INTEGRITY
Fusion Products, Inc.

IntegriFuse Electrofusion Fitting Training & Installation Manual

Fitting Range 2” - 54”

INTEGRITY FUSION
ACADEMY
ELECTROFUSION INSTALLATION TRAINING

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IntegriFuse Electrofusion Training & Installation

Integrity Fusion Products **strongly recommends** that all *permanent field installations should be done only by operators who have been* trained and qualified by an authorized instructor and have a strong working knowledge of polyethylene and heat fusion. Integrity Fusion Products training and qualification requires the following:

- **Attendance of personal classroom instruction *(in-person or on-line when applicable)***
- **Successful completion of required qualification tests *(hard-copy or on-line when applicable)***
- **Completion of a witnessed demonstration of instructed electrofusion procedures while making required electrofusion joint assemblies *(in-person or documented in our approved on-line test site when applicable)***
- **Test assemblies successfully pass required ASTM destructive testing requirements**

NOTE: ***Factory Authorized electrofusion training and qualification is available to all qualified Distributor Fusion Techs. Contractors and Municipalities can be Factory Trained and Qualified but must be recommended, vetted and sponsored by one of Integrity Fusion's distributors. All Contractor & Municipality training will be coordinated and scheduled through the sponsoring Distributor.***

There are 2 levels of **Factory Authorized Electrofusion Training and Qualification** covered in this manual.

- **Level 1 (L1) training and qualification for fittings 12" and smaller, and**
- **Level 2 (L2) training and qualification for fittings 14" and larger**
  (Installation of IntegriFuse EF Couplers 26" > requires the installer to hold a current IFP L2 certificate)

L1 & L2 qualification certificates are valid for 2 years after date of issuance. Other regulations may also apply depending on the application, local codes, and/or jurisdictional oversight of state and local regulating agencies.

Electrofusion Training Goals

The underlying goal at Integrity Fusion Products and Integrity Fusion Academy, is to provide our customers and the industries and end-users they serve; not only with high quality electrofusion products, but also with the necessary level of product understanding and procedural training required for the successful installation of those electrofusion products into applications they were designed for. To ensure our electrofusion products live up to all expectations, it is important to receive proper training from an authorized instructor and to read and comply with this instruction manual before attempting to make any electrofusion joints.

The installation procedures covered in this manual are part of the **Integrity Fusion Academy** Electrofusion training program designed for educating and training Distributor EF Technicians and Distributor sponsored Contractor/Municipality Installers that are needing factory authorized qualification & training in electrofusion installation procedures for Level 1 (L1) applications 12" and smaller and/or Level 2 (L2) applications 14" and larger.

This manual will focus on providing individuals with fundamental information for understanding the "what" is electrofusion and "why" does electrofusion do what it does, in addition to the "how to" questions surrounding electrofusion installation considerations and requirements that include a general introduction to the tools and procedural steps required for making a sound electrofusion joint when installing electrofusion couplers, branch saddles and flex restraints.

The instructions contained in this manual have been qualified to the requirements of Title 49 Code of Federal Regulations, Part 192.283. Integrity Fusion Products assumes no liability in connection with the data contained herein and all data is accepted at the user's risk.

BUILDING THE FOUNDATION

Fusion Process Background

When you work with polyethylene systems for any length of time, you quickly recognize that the most effective and reliable method for joining two pieces of polyethylene (PE) pipe together or attaching a polyethylene (PE) fitting onto the surface of a polyethylene (PE) pipe - all use the process called "***heat fusion"***. Stated in simplest terms, there are three basic elements

that must be addressed for the heat fusion of polyethylene to take place. Those elements revolve around the application and control of, ***Fusion Temperatures, Fusion Times, and Fusion Pressures.***

To heat fuse two polyethylene (PE) surfaces together you must:

- ***Simultaneously heat the two PE surfaces together for a specific amount of time under a specific amount of pressure to raise the temperature of both PE surfaces to an optimum fusion temperature, then***
- ***Quickly bring the two heated PE surfaces together and subject them to another set of specified amounts of interfacial pressure for another specific amount of time, and then***
- ***Allow the two PE surfaces to remain restrained and immobile to adequately cool for yet another specified amount of time.***

The result will be a homogenous joint exhibiting the same strength and performance characteristics of the pipe brought about through a process known as **co-crystallization** that takes place between the two fused surfaces.

Conventional fusion methods, such as butt fusion or sidewall fusion, use **fusion equipment** specifically designed and engineered to allow **trained individuals** (fusion techs) to exercise precise control regulating and applying the required fusion temperatures, fusion times, and fusion pressures to the fusion zones on both pipe and fitting surfaces. Many aspects of this process are now programed and automated to some degree by fusion equipment manufacturers; but the trained fusion tech is still responsible for maintaining direct input, over-sight, and control of the fusion equipment, as well as closely monitoring the crucial moments within the fusion process to accomplish a successful fusion joint.

The electrofusion process, as we will discuss, takes a different approach to the fusion process which somewhat minimizes this operator dependence.

Electrofusion Defined

The similarity between conventional fusion methods and the electrofusion method remains the same in that ***fusion temperatures, fusion times, and fusion pressures*** are still regulated and applied to pipe and fitting surfaces using proven (qualified) fusion procedures in order to achieve a successful fusion joint. This is also where that similarity disappears.

ASTM F-1290-90 defines the electrofusion process as:

> ***"a heat fusion process where the heat source is an integral part of the fitting, such as that when an electrical current is applied, heat is produced that melts and joins the plastic."***

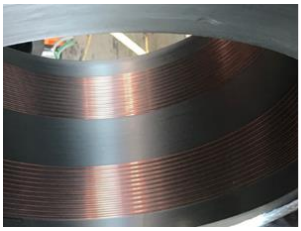
Whereas Conventional Fusion methods rely on the use of **engineered equipment** operated by **trained technicians** to assemble, and heat fuse the joints; the electrofusion process relies on **trained technicians,** following manufacturers "**qualified"** installation procedures to correctly assemble and fuse electrofusion joints using Engineered **Fittings** onto properly prepared pipe surfaces to accomplish the same heat fusion result.

Electrofusion Design

What does it mean when we say the electrofusion fitting is an **Engineered Fitting**? Simply put, the electrofusion fitting is designed to provide a controlled electrical voltage to a heating coil located in the fitting in order to generate and regulate fusion temperatures that will result in the necessary fusion pressures being applied to areas needing to be fused together, and when adequately cooled the result will be the same type of homogenous joint exhibiting the strength and performance characteristics of the pipe. This is a process that electrofusion fitting manufacturers design around, control and accomplish based on the following:

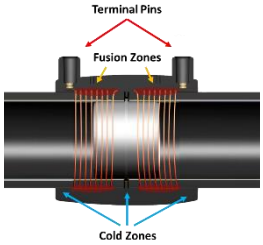
- **The geometrical configuration of the fitting needing to be used (i.e., its shape and size)**
- **The makeup of the wire used in the fusion coil (the alloy and the gauge)**
- **The number and spacing of the windings required to develop the melt pool (fusion zone)**
- **The fusion time needed to generate the necessary melt pool**
- **The size and location of the cold zones**
- **The proper use of restraint devices as required.**
- **The cooling time need to solidify the fused melt pool**

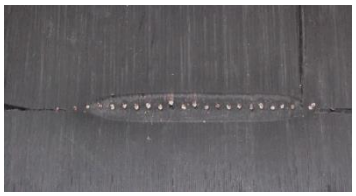
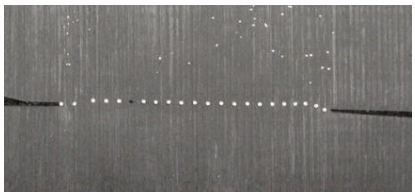
Regardless of what the specific design configuration of an electrofusion fitting may be (coupler, elbow, equal tee, reducer, branch saddle, tapping tee, restraint, etc.); Electrofusion fittings are functionally engineered and designed around two distinct interface zones that work together in generating and maintaining the needed fusion pressures. One has wires and is called the "fusion zone", the other does not have wires and is called "the cold zone". Both works together on the polyethylene surfaces as the wire in the fittings are heated up, the gaps between pipe surface a fitting are closed, and the subsequent interfacial pressures are built up for fusion.



Electrofusion Process Explained

The entire electrofusion process revolves around the effective generation, containment, and solidification of what is known as the ***melt pool.*** The ***melt pool*** is generated directly in the interfacial area between the pipe surface and the electrofusion fittings, which will soften, expand, and then liquefy when heat is generated and molecular bonding (***co-crystallization, i.e., fusion***) takes place as it cools.

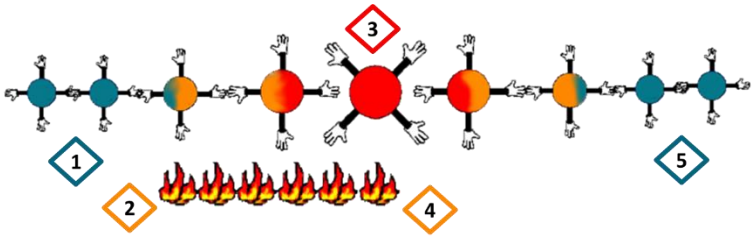


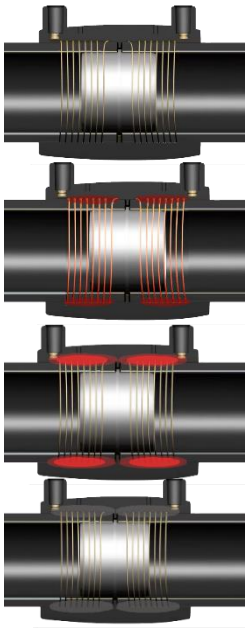
Let's Quickly Review the Process

We know:

1. The basic goal of heat fusion is to force the molecules in the fusion zone out of their steady stable state
2. By applying a controlled heat source to the area being fused that will agitate the molecules, causing them to expand and loosen their molecular bond.
3. The heat source will continue applying heat in the fusion zone until it reaches an appropriate temperature that will force the molecules to break their strong bonds.
4. When the heat source is removed at the appropriate time, the molecules will start realigning themselves across the fusion zone boundaries as the material cools.
5. The molecules will return to their new realigned state once completely cool down and the newly fused area will exhibit the normal material & performance characteristics of the pipe or fitting.



For electrofusion, that process looks like this.



- The pipe surfaces have been prepared.
- The fitting has been placed.
- The electrofusion joint has been assembled and restrained.
- The processor has been connected and the fitting barcode scanned.
- 0The fitting is ready to energize.

- The processor has been activated and a controlled voltage is applied to the fitting. The plastic material in the fusion zone heats up on the fitting and the pipe surface and begins to expand and closes the interfacial gap. The expanding material begins to move toward the fitting's cold zones.

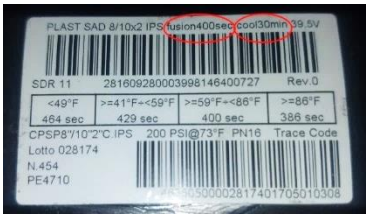
- The melt flow is forced into contact with the cold zone's cooler material, and it causes the hot melt flow to dam up, generating the necessary interfacial pressure for fusion to take place.

- As the fitting cools down, the molten plastic will begin to co-crystalize creating a molecular bond between the pipe and fitting, that once completely cooled, these two surfaces will be permanently bonded together and cannot be separated.

Fusion Cycle Explained

When you hear the term ***"fusion cycle"*** referred to when talking about electrofusion, it must be noted that the meaning of that term includes more than just energizing the fitting and melting the plastic.

When you look on the label that is supplied with each electrofusion fitting, you will see two different times noted that are near each other. One is labeled ***Fusion Time*** and the other is labeled ***Cooling Time***.



The Fusion Time is the amount of time that the manufacturer has determined will be needed to supply the necessary energy to the fittings heating coils in order to melt the plastic and generate the required melt pool.

The Cooling Time is the amount of time the manufacturer has determined will be needed for the molten plastic in the melt pool to co-crystallize and solidify sufficiently to remove the fitting from its alignment and restraint devices and be capable of rough handling and pressure testing.

Together, the ***fusion time*** and the ***cooling time*** both make up what we call the ***fusion cycle***!

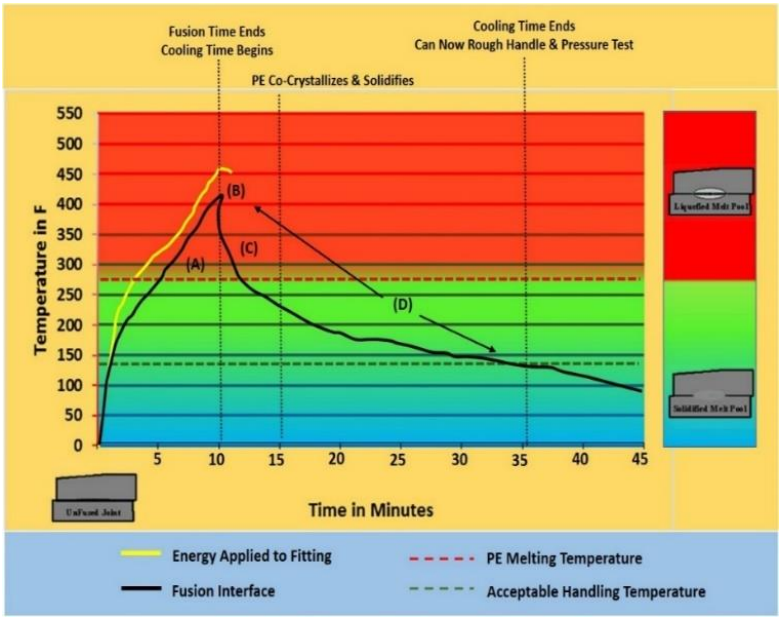
One of the most misunderstood and often ignored components of the entire electrofusion process is this ***melt cooling phase***. It is often assumed that if the fitting is cool enough to touch, it must be cool enough to remove from the restraint device or even subject the electrofusion fitting to a pressure test. The cooling phase is critical to the success of the electrofusion process and careful attention should be given to ensure that the stated cooling times are properly adhered to.

