The cleaning agent (isopropyl alcohol <greater than 90%>) must be completely evaporated before installation of the fitting. After cleaning agent is applied, remark the fusion zone. Degreased surfaces must be protected against dirt or unfavorable weather conditions. The operator should wear clean cotton gloves to ensure the cleaned surfaces don't come in contact with bare hands or any equipment/debris.

Figure 11

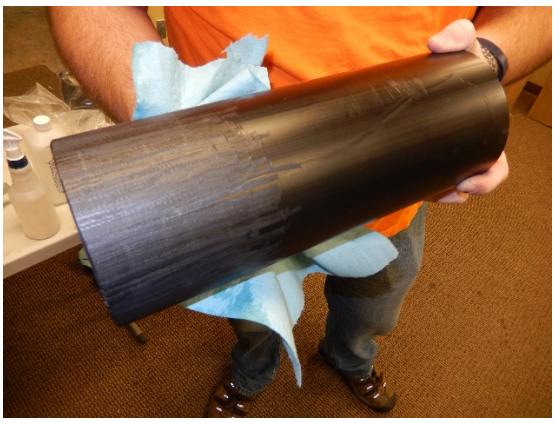


Figure 12

9. Insert the Pipe into the Coupler

Inserting of the pipe end into the coupler should be done without causing any tilting as shown in Figures 13 and 14. The pipes must be in alignment with the fitting as shown in Figures 15. Alignment clamps as shown in Figure 16 are recommended and are helpful to ensure proper pipe alignment. Tapping with a plastic hammer around the face of the coupler can assist insertion. Do not tap near the fusion connections as they could become damaged. The pipe end must be inserted into the fitting up to the insertion mark. Pipe should not be inserted if the fit is too tight. In order to control bending stresses do not let the pipes support their own weight in the coupler. In order to provide unstressed assembly it is recommended to use a suitable holding device. This stress-free condition must be maintained during the cooling period. Position the coupler so that the contact terminals of the fitting are easily accessible. **An assembly, which is stressed, may result in defective joint.** Before starting fusion operation, check seating of pipe insertion by means of line marks. If necessary do corrections. Ensure that both pipes are inserted into the fitting and the two ends are meeting each other in the center of the coupler (the cold zone). The maximum allowable gap between the two

pipes is to be less than > ½”.

Insert Coupler on pipe-Figure 13

Insert other end of pipe-Figure 14

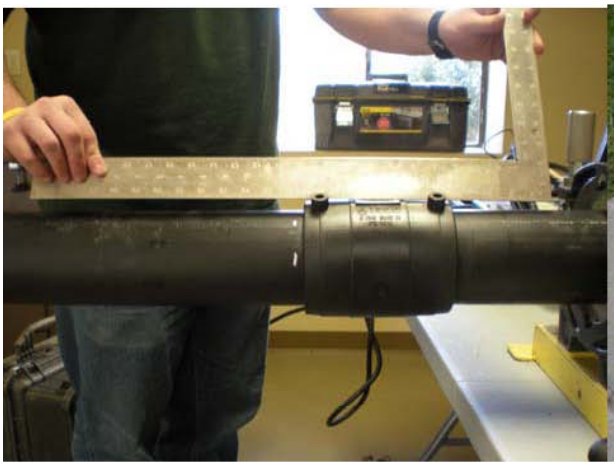
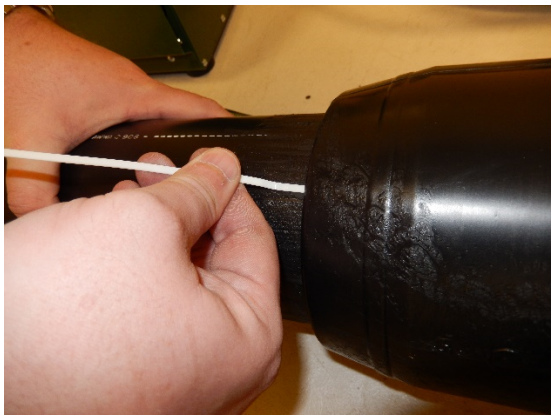


Figure 15

Figure 16

10. Check for gaps/Pre-Heat cycle

With a small electrical tie, check around the circumference of the pipe between the pipe and coupler, to determine for any gaps larger than the tolerance, as shown in Figure 17. If there are no gaps larger than the tolerance guide, then proceed to step 11. Mark any areas with gaps larger than the tolerance with a white marker pen. It will be necessary to perform a preheating cycle to close any gaps between the pipe and coupler larger than the allowed tolerance (distance from wire to pipe surface). Attach the leads of the IntegriFuse processor to the coupler. Switch the processor to manual mode and input the proper voltage for the fusion time specified on the coupler (check with Integrity Fusion Products for proper voltage). Press start and allow the preheat cycle to complete. After the cycle is complete, wait another 10 minutes to allow the pipe to expand. Measure the areas with gaps again. If the gaps have closed to within the tolerance, then go on to the fusion process. If the gaps have not closed, then repeat the preheat cycle a second time. Allow the coupler to cool 50 minutes after the preheat process is completed before checking the gaps again.