The importance of the cooling phase can be illustrated by looking at the actions of the melt pool during the fusion cycle. Using the following Figure, we will look closer at the melt pool stages created during the electrofusion process.

- **As current is applied to the fitting, the plastic on the fitting and pipe surface begins to melt and form a melt pool (A). This melt generation will continue until the current is removed and will continue a short time afterward.**

- **As the melt pool deepens and the PE material expands and encounters resistance from the cooler material surrounding it, significant interfacial pressure will build up in the fusion zone which will force the co-crystallization process to begin (B).**

- **This co-crystallization process takes place in the liquefied melt pool as it slowly begins to cool down. The molecular re-alignment and re-bonding in the fusion zone will continue until the PE material reaches solidification temperatures once again (C)**



- **The cooling phase (D) which began as soon as the current was removed from the fitting, combined with the design of the fitting, creates a controlled environment between the pipe and the fitting where the molecular re-orientation of the material between the pipe and the fitting can effectively take place. This process (also known as clamping time) must continue for a specific period of time beyond the point where the PE material re-solidifies. This allows ample time for the fusion area to regain the strength and flexibility it exhibited prior to fusion. Any movement or external stresses (binding, pulling, etc.) applied to the fused area during this cooling phase may result in a compromised fusion joint."**

Temperature Compensation

The default fusion times for electrofusion fittings are based on being done at an ambient temperature of 73º F. This is the baseline temperature that manufacturers use to calculate fusion times necessary for generating sufficient melt pools in the fusion zones. However, fusions performed at ambient temperatures higher or lower than 73º F can have an impact on the development of the melt pool; but this is not reason to worry.

Embedded in the barcode of every electrofusion fitting is a temperature compensation formula that is pre-determined by the fitting manufacturer. When you scan the barcode on the fitting prior to fusing it, the electrofusion processor automatically takes a reading of the ambient temperature, and then it automatically adjusts the fusion time accordingly. It will **increase** the fusion times accordingly in temperatures **below 73º F** and it will **decrease** the fusion times accordingly in temperatures **above 73º F**

Also, on the fitting label you will find temperature ranges listed and the pre-calculated fusion times for those ranges should you find yourself in the position of needing to manually fuse the fittings.

General Information

- IntegriFuse EF Electrofusion Fittings are produced from PE100 resin and can be fused with pressure pipes made of **PE3408**, **PE4710**, **PE80**, and **PE100**.
- IntegriFuse electrofusion fittings; contain 0% regrind, meet **ASTM D2513** & **ASTM D3261** requirements, meet specifications listed in **AWWA C-901/C-906**, **NSF-61** and **NSF-372**, meet **ASTM F-714** & **ASTM F-1055**, and are **FM** approved.
- To be b used on pipe with outside diameters that fall within the standard tolerances of ASTM F714. ***If the pipe is not within spec DO NOT proceed and contact the project manager immediately.***

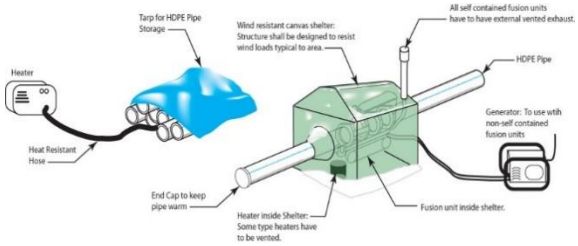
- Standard Working Temperature Range that IntegriFuse EF Fittings can be fused, are ambient temperatures of between **-10°C temperature (+14º F) and +45°C (+115 F).** ***Contact Integrity Fusion Products for applications that may fall outside of the standard range.***
- Care should be taken to provide a balanced ambient temperature level of both pipes and fittings before fusion operation
- IntegriFuse EF couplers ***16" and smaller*** can be fused with the **IntegriFuse I60**, and the **IntegriFuse I105** and with other standard universal electrofusion fusion machines.
- IntegriFuse EF couplers ***18" thru 24"*** can be fused with the **IntegriFuse I105** and with standard universal electrofusion fusion machines.
- IntegriFuse EF Couplers ***Larger than 26"*** ***recommends the exclusive use of the IntegriFuse IFuse 105 EF Processor***. IntegriFuse EF Couplers **26" and larger** are designed to require higher fusion amperages at the beginning of the fusion cycle than what some standard electrofusion processors may be designed to deliver.
- IntegriFuse recommends the use of generators with an output no less than 5,000 continuous watts with a 110-volt, 30-amp 3 prong twist lock outlet **when using the I Fuse 60 processor**, and a generator with 6,500 continuous watts with a 240-volt, 30 amp, and 4 prong twist-lock outlet **when using the I Fuse 105.** ***Dual purpose generators (welding generators) are not to be used!***
- IntegriFuse EF fittings must be fused in dry conditions. Do not perform any fusion if the pipe or couplers are wet or contain moisture.
- If fusing an Electrofusion coupler to **SDR 32.5** pipe, the technician should call Integrity Fusion Products for special Installation Instructions.

Fitting Storage/Handling

- Electrofusion fittings **should remain in their original packaging** 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!

Weather Guidelines

Temperature extremes, whether cold or hot, will cause polyethylene pipe and electrofusion fittings to expand or contract accordingly, and can influence the successful assembly and fusion of that joint. Care must be taken to acclimate both pipe and fittings to the same ambient temperatures.



In field environments experiencing colder temperatures ***(around 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 snow or frost. Make sure there is no water inside the line from condensation.

In field environments experiencing elevated temperature conditions **(up to 115˚F)**, temperature conditions can be improved by using a shade tent to cover the operator and the equipment when applicable.

In weather conditions where rain, sleet, or snow may be experienced, it is recommended that the fusion area be tented to stop any precipitation from reaching the fusion area if there is any present.

Remember: ***Electrofusion couplers are manufactured with very tight ID tolerances to accommodate HDPE pipes ASTM 714 dimensional requirements. Make sure that both pipe ends, as well as the electrofusion coupler are allowed to acclimate to the same ambient temperature when fusing in hot or cold conditions. The expansion and/or contraction of the pipe ends due to external temperature can have an impact on your ability to push a coupler on.***

Special Job-Site Installation Considerations

If installing an electrofusion joint assembly in **non-horizontal applications**, the installer must take precautionary steps to ensure that the pipe ends are cut straight, the pipe is inserted into the fitting correctly, that the electrofusion joint is immobile, adequately supported, straight, in a stress free, and in a non-binding position, and that the air-flow through the pipe is restricted by capping one or both ends off .

Re-Fusion of IntegriFuse Electrofusion Fittings

If an electrofusion fittings fusion cycle is interrupted for reasons other than an incorrect assembly of the fusion joint or a fitting failure (e.g., generator running out of fuel, loss of power to the processor, processor tips accidently getting disconnected); it may be necessary to re-fuse the fitting.

- IntegriFuse electrofusion fittings can be re-fused **up to 3 times.** If another fusion is needed, contact Integrity Fusion for approval.
- IntegriFuse fittings must be allowed to cool **until the fitting reaches ambient temperature** before re-fusing! If you attempt to re-fuse the fitting before it reaches ambient temperature, there is a high probability that the processor will give you an “out of resistance range” error code.
- ***Warning:*** *If you attempt to re-fuse the fitting while it is still hot or before it cools down to ambient temperature is reached, it could result in excessive heat being created in the fitting and could result in a fire.*

Pressure Testing Electrofusion Joints

Information on post installation testing of polyethylene pipe and fittings can be found in chapter 2 of the Plastic Pipe Institutes “Handbook of Polyethylene Pipe”. All pressure testing should be conducted in accordance with the recommendations of the pipe manufacturer or as described in.

ASTM F2164 STANDARD PRACTICE FOR LEAK TESTING OF POLYETHYLENE (PE) PRESSURE PIPING SYSTEMS USING HYDROSTATIC PRESSURE. or

ASTM F2786-16(2021) Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Gaseous Testing Media Under Pressure (Pneumatic Leak Testing)

- **Wait 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 is shown in PPI TR31.**
- **Pneumatic pressure testing, due to safety reasons, is not recommended.**

Jobsite Safety Procedures

In addition to following your companies established jobsite safety procedures, we recommend adding these additional steps when performing electrofusion installations.

- Make sure the work area is free of obstructions and potential hazards.
- Inspect the work site making sure the area is relatively dry., with no water flowing through the pipe or coming into direct contact with the electrofusion fittings fusion zone.

- 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.
- If installing couplers in vertical applications, it is highly recommended that you restrict potential increases in air flow by capping one end of the pipe or covering the chimney end.
- 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.

Introduction

There are no shortcuts to these instructions! Proper electrofusion fitting installation techniques, the installers understanding of these techniques, qualified training in the use of these techniques, combined with the intentional and effective examination of work site, material and equipment before installation are all essential keys to making a successful electrofusion joint. Suitable equipment should be available when transporting, handling, and installing larger diameter pipes in trench. **The entire operation (preparation, installation, fusion etc.) must be carried out by a trained & qualified installer.**

Before proceeding to the jobsite or beginning the assembly of any electrofusion joint; take the time to make sure that you have the proper tools on hand that are necessary for assembling and completing a successful electrofusion joint. Knowing what the proper tools are and knowing why and how to use them is important. The following types of tools and devices should be readily on hand during the installation process.

Types of Required Tools and Devices for Electrofusion Assembling

Pipe Measuring Tools – The most common measuring tool used for determining if pipe is within the required circumferential spec, is a **Pipe OD Tape.** The most common measuring tool used to measure for fitting placement, fitting stab depths, and pipe ovality (out-of-round condition), is a **steel measuring tape**.

Pipe Marking Tools - Marks are to be made on the outer surface of the pipe as a visual aid ***(witness marks)*** to help indicate fitting placement, fitting stab depths, and the required area of the pipe surface to be scrape. The marking devices used to make these witness marks on the pipe surface should be highly visible when applied and should dry fast and contain no oils or any other ingredients that may leave contaminates on the pipe surface after being prepared.

Pipe Cutting Tools – Cutting tools are used to make straight cuts (+/-3º) on the pipe ends. For smaller pipes, blade type pipe cutters, hand saws, and reciprocating cutting saws work fine. For larger pipe diameters, the most common cutting tool used in the field are chain saws. This is completely acceptable, but keep in mind that when using a chainsaw to cut HDPE pipe, no lubricant of any kind can be used in the chainsaw. Bar oil and other lubricants will contaminate the surface area of the pipe and create a non-fusible barrier between the pipe surface and the coupler interface.

Pipe Cleaning Material – Initial cleaning of pipe surfaces **before scraping** can be done with clean water to remove mud and dirt. **However,** after the pipe surface has been scraped, and virgin resin has been exposed, **only** a solution with a 90% or greater concentration of isopropyl alcohol, with no additional additive other than water, can be used as a cleaning agent. This is to be used with a clean, non-dyed, lint free cloth or wipe to clean the pipe.

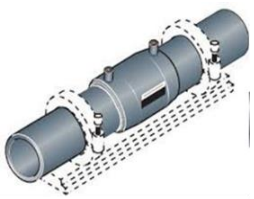
NOTE: Solutions such as De-natured alcohol, Rubbing Alcohol, Acetone, Methyl-Hydrate cannot be used under any circumstance!

Pipe Scraping Tools – The successful installation of all electrofusion fittings requires the removal of the oxidation layer from the pipe surface area. It is critical that a minimum of .007" ***(approx. the thickness of 2 sheets of paper)*** must be completely removed from the surface area being fused on to. The use of a mechanical scraper/peeler tool with a replaceable tungsten carbide steel blade is required.

NOTE: ***Under no circumstances are abrasives such as sandpaper and emery cloth, files, rasps, grinding wheels and wire wheels to be used!***

Pipe Re-Rounding Tools – The larger the pipe diameter, the greater the chance of needing to force a pipe end or surface that is out-of-round back into a round state. Not to be confused with a pipe that falls outside of its required ASTM minimum allowable OD circumferential spec. The need to re-round a pipe in an electrofusion assembly will vary on the diameter of the pipe being fused. For pipe sizes 3" and larger, re-rounding clamps **may** be needed on either side of an electrofusion fitting to ensure that the gap between the pipe surface and the fitting is not too large. For side-wall fittings with a base of 8" and larger, it **may** be necessary to use a re-rounding device on both sides of the fitting. On Pipe diameters 12" thru 24" it is imperative that you begin checking the pipe for an out-of-round condition, but it may not always be necessary to use re-rounding tools on every installation. On Pipe Diameters 26" and larger, however, re-rounding clamps are required and must be used on every installation.

Pipe Restraint and Alignment Devices – Are used for limiting movement and maintaining proper alignment of the pipe and fitting during the fusion and cooling process.



Sometimes it takes a bit of creativity, but the goal is to keep the pipe and fitting assembly straight and in a non-binding and stress-free position.

NOTE: **On side wall installations, the use of restraint devices is a critical component required for creating and maintaining the necessary interfacial pressures required for fusion and must remain in place until the cooling cycle completes.**

Pipe Beveling Tools – Are used to put a bevel on pipe ends to facilitate ease of installing the electrofusion coupler on the pipe ends, and to prevent any potential damage to the fusion coil wires if pipe tolerances are a bit tight.