Check coupler for Gaps

Figure 17

11. Carrying out the Fusion

Provided that the installation instructions are followed step by step, the fusion process can be started. Attach the leads of the processor as shown in Figure 18. Fusion parameters are included in the barcode label on the fitting. The fusion parameters are transferred into the fusion control box by means of barcode reader as the operator moves the reader wand over the barcode (Figure 19). After reading the barcode, the data on barcode label should be compared with the data on display. **Each side of bifilar couplers (coupler with two separate windings) has to be fused separately.** Start the fusion process. Progress of fusion operation can be followed by the display on fusion unit to see if the process is going on properly or not. **As a safety precaution, be careful to stay at least 3 feet away from the fusion area.** If the fusion process is interrupted for any reason (e.g. due to power failure) the fusion process can be repeated after the joint has cooled adequately.

Attach the leads to fitting
Figure 18

Scan the barcode
Figure 19

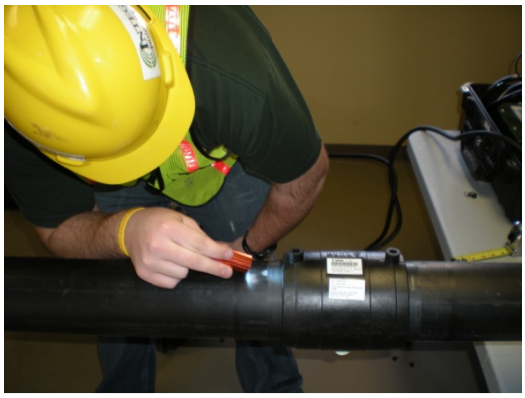
Cooling time is indicated as "Cool" on the barcode label. It is the time necessary to allow the jointed part to cool down to a temperature. Before completion of cooling time it is not allowed to move or pressurize the jointed components.

12. Examination of the Fused Coupler

With a flashlight, examine the area in between the coupler and pipe to check for any remaining gaps or wires that can be seen (Figure 20). With a large electrical tie, similar item, insert into the space between the pipe and coupler (Figure 21). You should hit the Electrofusion wires and not be able to insert the tie any more (the tie will stop). If there are any areas in which the clamp can be inserted without stopping, then allow the coupler to

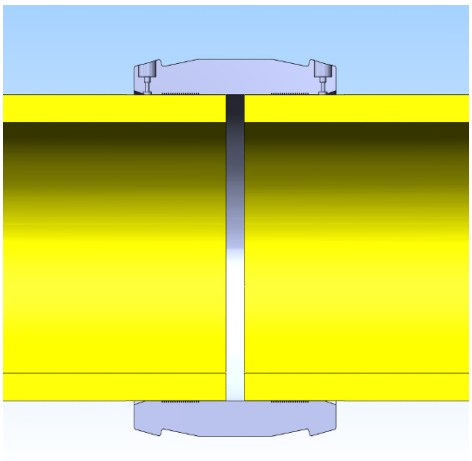
cool and fuse the coupler again. After the 2nd fusion process, repeat both the flashlight and tie examination to determine that proper HDPE melt has closed any gaps. The Electrofusion fitting can be fused up to 3 times after allowing the cooling process to complete. If an additional fusion is required, please contact Integrity Fusion Products before proceeding.

Check the fitting for gaps
Figure 20

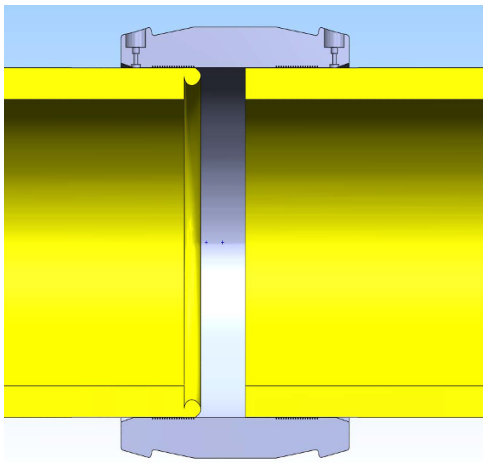


Check for gaps and visible wires
Figure 21

The Following illustrations are examples of acceptable and unacceptable fusions. These are taken from the Plastic Pipe Institute (PPI) TN-34/2009.