De-burring and beveling small diameter pipe are straight forward and simple to do simply using hand tools such as a hand scraper, will provide a sufficient bevel. On larger diameter pipes, we recommend using a router with a 22.5-degree angle bit or a power planer to bevel the pipe ends.

Adequate Power Supply – We recommend the use of well-maintained and regularly calibrated generators with an output no less than 5,000 continuous watts with a 110-volt, 30-amp L5 3 prong twist lock outlet when using the **I Fuse I60 Processor**, and at least 6,500 continuous watts with a 240-volt, 30-amp, L14 4 prong twist-lock outlet when using the **I Fuse I105 Processor**. DC to AC Inverters can be used if they produce a sufficient AC output.

Dual purpose generators (welding generators) are not acceptable!
Do not use plug adapters or pigtail adapters. Do not hard-wire processors into the generator!

Extension Cords – Extension cords are acceptable for use when the generator is located too far from where the electrofusion processor is to be placed. However, if an extension cord is to be used, the extension cord **must be** of sufficient wire length and wire gauge to accommodate the increases in anticipated amperage draw.

Cord Length	Require Wire Gage
25 ft.	#10/3
50 ft.	#8/3
100 ft.	#6/3

Electrofusion Processor – The electrofusion processor is responsible for providing the correct amount of energy to the fitting by supplying a consistent and carefully regulated current to the fitting for the entirety of the fusion cycle. It also monitors the stability of that power supply being used, looking for fluctuations and variations that may indicate power supply problems or certain assembly or fitting errors.

The **IntegriFuse IFuse 60 Processor** is a 110-volt, 30-amp 3 prong twist lock outlet and can be used to install electrofusion couplings with diameters up 16". The **IntegriFuse IFuse 105 EF processor** can also be used to fuse small diameter fittings, but it is a 240-volt, 30-amp, with a 4-prong twist-lock outlet so a larger generator will be required. ***Under NO circumstances is it OK to use plug adapters or to modify the processor in any way.***

The **IntegriFuse I-Fuse 105 Processor** has been designed to use 240 volts for very specific reasons. Any modifications made to the processor so that it can adapt to other outlets than the one the L14 twist lock is designed for is not only dangerous, but it can also seriously reduce the amount of needed amperage to the fitting and could cause a failure.

Joint Inspection Tools – An important part of the electrofusion installation process requires inspection of the interfacial gap area **before and after** fusing the fitting. The tools required for this inspection are:

- **A flashlight** to use for checking for gaps and determining proper melt
- **Electrical Ties or Hose Clamp** – for checking for gap sizes prior to fusion and adequate fusion melt after the fusion and cooling process is complete.

L-1 Small Diameter Electrofusion Coupler Installation

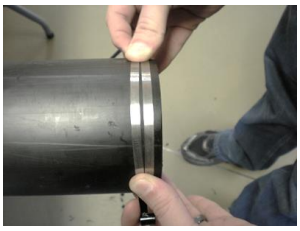
(1) Before Starting

- Inspect the work site making sure the area is dry and free of obstructions and potential hazards.
- In the event of bad weather, follow established inclement weather procedures before proceeding. Conditions can be improved with tents and/or blanketing equipment. Pipe surfaces must be dry during fitting assembly and fusion and should be protected from moisture due to heavy rain or snow. **IntegriFuse electrofusion fittings can be installed at ambient temperatures ranging from 14° F (-10° C) to 114° F (44.5° C) without change to the fusion procedure**.
- If the fitting assembly is to be installed in an excavated pit, the technician must ensure that the area is adequately exposed and free of mud and contaminates.
- Initial cleaning of the pipe surfaces can be done with clean water using a pressure washer or a brush prior to pipe preparation.
- **DO NOT** proceed with the fusion process if there is any water coming into direct contact with the fusion area. All heat fusion joining methods require that there be no water, flowing or standing in or below the pipe that can reach the fusion surfaces. Dewatering of the site may be required. A small amount of standing water may be unavoidable and is acceptable, however at no time is it acceptable for it to reach the prepared fusion surfaces or pipe and fitting assembly during the fusion process.
- Flowing water from inside of the pipe being fused must be stopped. Water coming into contact with the fusion surfaces during assembly and fusion must be avoided.

If 100% shutoff of the water flow cannot be achieved, bread or dry ice can be used to create a temporary dam so that the electrofusion installation can take place. Care must be taken however, to make sure that the flow is sufficiently stopped for the entire time that fusion is taking place otherwise water may be able to get between the pipe surface and the fitting interface. This will compromise the fusion zone. If dry ice is used, then care must be taken to ensure that it is placed as far away from the fusion area upstream as possible. The reason for this is because dry ice can cause condensation to develop in the fusion zone as it evaporates. This too can compromise the fusion zone.

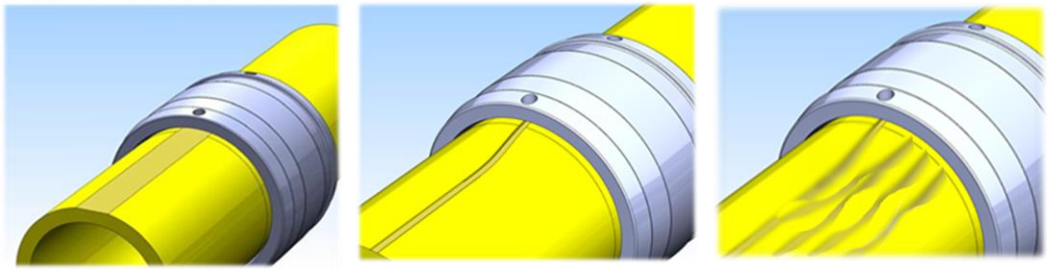
(2) Confirm Fitting Size & Verify Pipe Ends Are in Spec

- Before proceeding, confirm that the pipe diameter and the fitting are the correct size.
- As pipe diameters get larger, use a pipe OD tape and Pipe OD Chart **(page. 30)** and verify that both sides of the pipe are within the required ASTM 714 minimum allowable pipe OD spec. **If the pipe OD is not within spec DO NOT proceed and contact the project or site manager immediately**.



(3) Check Pipe Surface for Excessive Gouges and Flat Spots

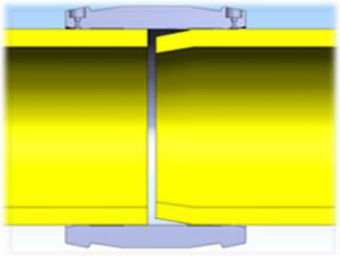
- Check the surface condition of the pipe in the immediate proximity of the area to be fused. Check to see if the pipe surface has evidence of flat spots, excessive gouges or scratches, gouges, or any unusual surface texture issues that either exceed the 10% of the minimum wall thickness required for the operating pressure, or that may impede the fusion process in any way. If the flat spots, scratches, gouges or texture issues exceed the 10% minimum, inform the project manager and contact Integrity Fusion Products before proceeding.



Damaged ends, flat spots, deep gouges, excessive scratches, and unusual surface anomalies in the area to be fused, should be cut back to where the pipe surface is in an acceptable condition and the pipe OD falls within the required tolerances. It may require removing an entire section of the pipe to correct these issues.

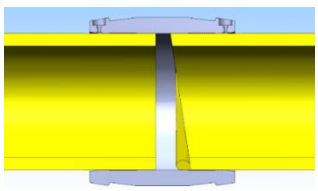
(4) Check Pipe Ends for Excessive Toe-In

- The longer an HDPE pipe remains stored outside or remains unused, the pipe ends naturally "contract" inward and develop a condition commonly known as toe-in. Too much toe-in can be the source of significant issues when fusing an electrofusion coupling. When it does, the result can be an excessive gap found between the outer pipe surface and the fittings inner diameter which can result in a compromised fusion or no fusion at all. Using a carpenter's square (or similar). the installer must examine both ends of the pipe being fused to determine if an excessive toe-in condition exists. Toe-in should not exceed more than 2" from the pipe end. If it is found to exceed more than 2" from the end of the pipe, the pipe end must be cut back to a point beyond where the toe-in ends before proceeding.



(5) Cut the Pipe Ends

- Pipe ends must be cut square and at right angles to the pipe axis and as close to a 90º angle as possible. Electrofusion fittings are designed to have cold zone lengths long enough to accommodate small irregularities on the pipe end cut, but that only amounts to approx. a +/- 3º deviation.



Maximum Cut Deviation	
Pipe Dia.	Max Gap
1"	1/8"
2"	3/16"
3"	5/16"
4"	5/16"
6"	1/2"
8"	3/4"
10"	7/8"
12"	1"

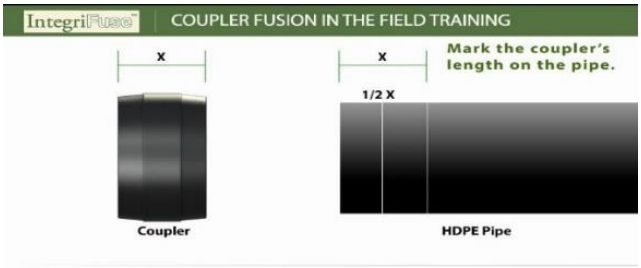
Anything beyond this acceptable deviation is considered a mis-cut assembly. The angle of the cut in a mis-cut assembly can lead to the pipe ends falling outside of the effective area of the center cold zone in the coupler which will result in; **a)** an excessive loss of interfacial pressure and melt in the center of the coupler, **b)** over-heating of the material in the fusion zone, **c)** uncontrolled melting of material in the fusion zone, and d) the possibility of sudden ignition of molten material in the fusion zone.

- On larger pipe diameters that must be cut by hand, it may be necessary to use a strap, a clamp, or some other form of device to provide the installer with the means for to mark a visual indicator on the pipe surface that will help them guide and control their cut.

- Pipe ends can be cut using a variety of different tools. Unfortunately, as the pipe diameters increase in size, the availability of effective cutting tools diminishes. On large diameter pipes, it is not uncommon to find chainsaws being used to cut pipe ends. This is completely acceptable, but keep in mind that when using a chainsaw to cut HDPE pipe, **no lubricant of any kind can be used in the chainsaw.** Bar oil and other lubricants will contaminate the surface area of the pipe and create a non-fusible barrier between the pipe surface and the coupler interface.

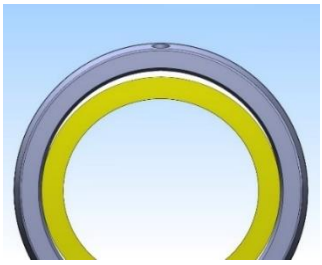
(6) Mark Your Stab Depth and Coupling Length

- Before scraping the pipe, make two marks on the surface of the pipe. One mark to indicate the total length of the electrofusion coupler, and the second mark to indicate ½ of the electrofusion couplers total length.



Both marks are considered “stab depth” marks and will serve as a visual indicator telling you where the couplers stab depth is and it will help you ensure that the pipe end will be located exactly in the center of the couplers cold zone. If the coupler is being used in a tie-in or repair situation and will require the coupler being pushed all of the way onto the pipe, it is important that the mark that represents the full length of the coupler on the pipe surface be visible as well.

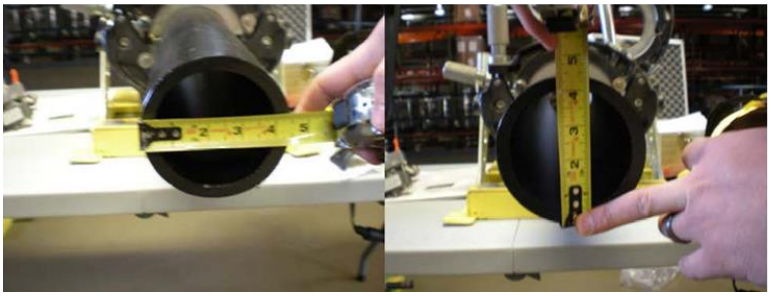
(7) Check The Pipe Ends for Excessive Out-of-Round Condition



As pipe diameters increase in size, out-of-round conditions become more of an issue. **For the electrofusion process to work, it is crucial for the pipe to be as round as possible.** The electrofusion process relies on closing the gap between the pipe surface and the fitting and for an even amount of interfacial pressure to build up. An excessive gap in the fusion area that is larger than the melt expansion can close will result in lower fusion pressures in the fusion zone and potentially result in melt expulsion at the end of the coupler.

Unlike pipes that are inadvertently manufactured with their outside diameters out of circumferential spec, or pipe surfaces that have defects like flat spots that reduce the wall thickness in those areas of the pipe, ***(issues that can be identified by the installer but cannot be corrected by the installer)***; pipe ends that are out-of-round on the other hand are a very common problem found on larger diameters of pipe, and with the right kind of tools, and the installer can quickly and easily correct this issue with the right tools.

- To check for an out-of-round condition, the pipe ends must be measured horizontally and vertically with a tape measure in order to determine the high and low points of the pipe.



Maximum Out-of-Roundness	
Pipe Dia.	Max Difference
3”	1/8"
4”	1/8"
6”	3/16"
8”	3/16"
10”	1/4"
12”	1/4"

- If the difference is greater than stated on the supplied chart then a full encirclement re-rounding clamp should be placed immediately to the outside of the mark indicating the couplers stab depth, or the mark identifying the full length of the coupler. Pressure should be applied to the re-rounding clamp in this area until the pipe end is brought back into tolerance. This will make it easier to put the coupler onto the pipe, but it will also ensure the gap between the pipe and the fitting will not be too large to fill during the fusion process.

(8) Mark the Area Where the Fitting Will be Fused

- Mark and area 2 times the length of the coupler on both sides of the pipe. This will be your designated installation work area.

- Using your approved marking tool, clearly highlight the fusion area on the pipe surface to scrape. These “witness marks” will not only provide you with a visual indicator of what areas of the pipe need to be scraped, they will also help you monitor the effectiveness of your scrapping tool as you remove material from the pipe surface. Gouges on the pipe surface that are deeper than the scraper/peeler is removing and yet still do not exceed the 10% wall thickness minimum may require extra attention. These marks will help you identify those areas quickly.

NOTE: Stab depth *marks will need to be reapplied after scraping to visually indicate to the installer that the pipe ends have been inserted to the center of the coupler and to help monitor any unusual movement during fusion.*

(9) Scrape The Pipe

The removal of the oxidation layer and surface contaminates from the fusion zone on the pipe is by far the most important and most critical aspect of the electrofusion process. The failure to adequately remove this material on the pipe surface and expose virgin material in the fusion zone is overwhelmingly the #1 cause of unsuccessful electrofusion joints. Any person that does not completely understand the goal of proper pipe scraping and surface preparation should not be involved in this critical part of the installation process.

The oxidation layer on the pipe surface is very thin, no more than a few thousands of an inch in total depth. It is a normal by-product resulting from the pipe extrusion process, transportation, everyday handling, and outdoor U V exposure**.**

Proper pipe preparation requires the complete removal of a minimum of .007” of an inch of material from the surface of the pipe in the area that is to be fused. That is roughly the thickness of 2 sheets of paper. This outer layer or “skin” must be removed by scraping or peeling it away from the surface of the pipe to expose non-contaminated, virgin resin. This is accomplished by using tools that have been tested and are acceptable for use.

OXIDATION IS A PHYSICAL BARRIER!! Oxidation cannot be wiped away with any cleaner. Oxidation cannot be removed by simply roughing or scratching the pipe surface area. Pipe surface areas that have oxidation on them CAN NOT BE HEAT FUSED!!

Mechanical "Peeling" tools are commercially available tools specifically designed for electrofusion pipe preparation and are recommended for use whenever possible.

The "peeling" type of tool is preferred and recommended because they provide a consistent level of pipe surface preparation that allows the installer to visually verify adequate surface material removal. By monitoring the thickness of the ribbon being removed from the surface of the entire circumference of the pipe and by looking for skipped or missed paths between revolutions; the installer can quickly identify low spots and missed areas on the pipe surface that may require more careful attention. The installer should be familiar with these tools and should qualify fusions using them.



NOTE: ***Hand scrapers*** ***(paint scrapers, scrapers with serrated blades, etc.) have been successfully used for many years, and they can still be used effectively in some cases. Particularly when working in situations where space is limited and where pipe scratches or gouges in the pipe require the use of a hand tool.***

However, as a best practice, ***the use of hand scrapers is not recommended due to the significant operator experience needed to know when adequate pipe surface material has been removed. Installers using hand scrapers are required to spend more time, exert more effort and be more diligent in their work habits in order to ensure that the entire fusion area is being completely scraped.***



- IMPORTANT REMINDER -

Under no circumstances *should you use abrasives such as sandpaper or emery cloth. Abrasives not only fail to remove material from the pipe surface, but they in fact also embed abrasive granules into the surface of the pipe creating even more of a contamination barrier.*

Under no circumstances *should other devices such as grinding wheels or wire wheels be used to prepare pipe surfaces. Grinding wheels and wire wheels do not remove surface material. At best they only move it around and when combined with the heat they generate while in use they push contaminates deeper into the pipe surface*

Always inspect your scraping tools before leaving for the jobsite. It is the Installers responsibility to ensure that they are in good working order and free of grease or other contaminates. That all bushings, bearings, rollers and guides are tight and working properly. That peeler blades are not knicked, damaged or dull.

- Using a sharp instrument such as a box cutter, make several shallow scribes on the pipe surface that is to have surface material removed. This is done so that the ribbons produced by the scrapers will fall off in smaller pieces and not inadvertently re-contaminate the freshly exposed virgin resin.

- Using an appropriate "peeler" type of scraper, position it on the pipe using the "witness marks" as your guide to adjust the cutting head accordingly. Remove the surface material from the pipe, carefully inspecting the entire circumference of the of the area as it is being scraped, visually checking for high and low spots that may need special attention and to make sure that that your scraper is providing you with adequate scraping coverage.

Take care not to inadvertently re-contaminate the freshly scraped area by touching it, handling it, placing tools or other items on it, getting it wet, etc.

- Make sure to re-apply small witness marks on the pipe surface indicating both the couplers stab depth and the full coupler lengths. These marks do not have to go completely around the circumference of the pipe, but they do need to be visible enough to be used as a visual guide for inserting the coupling into the proper position on the pipe.
  .
- Fitting Assembly should take place as soon as possible after scraping.

(10) Re-Check for Out-of-Round Conditions

- Check the pipe ends for any adjustments that may need to be made for an out-of-round condition before attempting to insert the coupler onto the pipe end. *(See step 7)* This will help in reducing the required amount of effort in sliding the coupler onto the pipe ends during the insertion process. This will also help reduce any excessive gaps between the pipe surface and the coupler interface.

REMEMBR: ***A gap that is too large will result in insufficient melt generation in those areas of the fusion zone and could potentially fail to sufficiently close the pipe and coupler interface.***

(11) De-burr and Bevel Pipe Ends

As stated earlier, a bevel on pipe ends is to facilitate ease of installing the electrofusion coupler on the pipe ends, and to prevent any potential damage to the fusion coil wires if pipe tolerances are a bit tight.

De-burring and beveling small diameter pipe are straight forward and simple to do simply using hand tools such as a hand scraper, will provide a sufficient bevel.

(12) Final Cleaning of the Fusion Zone and Fitting

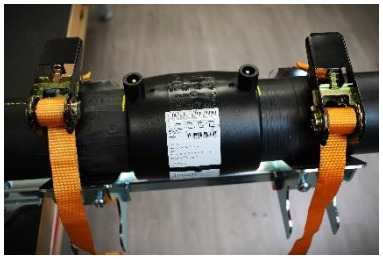
- Clean the freshly scraped fusion zone on the pipe using a 90% or greater solution of Isopropyl Alcohol with no additives and a clean, non-dyed, lint free cloth or wipe. This will remove any residual surface contaminates, such as dirt and moisture, from the fusion zone that may have inadvertently come in contact with the pipe. Take care not to re-contaminate your cleaned area by touching them.

- Remove the electrofusion fitting from its protective packaging and wipe down the fusion zone on the inside of the fitting using the same 90% or greater solution of Isopropyl Alcohol with no additives and a clean, non-dyed, lint free cloth or wipe. Make sure that the cleaning solution has completely evaporated before installing the fitting and using your approved marker, re-mark the stab depth.

- If the prepared area is not to be assembled immediately, a plastic bag, clean plastic sheeting or shrink wrap, can be used to cover the scraped area on the pipe and the fitting can be placed back into its original plastic packaging until the assembly is to be made. All that will need to be done then will be to wipe both surfaces down again with a 90% or greater solution of Isopropyl Alcohol with no additives and a clean, non-dyed, lint free cloth or wipe.

(13) Begin Joint Assembly

- Make sure that your pipe ends are properly aligned and supported.



- Push the IntegriFuse Coupler onto the pipe end until the edge of the coupler that is on the pipe is aligned with the stab depth witness mark. ***If you are doing a repair type of fusion, you will push the coupler on until you are aligned with the full coupler length witness mark and then pull the couple back until the stab mark is visible.*** The weight of the fitting or the tight tolerance of the pipe OD may make it necessary to use a rubber mallet, a dead blow hammer, or a sledgehammer with wooden blocks, to carefully nudge the fitting onto the pipe. Take care not to strike directly in the electrofusion terminal pins.

- Secure the joint assembly with an appropriate restraint device making sure the assembly is straight, level, and in a non-binding position.

(14) Check for Excessive Gaps

- Using a flashlight and a small electrical tie or something similar; check the gap around the entire circumference of the pipe and fitting. The gap should be evenly spaced and no larger than the tolerance provided in the chart on **page 22**. The electrical tie will help you determine where the gap is unevenly spaced. Using the re-rounding clamp, adjust the hydraulic pressure to make the necessary adjustments.

Beginning the Fusion Sequence

- **Verify that the electrofusion processor switch is in the off position.**
- **Make sure that your generator is fueled, operating normally, and running at full throttle.**
- **Make sure that your processor is plugged into the correct outlet and that all breakers or relays are in the correct voltage output position.**
- **Turn on the processor and wait for software initialization to complete. When prompted, press START to begin.**
- **When prompted, connect the processor leads to the IntegriFuse coupler making sure that both connections are tight and secure. Loose lead tips or failure to make a secure connection can result in unwanted arcing at the loose connection and result in an interrupted fusion cycle and potentially blown fuses, or a damaged processor.**

- **At the prompt, scan the bar-code.**

- **Depending on the level of traceability chosen, follow the prompts and answer the questions on the processor screen and press OK to proceed to the next screen.**
- **On the final screen you will be prompted to choose between beginning the fusion or to abort the process.**
- **Press Start to Begin.**

- **When the fusion cycle is completed, the processor will beep indicating it is done and it is time to remove the leads from the coupler.**

- **Repeat the electrofusion sequence for the next fitting.**
- **Let the coupler cool for the recommended cooling time indicated on the label and then use a flashlight and a 4" electrical tie to verify that the pipe and coupler interface gaps are closed and that adequate melt in the fusion zones has taken place.**
- **Once the recommended cooling time is complete, your IntegriFuse Electrofusion Coupler is ready for pressure testing.**
- **For traceability purposes, we highly recommend that the Installer use the approved marker to record on the pipe surface next to the fitting; the Installers initials, the time the fusion cycle completed, and the date of the install.**

L-1 Sall Diameter Electrofusion Branch Saddle Installation

NOTE: Electrofusion Branch Saddles are surface mounted fittings. The same considerations, information and required tooling regarding the installation of electrofusion couplings should be applied to the installation of electrofusion branch saddles as well.

(1) Before Starting

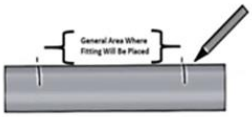
- Inspect the work site making sure the area is dry and free of obstructions and potential hazards.
- In the event of bad weather, follow established inclement weather procedures before proceeding. Conditions can be improved with tents and/or blanketing equipment. Pipe surfaces must be dry during fitting assembly and fusion and should be protected from moisture due to heavy rain or snow. **IntegriFuse electrofusion fittings can be installed at ambient temperatures ranging from 14° F (-10° C) to 114° F (44.5° C) without change to the fusion procedure**.
- If the Branch Saddle is to be installed in an excavated pit, on the underside of the pipe, the technician must ensure that the area is adequately exposed and free of mud and contaminates. If the Branch Saddle is to be installed in an overhead application, the installer must make sure there is adequate space for cleaning, securing, and restraining the fitting in place for the entirety of the fusion cycle.
- Initial cleaning of the pipe surfaces can be done with clean water using a pressure washer or a brush prior to pipe preparation.

(2) Confirm the Base Size & Pipe Diameter Are Compatible

- Before proceeding, confirm that the pipe diameter and the Branch Saddle base are the correct sizes.

(3) *Identify the General Location the Fitting is to be Installed*

- Take note of the location and orientation that the branch saddle will have on the pipe (top, side, or bottom) and mark an area 3 times the width of the Branch Saddle. This is your go – no go zone. Do not wipe outside of this initially cleaned area during the pipe preparation procedures.



(4) Check Pipe Surface for Excessive Gouges and Flat Spots

- Check the surface condition of the pipe in the immediate proximity of the area to be fused. Make sure there are no deep gouges, flat spots, or other significant surface imperfections in that area of the pipe that could have an impact on your fusion. If they exist – move the installation location to another location.
- Take note as well, to possible out-of-round conditions on the surface of the pipe due to long term storage or buried earth load conditions. Many electrofusion branch saddles have fixed bases, and even with proper clamping, the flexibility of the branch saddle base may not be sufficient to overcome this out-of-round condition and it can be very possible to have excessive gaps in the fusion zone due to a pipes out-of-round condition on its surface. Re-rounding Clamps may be required.

NOTE: On electrofusion Branch Saddles, the fusion zone is in the area where the embedded wires in the base of the electrofusion saddle meet the surface of the pipe. Avoid having flat spots, gouges, and excessive scrapes going through this area.

(5) Mark the Fitting Location

- Keep the Branch Saddle in its original packaging when marking where it will be placed. If it is not possible, take care to not contaminate the saddles base.

- Place and orient the Branch Baddle on the pipe surface where it is to be installed and clearly outline the Branch saddle base. Make the marked area slightly larger than the size of the fittings base.

- Remove the packaged fitting from the pipe surface and use your marker to highlight the area of the pipe surface needing to be scrapped. These marks will serve as a visual indicator of the effectiveness of your scraping.

(6) Scrape the Fusion Zone

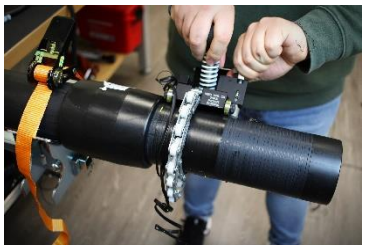
***NOTE*: We repeat our emphasis on pipe scraping because of its crucial importance.**

Proper pipe preparation requires the complete removal of a minimum of .007" of an inch of material from the surface of the pipe in the area that is to be fused. That is roughly the thickness of 2 sheets of paper. This outer layer or "skin" must be removed by scraping or peeling it away from the surface of the pipe to expose non-contaminated, virgin resin. This is accomplished by using tools that have been tested and are acceptable for use.