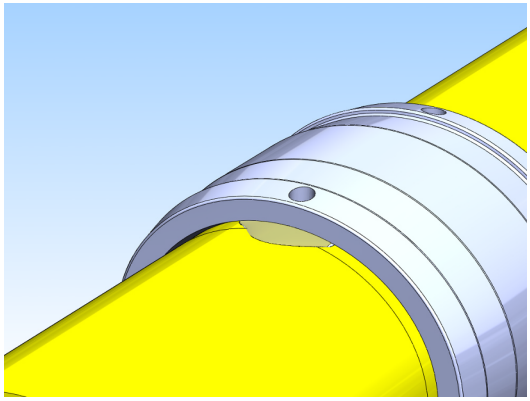


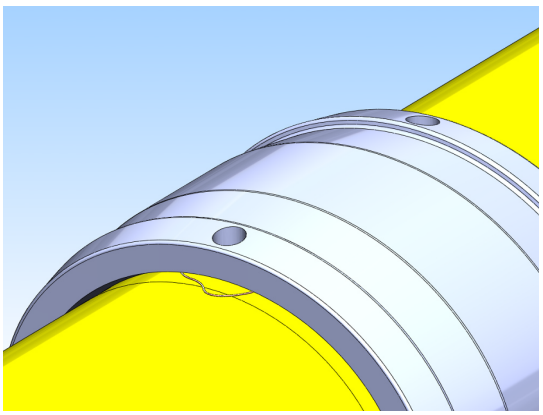
<u>Good Fusion-</u> Acceptable.



<u>Short Stab- UnacceptableFusion</u>

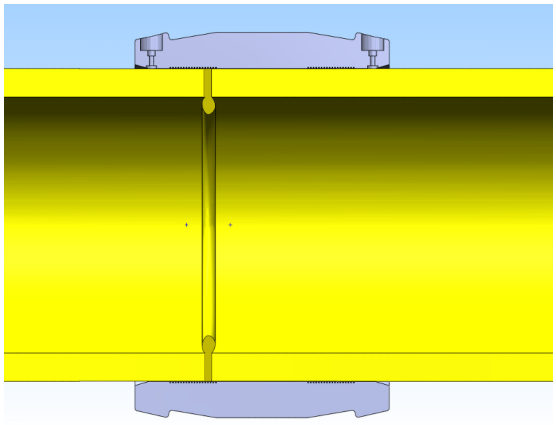
Possible Causes: Failure to mark and monitor stab depth.





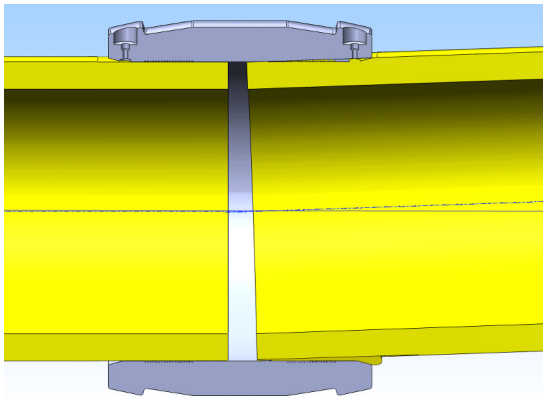
Melt Out- Unacceptable Fusion

Possible Causes: Pipe Ovality, Flat Spots, Undersized Pipe, Binding, or Mis-Alignment



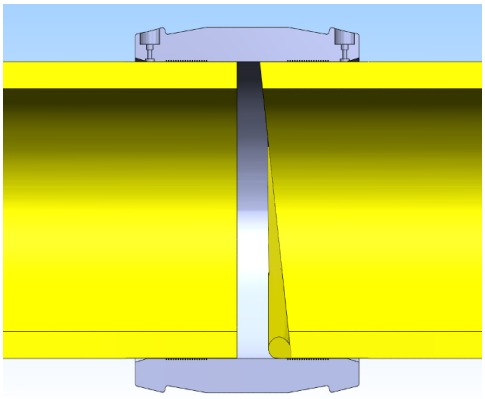
Exposed Wire- UnacceptableFusion

Possible Causes: Pipe Ovality, Flat Spots, Undersized Pipe, Binding or Mis-Alignment



Mis-Stab- Unacceptable Fusion

Possible Causes: Failure to mark and monitor stab depth.

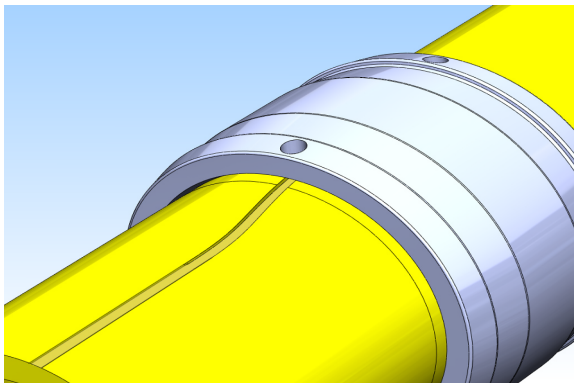


Mis-Alignment- Unacceptable Fusion

Possible Causes: Inadequate Clamping or Restraint during fusion.

Mis-Cut- Unacceptable Fusion

Possible Causes: Failure to cut the pipe end perpendicular to the axis of the pipe.



Gouges and Scratched-Unacceptable

Possible Cause: Damage during transportation or handling of the pipe.