OXIDATION IS A PHYSICAL BARRIER!! Oxidation cannot be wiped away with any cleaner. Oxidation cannot be removed by simply roughing or scratching the pipe surface area. Pipe surface areas that have oxidation on them CAN NOT BE HEAT FUSED!!

Mechanical "Peeling" tools are commercially available tools specifically designed for electrofusion pipe preparation and are recommended for use whenever possible. The "peeling" type of tool is preferred and recommended because they provide a consistent level of pipe surface preparation that allows the installer to visually verify adequate surface material removal. By monitoring the thickness of the ribbon being removed from the surface of the entire circumference of the pipe and by looking for skipped or missed paths between revolutions; the installer can quickly identify low spots and missed areas on the pipe surface that may require more careful attention.

- Using an appropriate "peeler" type of scraper, position it on the pipe using the "witness marks" as your guide to adjust the cutting head accordingly. Remove the surface material from the pipe, carefully inspecting the entire circumference of the of the area as it is being scraped, visually checking for high and low spots that may need special attention and to make sure that that your scraper is providing you with adequate scraping coverage.



- Inspect the scraped surface to make sure that the oxidation layer has been removed and only virgin resin has been exposed. Visually confirm that all of your "witness marks" have been removed. Take care to not re-contaminate the scraped area.

NOTE: ***Hand scrapers (paint scrapers, scrapers with serrated blades, etc.) have been successfully used for many years, and they can still be used effectively in some cases. Particularly when working in situations where space is limited and where pipe scratches or gouges in the pipe require the use of a hand tool.***

However, as a best practice, ***the use of hand scrapers is not recommended due to the significant operator experience needed to know when adequate pipe surface material has been removed. Installers using hand scrapers are required to spend more time, exert more effort and be more diligent in their work habits in order to ensure that the entire fusion area is being completely scraped.***

CAUTION: In The Event A Hand Scraper Has To Be Used, make sure that you have a good scraper that uses replaceable blades. The blades need to be sharp and made of tungsten carbide. You must take your time, pay close attention to your scraping procedure, scrape material off while pulling in only one direction, and you must closley monitor your scraping pattern.

(7) Clean the Fusion Zone & Branch Saddle Base

- Clean the freshly scraped fusion zone on the pipe using a 90% or greater solution of Isopropyl Alcohol with no additives using a clean, non-dyed, lint free cloth or wipe. This will remove any residual surface contaminates, such as dirt and moisture, from the fusion zone that may have inadvertently come in contact with the pipe. Take care not to re-contaminate your cleaned area by touching them.

- Remove the electrofusion fitting from its protective packaging and wipe down the fusion zone on the inside of the fitting using the same 90% or greater solution of Isopropyl Alcohol with no additives and a clean, non-dyed, lint free cloth or wipe. Make sure that the cleaning solution has completely evaporated before installing the fitting. Re-mark the area where the Branch Saddle is to be placed.

(8) Begin Joint Assembly

- Place the cleaned Branch Saddle onto the scraped and cleaned pipe surface.

- Secure the Branch Saddle to the prepared pipe surface using the designated restraint device for your particular saddle fitting, making sure that the Branch Saddle is oriented where you need it to be. ***DO NOT tapp the pipe before installing the Branch Saddle!***

- With a small wire tie, check the secured fitting for excessive gaps around the saddle base.

Restraint devices are always required when fusing branch saddles and ***MUST be left in place*** until the fitting has completed its cooling cycle. Typical restaint devices used to hold Branch Saddles onto the surface of the pipe are going to be; reusable mechanical clamps, intergrated bolt-on clamps or ratchet straps. Each electrofusion manufacturers saddle fitting has pecific restraint requirements that have been designed and qualified for use - ***substitutions are not acceptable***.

Beginning the Fusion Sequence

- **Verify that the electrofusion processor switch is in the off position.**
- **Make sure that your generator is fueled, operating normally, and running at full throttle.**
- **Make sure that your processor is plugged into the correct outlet and that all breakers or relays are in the correct voltage output position.**
- **Turn on the processor and wait for software initialization to complete. When prompted, press START to begin.**
- **When prompted, connect the processor leads to the IntegriFuse Branch Saddle, making sure that both connections are tight and secure. Loose lead tips or failure to make a secure connection can result in unwanted arcing at the loose connection and result in an interrupted fusion cycle and potentially blown fuses, or a damaged processor.**

- **At the prompt, scan the bar-code.**

- **Depending on the level of traceability chosen, follow the prompts and answer the questions on the processor screen and press OK to proceed to the next screen.**
- **On the final screen you will be prompted to choose between beginning the fusion or to abort the process.**
- **Press Start to Begin.**

- **When the fusion cycle is completed, the processor will beep indicating it is done and it is time to remove the leads from the fitting.**

- **Repeat the electrofusion sequence for the next fitting.**
- **Let the Branch Saddle cool for the recommended cooling time indicated on the label and then use a flashlight and an electrical tie to verify that the pipe and coupler interface gaps are closed and that adequate melt in the fusion zones has taken place.**

- **Once the recommended cooling time is complete, your IntegriFuse Electrofusion Saddle is ready to have the restraining device removed and be pressure tested**.
- **For traceability purposes, we highly recommend that the Installer use the approved marker to record on the pipe surface next to the fitting; the Installers initials, the time the fusion cycle completed, and the date of the install.**

L-1 Small Diameter Electrofusion Flex Restraint Installation

NOTE: Electrofusion Flex Restraints are surface mounted fittings. The same considerations, information and required tooling regarding the installation of electrofusion couplings should be applied to the installation of electrofusion branch saddles as well.

What You Need to Know Before Starting

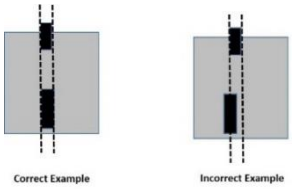
The design engineer for the Flex Restraint project is responsible for:

- ***calculating the amount of anticipated thrust force that will result from expansion & contraction***
- ***determining the correct number of Flex Restraints required for each application.***

For equal distribution of axial resistance forces to be achieved, the Flex Restraint installer is responsible for:

- ***Installing Flex Restraints (a minimum of 2,) that must be equidistantly spaced around the circumference of the pipe surface, and***

- ***Installing the Flex Restraints equally aligned in a straight line around the circumference of the pipe.***



The data provided in this table is for use only as a guideline for the designer. The maximum number of restraints per pipe OD only reflects the total number of Flex Restraints that can be installed in a straight line around the circumference of a specified pipe OD. The designer is responsible for determining all expansion/contraction forces in their specific application and for calculating the appropriate number of flex restraints to be used for restraining those forces. The designer should consider all other additional affecting factors.

Pipe OD	Max. # of Restraints**	Pipe OD	Max. # of Restraints**	Pipe OD	Max. # of Restraints**	Pipe OD	Max. # of Restraints**	Pipe OD	Max. # of Restraints**
6″	3	16″	8	26″	13	36″	18	46″	24
8″	4	18″	9	28″	14	38″	19	48″	25
10″	5	20″	10	30″	15	40″	20	--	--
12″	6	22″	11	32″	16	42″	21	--	--
14″	7	24″	12	34″	17	44″	23	--	--

(1) Before Starting

- Inspect the work site making sure the area is dry and free of obstructions and potential hazards.
- In the event of bad weather, follow established inclement weather procedures before proceeding. Conditions can be improved with tents and/or blanketing equipment. Pipe surfaces must be dry during fitting assembly and fusion and should be protected from moisture due to heavy rain or snow. **IntegriFuse electrofusion fittings can be installed at ambient temperatures ranging from 14° F (-10° C) to 114° F (44.5° C) without change to the fusion procedure**.
- Initial cleaning of the pipe surfaces can be done with clean water using a pressure washer or a brush prior to pipe preparation.

Important Note: ***Keep the Flex Restraints in their original packaging until ready to place and secure it.***

(2) *Identify the Location the Flex Restraints are to be Installed*

- Identify the desired location where the Flex Restraints are to be placed. If the Flex Restraints are to be installed in an excavated pit, the technician must ensure that the area is adequately exposed and free of mud and contaminates. If the Flex Restraints are to be installed in an overhead application, the installer must make sure there is adequate space for cleaning, securing, and restraining the fitting in place for the entirety of the fusion cycle.

(3) Check Pipe Surface for Excessive Gouges and Flat Spots

- Check the surface condition of the pipe in the immediate proximity of the area to be fused. Make sure there are no deep gouges, flat spots, or other significant surface imperfections in that area of the pipe that could have an impact on your fusion. If they exist – move the installation location to another location.

NOTE: On electrofusion Flex Restraints, the fusion zone is in the area where the embedded wires in the base of the electrofusion saddle meet the surface of the pipe. Avoid having flat spots, gouges, and excessive scrapes going through this area.

(4) Mark the Flex Restraint Locations

- Using your marker, draw a clear line on the pipe surface completely around the pipe's circumference. This line will be used as your reference point to align the Flex Restraint in a straight line.

- Keep the Flex Restraint in its original packaging when marking where each of the Flex Restraints will be placed equidistantly around the pipe. Clearly outline the Flex Restraint and make the marked area slightly larger than the size of the fitting.

- Use your marker to highlight the area of each area on the pipe surface that will need to be scrapped. These marks will serve as a visual indicator of the effectiveness of your scraping.

(5) Scrape the Fusion Zone

***NOTE*: We repeat our emphasis on pipe scraping because of its crucial importance.**

Proper pipe preparation requires the complete removal of a minimum of .007" of an inch of material from the surface of the pipe in the area that is to be fused. That is roughly the thickness of 2 sheets of paper. This outer layer or "skin" must be removed by scraping or peeling it away from the surface of the pipe to expose non-contaminated, virgin resin. This is accomplished by using tools that have been tested and are acceptable for use.

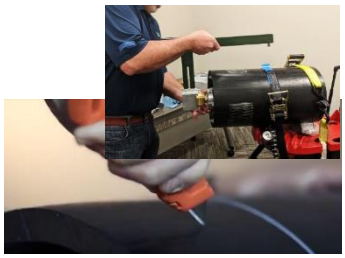
OXIDATION IS A PHYSICAL BARRIER!! Oxidation cannot be wiped away with any cleaner. Oxidation cannot be removed by simply roughing or scratching the pipe surface area. Pipe surface areas that have oxidation on them CAN NOT BE HEAT FUSED!!

Mechanical "Peeling" tools are commercially available tools specifically designed for electrofusion pipe preparation and are recommended for use whenever possible. The "peeling" type of tool is preferred and recommended because they provide a consistent level of pipe surface preparation that allows the installer to visually verify adequate surface material removal. By monitoring the thickness of the ribbon being removed from the surface of the entire circumference of the pipe and by looking for skipped or missed paths between revolutions; the installer can quickly identify low spots and missed areas on the pipe surface that may require more careful attention.

NOTE: ***Hand scrapers** (paint scrapers, scrapers with serrated blades, etc.) have been successfully used for many years, and they can still be used effectively in some cases. Particularly when working in situations where space is limited and where pipe scratches or gouges in the pipe require the use of a hand tool.*

***However, as a best practice**, the use of hand scrapers is not recommended due to the significant operator experience needed to know when adequate pipe surface material has been removed. Installers using hand scrapers are required to spend more time, exert more effort and be more diligent in their work habits in order to ensure that the entire fusion area is being completely scraped.*

- If using a rotary/peeler type of scraper, use a utility knife, or similar object, to make 2 or 3 scribes around the pipe in order to break up the peeled ribbon into smaller pieces as the scraper goes around the pipe in order to not unintentionally recontaminate the pipe surface.



- Using an appropriate "peeler" type of scraper, position it on the pipe using the "witness marks" as your guide to adjust the cutting head accordingly. Remove the surface material from the pipe, carefully inspecting the entire circumference of the of the area as it is being scraped, visually checking for high and low spots that may need special attention and to make sure that that your scraper is providing you with adequate scraping coverage.

- Inspect the scraped surface to make sure that the oxidation layer has been removed and only virgin resin has been exposed. Visually confirm that all of your "witness marks" have been removed. Take care to not re-contaminate the scraped area.

Due to the many unconventional applications and the many difficult locations Flex Restraints may be used in; Hand Scrapers may be the only viable scraping tool option available to the installer. In The Event A Hand Scraper Has To Be Used, make sure that you have a good scraper that uses replaceable blades. The blades need to be sharp and made of tungsten carbide. You must take your time, pay close attention to your scraping procedure, scrape material off while only pulling in unidirectional direction, (one direction. You must be diligent about monitoring your scraping pattern.



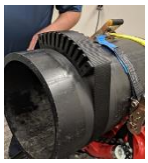
(Rasps, grinders & wire brushes/wheels are NOT allowed)

(6) Clean the Fusion Zone & Flex Restraint Base

- Clean the freshly scraped fusion zone on the pipe using a 90% or greater solution of Isopropyl Alcohol with no additives using a clean, non-dyed, lint free cloth or wipe. This will remove any residual surface contaminates, such as dirt and moisture, from the fusion zone that may have inadvertently come in contact with the pipe. Take care not to re-contaminate your cleaned area by touching them.

- Remove the Flex Restraint from its protective packaging and wipe down the fusion zone on the inside of the fitting using the same 90% or greater solution of Isopropyl Alcohol with no additives and a clean, non-dyed, lint free cloth or wipe. Make sure that the cleaning solution has completely evaporated before installing the fitting.

- Place the Flex Restraint immediately on the prepared surface where it is to be fused, minimize the movement of the flex restraint while unsecured on the pipe surface, with duct tape or gorilla tape, until all Flex Restraints are properly place and then secure them in place with a 2" ratchet strap.



Note: 2" Ratchet straps are the required application tool due to the ease of use and more reliable distribution of clamping pressures.

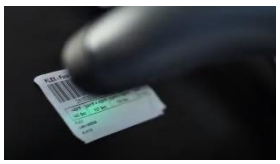
- While holding the Flex Restraint in place, tighten the 2" ratchet strap until the Flex Restraints are conformed to the pipe wall. It is critical to ensure that the base of the Flex Restraint contacts the pipe over the entire fusion area, and no gap can be seen between fitting and the pipe. If more than one Flex Restraint is to be fused, make sure that all fittings are in place before completely securing the ratchet straps, ensuring the ratchet buckle is equidistant between two of the Flex Restraints before tightening.

Beginning the Fusion Sequence

- **Verify that the electrofusion processor switch is in the off position.**
- **Make sure that your generator is fueled, operating normally, and running at full throttle.**
- **Make sure that your processor is plugged into the correct outlet and that all breakers or relays are in the correct voltage output position.**
- **Turn on the processor and wait for software initialization to complete. When prompted, press START to begin.**

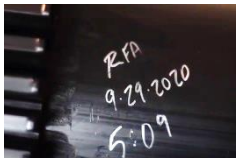
- **When prompted, connect the processor leads to the IntegriFuse Flex Restraint, making sure that both connections are tight and secure. Loose lead tips or failure to make a secure connection can result in unwanted arcing at the loose connection and result in an interrupted fusion cycle and potentially blown fuses, or a damaged processor.**

- **At the prompt, scan the bar-code.**



- **Depending on the level of traceability chosen, follow the prompts and answer the questions on the processor screen and press OK to proceed to the next screen.**
- **On the final screen you will be prompted to choose between beginning the fusion or to abort the process.**
- **Press Start to Begin.**
- **When the fusion cycle is completed, beep indicating it is done and it is time to remove the leads from the fitting.**

- **Repeat the electrofusion sequence foreach of the remaining Flex Restraints to be installed.**
- **Let the Flex Restraints cool for the recommended cooling time indicated on the label and then use a flashlight and an electrical tie to verify that the pipe and coupler interface gaps are closed and that adequate melt in the fusion zones has taken place.**
- **Once the recommended cooling time is complete, your IntegriFuse Electrofusion Flex Restraint is ready to have the restraining device removed.**
- **For traceability purposes, we highly recommend that the Installer use the approved marker to record on the pipe surface next to the fitting; the Installers initials, the time the fusion cycle completed, and the date of the install.**



Minimum Allowable Pipe OD Tolerance Guide 2" IPS thru 12" DIPS				
Pipe Size	Using Pipe OD Tape		Using Standard Measuring Tape	
	Average Pipe OD	Minimum Pipe OD	Average Pipe OD	Minimum Pipe OD
2" IPS	2.375 "	2.369"	7 15/32"	7 7/16"
3" IPS	3.500 "	3.492"	11"	10 31/32"
3" DIPS	3.960"	3.944"	12 7/16"	12 3/8"
4" IPS	4.500 "	4.491"	14 1/8	14 3/32"
4" DIPS	4.800"	4.778"	15 3/32""	15"
6" IPS	6.625"	6.614"	20 7/8"	20 25/32"
6" DIPS	6.900"	6.869"	21 11/16"	21 19/32"
8" IPS	8.625"	8.612"	27 3/32"	27 1/16"
8" DIPS	9.050"	9.009"	28 7/16"	28 5/16"
10" IPS	10.75"	10.735"	33 25/32"	33 3/4"
10" DIPS	11.100"	11.050"	34 7/8"	34 11/16"
12" IPS	12.75"	12.733"	40 1/6"	40"
12" DIPS	13.200"	13.141"	41 15/32"	41 9/32"

Minimum Allowable Pipe OD Tolerance Guide 14" IPS thru 48" DIPS				
Pipe Size	Using Pipe OD Tape		Using Standard Measuring Tape	
	Average Pipe OD	Minimum Pipe OD	Average Pipe OD	Minimum Pipe OD
14" IPS	14.00"	13.940"	43 31/32"	43 3/4"
14" DIPS	15.300"	15.230"	48"	47 5/8"
16" IPS	16.00"	15.930"	50 1/4"	50"
16" DIPS	17.400"	17.320"	54 5/8"	54 3/8"
18" IPS	18.00"	17.940"	56 9/16"	56 3/8"
18" DIPS	19.500"	19.412"	61 1/4"	60 15/16"
20" IPS	20.00"	19.910"	62 13/16"	62 1/2"
20" DIPS	21.600"	21.500"	67 7/8"	67 1/2"
22" IPS	22.00"	21.900"	69 1/8"	68 3/16"
22" DIPS	Is Not Currently Manufactured			
24" IPS	24.00"	23.890"	75 13/32"	75 1/16"
24" DIPS	25.800"	25.680"	81 1/16"	80 21/32"
26" IPS	26.00"	25.880"	81 5/8"	81 9/32"
26" DIPS	Is Not Currently Manufactured			
28" IPS	28.00"	27.870"	87 29/32"	87 1/2"
28" DIPS	Is Not Currently Manufactured			
30" IPS	30.00"	29.860"	94 1/4"	93 25/32'
30" DIPS	32.000"	31.860"	100 15/32"	100 1/32"
32" IPS	32.00"	31.860"	100 15/32"	100 1/32"
32" DIPS	Is Not Currently Manufactured			
36" IPS	36.00"	35.840"	113 3/32"	112 19/32"
36" DIPS	38.300"	38.130"	120 5/16"	119 25/32"
42" IPS	42.00"	41.810"	131 15/16"	131 11/32"
42" DIPS	44.500"	44.300"	139 13/16"	139 3/32"
48" IPS	48.00"	47.780"	150 25/32"	150 3/32"
48" DIPS	50.800"	50.570"	159 19/32"	158 7/8"

EXAMPLE: IntegriFuse Electrofusion Installation Field Form

Date:		Time:	

Company:			
Contact Name:		Contact PH: #	
Project Name:			
Project Location:			

Installers Name:			
Installer Certified (Y/N):		Installers Certificate #:	
Certificate Issued By:		Certificate Current (Y/N)	

Weather Conditions:		Outside Temperature:	
Jobsite Conditions:		Water Present in Fusion Area:	

Pipe Manufacturer:		Print Line Data:	

Pipe Diameter (IPS/DIPS):		Min Allowable Pipe OD:		Pipe SDR:	
Actual Measured Pipe OD Side 1:		Actual Measured Pipe OD Side 2:			
Flat Spots, Gouges or Other Pipe Surface Anomalies Present on Pipe Surface or in Fusion Zone (Y/N):					
Excessive Toe-In Present on Pipe Ends (Y/N):					
Was Toe-In Cut Back or Removed (Y/N):					

Was a Re-Rounding Device Used: (Y/N)?		If No - Why?	
What Kind of Re-Rounding Device Was Used?			
What Kind of Device Was Used to Scrape the Fusion Zone?			
What Cleaning Solution Was Used			
What type of Device or Equipment Was Used to Align the Pipe/Relieve the Stress in the Fusion Zone/ or Restrain the Movement of the Fitting During the Fusion Process?			

Make & Model of Power Source Used:			
Was a Plug Adapter Used (Y/N)?		Was an Extension Cord Required (Y/N)?	
If Yes – Provide Cord Length and Wire Gauge:			

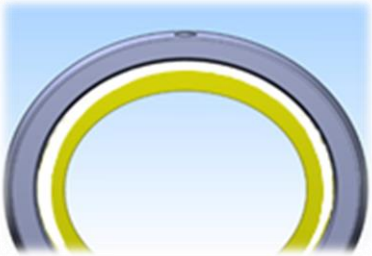
Was the Fitting Kept in Its Unopened, Original Packaging & Protected Until Joint Assembly (Y/N)			
Fitting Type & Size:		Processor Mfg.:	
IPS/DIPS:		Processor #:	
Fusion Time on Fitting:		Cooling Time on Fitting:	
Side 1 Complete Fusion Time (Y/N):		Side 2 Complete Fusion Time (Y/N):	
If No – List Indicated Error Code:		If No – List Indicated Error Code:	

NOTES:

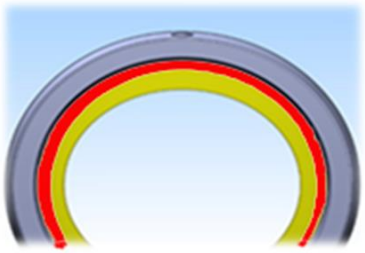
Electrofusion Failure Modes Installers Can Avoid

PRE-ASSEMBLY inspection of the pipe for identifiable manufacturing related anomalies and/or common storage and handling related issues; helps avoid non-installer related problems that can seriously impact the successful completion of an electrofusion joint!

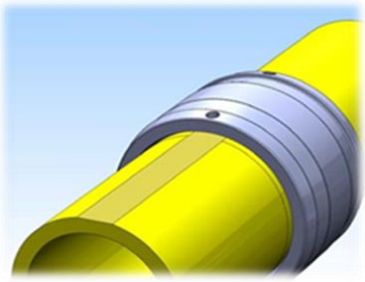
Out-of-Spec Pipe



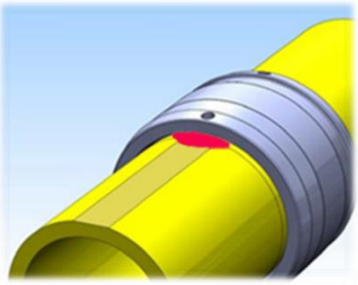
If the OD of the pipe fails to conform to the dimensional requirements of ASTM F714 in the area being fused; the melt flow generated in electrofusion fittings' fusion zone will be unable to effectively close the excessive gap in the annular space between the fitting and the undersized pipe surface. This will result in a loss of necessary fusion pressures building up inside the fitting and could result in a failed fusion joint.



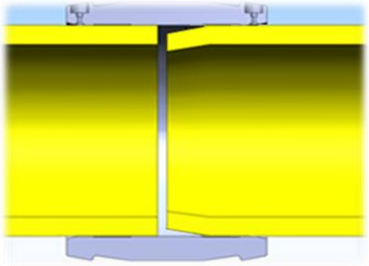
Flat Spots



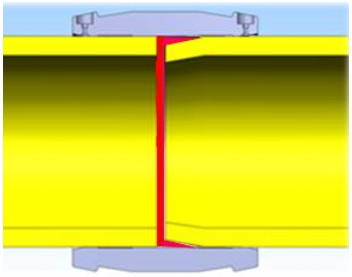
Flat spots and other surface anomalies are caused by issues related to manufacturing process. The pipe can also be damaged during transportation and portions of the pipe surface can be damaged, or the pipe can be mishandled in such a way which resulted in a damaged area on the pipe. If there are flat spots, anomalies, or damaged spots in the area to be fused that are >10% of the minimum pipe wall thickness, they must be cut back to where the pipe surface is in an acceptable condition and the pipe OD falls within tolerance.



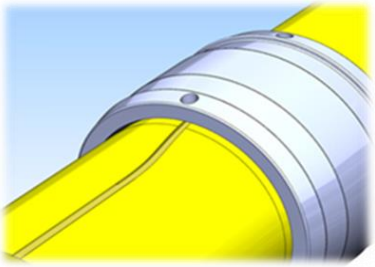
Excessive Toe-In



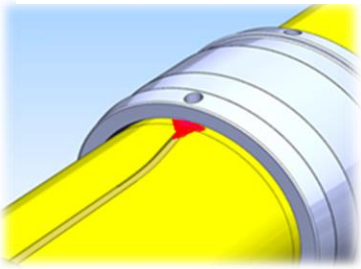
Too much toe-in can result in a significant gap on the end of the pipe that may be large enough to not be able to contain the melt pool at the most critical place in the center cold zone. It this gap is too wide; a sudden and excessive loss of interfacial pressure and melt can take place and compromise the fusion joint. If a toe-in condition exists, the pipe end must be cut back to a point where the toe-in condition is removed.



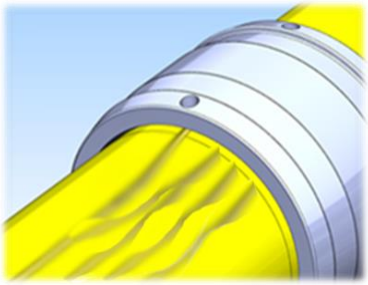
Gouges



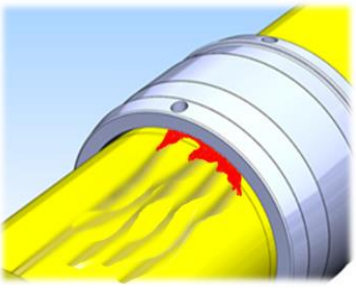
Gouges are the result of transportation, handling, and construction site issues. If the gouges exceed the 10% minimum pipe wall thickness in the area to be fused, that section of pipe must be cut back to where the pipe surface is in an acceptable condition and the pipe OD falls within tolerance. Gouges that are greater than the scrape depth but do not exceed 10% of the pipe wall thickness, may require extra attention when scraping the pipe.



Scratches

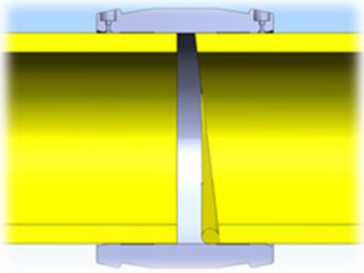


Scratches are the result of transportation, handling, and construction site issues. If the scratches exceed the 10% minimum pipe wall thickness in the area to be fused, that section of pipe must be cut back to where the pipe surface is in an acceptable condition and the pipe OD falls within tolerance.



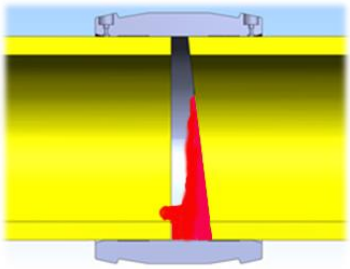
Electrofusion Failure Modes Installers Can Avoid

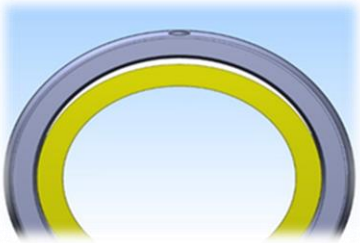
PAYING ATTENTION TO THE DETAILS during pipe preparation and joint assembly; helps avoid installer related problems that can seriously impact the successful completion of an electrofusion joint!



Pipe Ends Mis-Cut

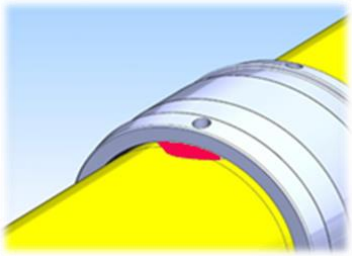
Pipe ends must be cut straight and square. Anything exceeding the acceptable +/- 3-degree deviation is considered a mis-cut assembly and may not be able to ensure full coverage of the heating coils and can result in an excessive gap that falls outside of the effective area of the center cold zone to contain the melt flow.

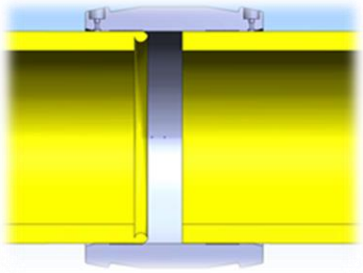




Failure to Re-Round

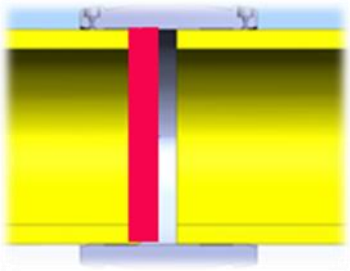
As the polyethylene is melted. it expands and closes the gap between the pipe surface and the fitting. If there is an excessive gap that is more than the expansion of the material can close, this will result in a lower fusion pressure being generated in the fusion zone and possibly result in a compromised joint. Another result could be the expulsion of molten material at the outside ends of the coupling.

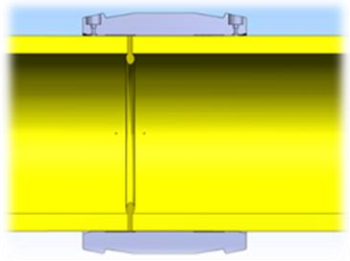




Pipe End Short-Stabbed

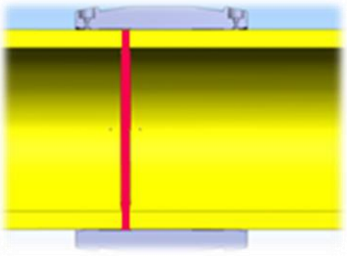
If the pipe ends are not properly inserted all of the way, this is considered a Short Stab and as the melt pool expands during the fusion process, material will flow over the exposed pipe inside the fusion zone in the area of the short stab. The result will be uncontained movement of the melt flow that will cause shorting in the fusion coil and rapid over heating in the fusion zones.

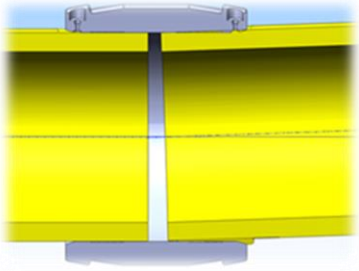




Pipe End Mis-Stabbed

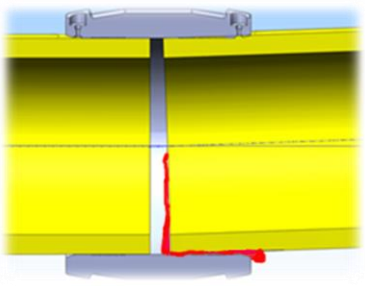
If pipe ends are over inserted on one side and under inserted on the other, this is considered a Mis-Stab. As the melt pool expands during the fusion process, material will escape between incorrectly aligned pipe ends in the mis-stab condition. The result will be uncontained movement of the melt flow that will cause shorting in the fusion coil and rapid over heating in the fusion zones.





Pipe End Mis-Aligned or Binding

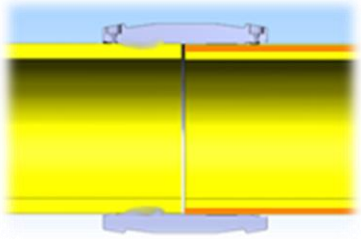
Unrestrained and/or unsupported pipe and fitting assemblies create stresses from the weight of the pipe, the fittings and other heavy system components. Aligning and supporting the fitting assembly, ensures that the area being fused remains straight, stable, immobile, and free of external stresses until the cooling time has been completed.



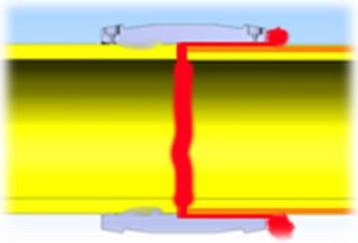
Electrofusion Failure Modes Installers Can Avoid

PAYING ATTENTION TO THE SPECIFIC REQUIREMENTS of pipe preparation and joint assembly; helps avoid installer related problems that can seriously impact the successful completion of an electrofusion joint!

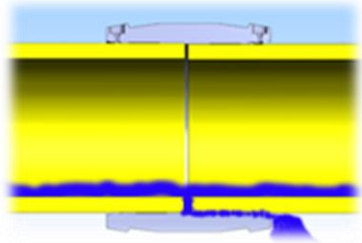
Unscraped or Improperly Scraped Pipe Surface



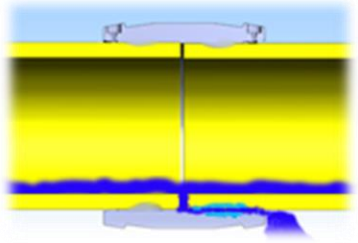
If the surface of the pipe has not been scraped, or it has been improperly scraped, and virgin resin is not exposed in the fusion zone; the oxidation layer on the pipes surface is enough to create an impenetrable barrier that will impede the necessary molecular boding to take place. Resulting in a joint that will either leak and/or fail.



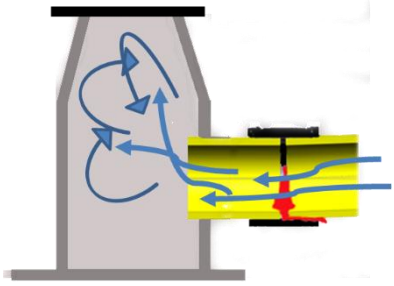
Water Flowing in the Fusion Zone



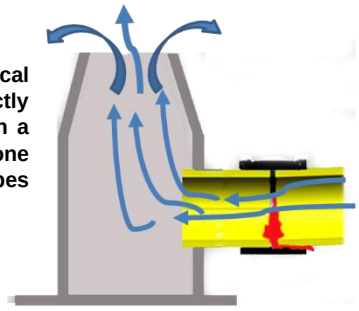
Water in the fusion zone not only creates a layer of impenetrable contamination between the pipe surface and the fitting; it also results in the water turning into steam when it meets the fusion coil which in turn creates a void in the fusion zone as the steam expands which can result in it becoming a leak path.



Restricting Airflow in Vertical Applications



If fusing an Electrofusion coupler into or part of a vertical application, you must ensure that your joint is correctly assembled and not short stabbed, mis-stabbed or in a binding situation. The heat generated in the fusion zone can become accentuated if the molten material escapes and is exposed to an increase in airflow.



You must take steps to minimize the potential increase in airflow through the fusion area by covering the opening with a tarp or piece of plywood, on one or both ends, to avoid creating a venturi effect ("rocket stove effect")

L-2 Large Diameter Electrofusion Coupling Installation

(1) Before Starting

- Integrity Fusion Products highly encourages all trained installers to use an **Electrofusion Installation Field Form (see page 31)** for keeping an accurate record of the following types of information.

  - **Company & Project Information**
  - **Weather & Jobsite Information**
  - **Equipment Used for Installation**
  - **Fitting Information**
  - **Fitting Installers Information**
  - **Pipe Mfg. & Pipe Information**
  - **Power Source Information**
  - **Fusion Results Information**

- In the event of bad weather, follow established inclement weather procedures before proceeding. Conditions can be improved with tents and/or blanketing equipment. Pipe surfaces must be dry during fitting assembly and fusion and should be protected from moisture due to heavy rain or snow. **IntegriFuse electrofusion fittings can be installed at ambient temperatures ranging from 14º F (-10º C) to 114º F (44.5º C) without change to the fusion procedure**. In hot temperatures or cold temperatures, pipe and fittings need to be acclimated to the same ambient temperature before fusing.

- If installed in an excavated pit, the technician must ensure that the area is adequately exposed and free of debris, mud and contaminates.

- Initial cleaning of the pipe surfaces can be done with clean water and a pressure washer prior to pipe preparation.

- **DO NOT** proceed with the fusion process if there is any water coming into direct contact with the fusion area. All heat fusion joining methods require that there be no water, flowing or standing in or below the pipe that can reach the fusion surfaces. **Dewatering of the site may be required**. A small amount of standing water may be unavoidable and is acceptable, however at no time is it acceptable for it to reach the prepared fusion surfaces or pipe and fitting assembly during the fusion process.

- Flowing water from inside of the pipe being fused must be stopped. Water meeting the fusion surfaces during assembly and fusion must be avoided.

If 100% shutoff of the water flow cannot be achieved, bread or dry ice can be used to create a temporary dam so that the electrofusion installation can take place. Care must be taken however, to make sure that the flow is sufficiently stopped for the entire time that fusion is taking place otherwise water may be able to get between the pipe surface and the fitting interface. This will compromise the fusion zone. If dry ice is used, then care must be taken to ensure that it is placed as far away from the fusion area upstream as possible. The reason for this is because dry ice can cause condensation to develop in the fusion zone as it evaporates. This too can compromise the fusion zone.

(2) Confirm Fitting Size & Verify Pipe Ends Are in Spec

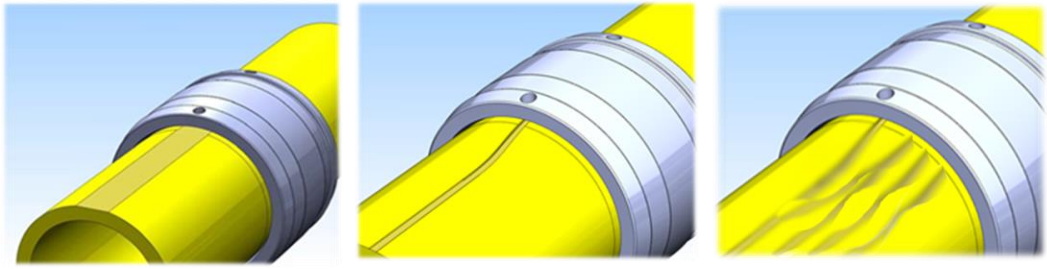
- Before proceeding, confirm that the pipe diameter and the fitting are the correct size.

- Electrofusion couplers are manufactured to work within tight ASTM dimensional tolerances. As pipe diameters get larger, it is important for the installer to make sure that the pipe OD will work and is the correct size for the electrofusion fitting.

- Use a P**ipe OD tape** and **Pipe OD chart** ***(see page 30)***, and verify that both sides of the pipe are within the required tolerances of the ASTM F714 minimum allowable pipe OD spec. **If the pipe is not within spec DO NOT proceed and contact the project or site manager immediately**.

(3) Check Pipe Surface for Excessive Gouges and Flat Spots

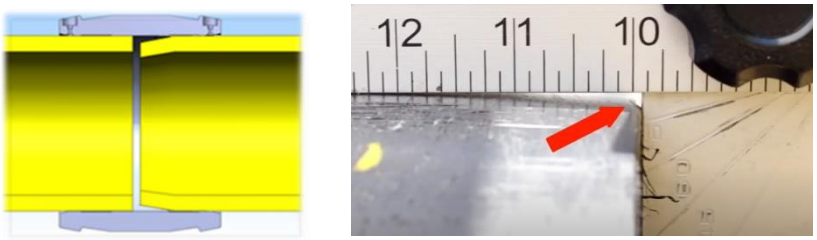
- Check the surface condition of the pipe in the immediate proximity of the area to be fused. Check to see if the pipe surface has evidence of flat spots, excessive gouges or scratches, gouges, or any unusual surface texture issues that either exceed the 10% of the minimum wall thickness required for the operating pressure, or that may impede the fusion process in any way. If the flat spots, scratches, gouges or texture issues exceed the 10% minimum, inform the project manager and contact Integrity Fusion Products before proceeding.



Damaged ends, flat spots, deep gouges, excessive scratches, and unusual surface anomalies in the area to be fused, should be cut back to where the pipe surface is in an acceptable condition and the pipe OD falls within the required tolerances. It may require removing an entire section of the pipe to correct these issues.

(4) Check Pipe Ends for Excessive Toe-In

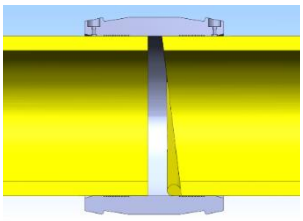
- The longer an HDPE pipe remains stored outside or remains unused, the pipe ends naturally "contract" inward and develop a condition commonly known as **Toe-In**. Too much **Toe-In** can be the source of significant issues when fusing an electrofusion coupling. When it does, the result can be an excessive gap found between the outer pipe surface and the fittings inner diameter which can result in a compromised fusion or no fusion at all.



- Using a carpenter's square (or similar). the installer must examine both ends of the pipe being fused to determine if an excessive **Toe-In** condition exists. **Toe-In** should not exceed more than 2" from the pipe end. If it is found to exceed more than 2" from the end of the pipe, the pipe end must be cut back to a point beyond where the toe-in ends before proceeding.

(5) Cut the Pipe Ends

- Pipe ends must be cut square and at right angles to the pipe axis and as close to a 90º angle as possible. Electrofusion fittings are designed to have cold zone lengths long enough to accommodate a small number of irregularities on the pipe end cut, but that only amounts to approx. a +/- 3º deviation. Anything beyond this acceptable deviation is considered a mis-cut assembly.

The angle of the cut in a mis-cut assembly can lead to the pipe ends falling outside of the effective area of the center cold zone in the coupler which will result in; **a)** an excessive loss of interfacial pressure and melt in the center of the coupler, **b)** over-heating of the material in the fusion zone, **c)** uncontrolled melting of material in the fusion zone, and **d)** the possibility of sudden ignition of molten material in the fusion zone.

- On larger pipe that must be cut by hand, it may be necessary to use a strap, a clamp, or some other form of device to provide a visual on the pipe surface that will help the installer guide and control his cut. Pipe ends can be cut using a variety of different tools.

- Unfortunately, as the pipe diameters increase in size, the availability of effective cutting tools diminishes.

- On large diameter pipes, 14” and larger, it is not uncommon to find chainsaws being used to cut pipe ends. This is completely acceptable, but keep in mind that when using a chainsaw to cut HDPE pipe, **no lubricant of any kind can be used in the chainsaw.** Bar oil and other lubricants will contaminate the surface area of the pipe and create a non-fusible barrier between the pipe surface and the coupler interface.

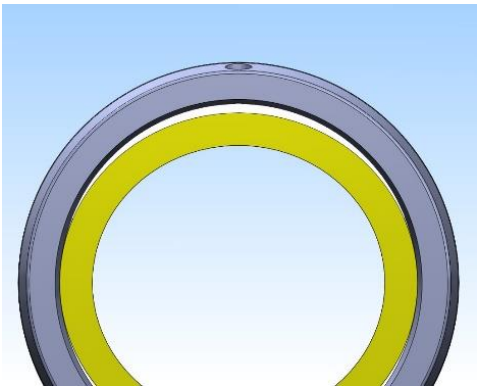
(6) Mark Your Stab Depth and Coupling Length

- Give yourself plenty of room to work. Clean an area approximately 2 times the length of the coupler of both sides of the pipe and designate this your joint assembly area.

- Place two (2) stab depth marks on the pipe surface by first measuring the total length of the electrofusion coupler and then, using your approved marking tool, place a mark on the surface of the pipe that is **½ the total length** of the coupler. This first mark is a visual indicator telling you how far you will need to push the coupler on the pipe to ensure that the pipe end will be located exactly in the center of the couplers cold zone. The second mark needs to indicate the couplers full length, and this mark will be used when working in tight spaces to do a tie-in or when used in repair situations. In these cases, the coupler will be required to be pushed all of the way onto the pipe before being pulled back to your first stab depth mark for your final coupler placement.

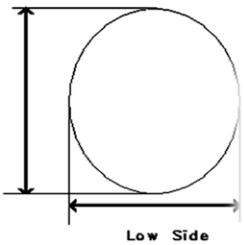

(7) Check The Pipe Ends for Excessive Out-of-Round Condition

As pipe diameters increase in size, out-of-round conditions become more of an issue. **For the electrofusion process to work, it is critical for the pipe to be as round as possible.** The electrofusion process relies on closing the gap between the pipe surface and the fitting and to allow an even amount of interfacial pressure to build up. An excessive gap that is larger than the melt expansion can close will result in lower fusion pressures in the fusion zone and potentially result in melt expulsion at the end of the coupler.



Unlike pipes that are inadvertently manufactured with their outside diameters out of spec or pipe surfaces that have surface defects like flat spots that actually reduce the wall thickness in those areas of the pipe; these issues can be identified by the installer but **cannot be corrected** by the installer. Pipe ends that are out-of-round on the other hand are a very common problem found on larger diameters of pipe, and with the right kind of tools, the installer can quickly and easily correct this issue.

- To check for an out-of-round condition, the pipe ends must be measured horizontally and vertically with a tape measure to determine the high and low points of the pipe. The difference between the high and low diameters should not exceed ¼".



- If the difference is greater than ¼" then a full encirclement re-rounding clamp should be placed immediately to the outside of the mark indicating the couplers stab depth, or the mark identifying the full length of the coupler. Pressure should be applied to the re-rounding clamp in this area until the pipe end is brought back into tolerance. This will make it easier to put the coupler onto the pipe, but it will also ensure the gap between the pipe and the fitting will not be too large to fill during the fusion process




(8) Mark the Area Where the Fitting Will be Fused

- After you have completed re-rounding the areas to be fused on the pipe; use your approved marking tool and clearly highlight the fusion area to be scrapped. These "witness marks" will not only provide you with a visual indicator of what areas of the pipe need to be scraped, they will also help you monitor the effectiveness of your scrapping tool as you remove material from the pipe surface. Gouges on the pipe surface that are deeper than the scraper/peeler is removing and yet still do not exceed the 10% wall thickness minimum may require extra attention. These marks will help you identify those areas quickly.


NOTE: Small stab depth marks will need to be reapplied after scraping to identify stab depth and coupling length.

(9) Scrape The Pipe

The removal of the oxidation layer and surface contaminates from the fusion zone on the pipe is by far the most important and most critical aspect of the electrofusion process. The failure to adequately remove this material on the pipe surface and expose virgin material in the fusion zone is overwhelmingly the #1 cause of unsuccessful electrofusion joints. Any person that does not completely understand the goal of proper pipe scraping and surface preparation should not be involved in this critical part of the installation process.

The oxidation layer on the pipe surface is very thin, no more than a few thousands of an inch in total depth. It is a normal by-product resulting from the pipe extrusion process, transportation, everyday handling, and outdo or U V exposure**.**

Proper pipe preparation requires the complete removal of a minimum of .007" of an inch of material from the surface of the pipe in the area that is to be fused. That is roughly the thickness of 2 sheets of paper. This outer layer or "skin" must be removed by scraping or peeling it away from the surface of the pipe to expose non-contaminated, virgin resin. This is accomplished by using tools that have been tested and are acceptable for use.

OXIDATION IS A PHYSICAL BARRIER!! Oxidation cannot be wiped away with any cleaner. Oxidation cannot be removed by simply roughing or scratching the pipe surface area. Pipe surface areas that have oxidation on them CAN NOT BE HEAT FUSED!!

Mechanical "Peeling" tools are commercially available tools specifically designed for electrofusion pipe preparation and are recommended for use whenever possible.

The "peeling" type of tool is preferred and recommended because they provide a consistent level of pipe surface preparation that allows the installer to visually verify adequate surface material removal. By monitoring the thickness of the ribbon being removed from the surface of the entire circumference of the pipe and by looking for skipped or missed paths between revolutions; the installer can quickly identify low spots and missed areas on the pipe surface that may require more careful attention. The installer should be familiar with these tools and should qualify fusions using them.



NOTE: ***Hand scrapers*** ***(paint scrapers, scrapers with serrated blades, etc.) have been successfully used for many years, and they can still be used effectively in some cases. Particularly when working in situations where space is limited and where pipe scratches or gouges in the pipe require the use of a hand tool.***

However, as a best practice*, the use of hand scrapers is not recommended due to the significant operator experience needed to know when adequate pipe surface material has been removed. Installers using hand scrapers are required to spend more time, exert more effort and be more diligent in their work habits in order to ensure that the entire fusion area is being completely scraped.*



- IMPORTANT REMINDER -

Under no circumstances *should you use abrasives such as sandpaper or emery cloth. Abrasives not only fail to remove material from the pipe surface, but they in fact also embed abrasive granules into the surface of the pipe creating even more of a contamination barrier.*

Under no circumstances *should other devices such as grinding wheels or wire wheels be used to prepare pipe surfaces. Grinding wheels and wire wheels do not remove surface material. At best they only move it around and when combined with the heat they generate while in use they push contaminates deeper into the pipe surface*

Always inspect your scraping tools before leaving for the jobsite. It is the Installers responsibility to ensure that they are in good working order and free of grease or other contaminates. That all bushings, bearings, rollers and guides are tight and working properly. That peeler blades are not knicked, damaged or dull.

- Using a sharp instrument such as a box cutter, make several shallow scribes on the pipe surface that is to have surface material removed. This is done so that the ribbons produced by the scrapers will fall off in smaller pieces and not inadvertently re-contaminate the freshly exposed virgin resin.

- Using an appropriate "peeler" type of scraper, position it on the pipe using the "witness marks" as your guide to adjust the cutting head accordingly. Remove the surface material from the pipe, carefully inspecting the entire circumference of the of the area as it is being scraped, visually checking for high and low spots that may need special attention and to make sure that that your scraper is providing you with adequate scraping coverage.

Take care not to inadvertently re-contaminate the freshly scraped area by touching it, handling it, placing tools or other items on it, getting it wet, etc.

- Make sure to re-apply small witness marks on the pipe surface indicating both the couplers stab depth and the full coupler lengths. These marks do not have to go completely around the circumference of the pipe, but they do need to be visible enough to be used as a visual guide for inserting the coupling into the proper position on the pipe.
  .
- Fitting Assembly should take place as soon as possible after scraping.

(10) Re-Check for Out-of-Round Conditions

- Check the pipe ends for any adjustments that may need to be made for an out-of-round condition before attempting to insert the coupler onto the pipe end. *(See step 7)* This will help in reducing the required amount of effort in sliding the coupler onto the pipe ends during the insertion process. This will also help reduce any excessive gaps between the pipe surface and the coupler interface. **REMEMBR:** ***A gap that is too large will result in insufficient melt generation in those areas of the fusion zone and could potentially fail to sufficiently close the pipe and coupler interface.***

(11) De-burr and Bevel Pipe Ends

- Deburring and beveling the pipe ends prior to coupler installation is done to facilitate easier installation of the coupler onto the pipe and to help prevent the possibility of inadvertent damage to the fitting's fusion coils during installation. A router with a 22.5-degree angle bit is recommended but a power planer can be used as well. Keeping in mind that power planers can be a bit tricky when working with plastic. Hand Scrapers with serrated blades can also work equally well. The goal being, to remove shavings from the pipe edges and to remove the sharp right angles on the pipe ends for easier coupler insertion.



(12) Final Cleaning of the Fusion Zone and Fitting

- Clean the freshly scraped fusion zone on the pipe using a 90% or greater solution of Isopropyl Alcohol with no additives and a clean, non-dyed, lint free cloth or wipe. This will remove any residual surface contaminates, such as dirt and moisture, from the fusion zone that may have inadvertently come in contact with the pipe. Take care not to re-contaminate your cleaned area by touching them.

- Remove the electrofusion fitting from its protective packaging and wipe down the fusion zone on the inside of the fitting using the same 90% or greater solution of Isopropyl Alcohol with no additives and a clean, non-dyed, lint free cloth or wipe.



- If the prepared area is not to be assembled immediately, a plastic bag, clean plastic sheeting or shrink wrap, can be used to cover the scraped area on the pipe and the fitting can be placed back into its original plastic packaging until the assembly is to be made. All that will need to be done then will be to wipe both surfaces down again with a 90% or greater solution of Isopropyl Alcohol with no additives and a clean, non-dyed, lint free cloth or wipe.

(13) Begin Joint Assembly

- ***Make sure stab depth marks are reapplied and visible after scraping.***

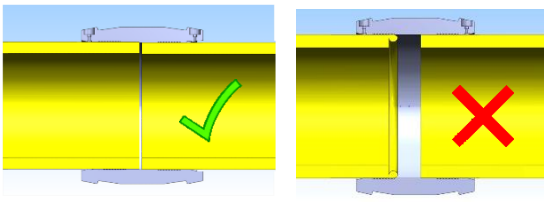
- Push the IntegriFuse Coupler onto the pipe end until the edge of the coupler that is on the pipe is aligned with the stab depth witness mark. ***If you are doing a repair type of fusion, you will push the coupler on until you are aligned with the full coupler length witness mark and then pull the couple back until the stab mark is visible.***

The weight of the fitting or the tight tolerance of the pipe OD may make it necessary to use a rubber mallet, a dead blow hammer, a sledgehammer with wooden blocks, porta-power, or other installation aid to carefully nudge the fitting onto the pipe. Take care not to strike directly in the electrofusion terminal pin area. The re-rounding clamps can be used as anchors for pulling or pushing the couplers into position by using hydraulic or mechanical assist devices such as porta packs, a come along, or hand winches.

- Repeat procedure for the 2nd side making sure that both ends of the pipe are in alignment and that the pipe and coupler are not in a binding situation. In order to control bending stresses do not let the pipes support their own weight in the coupler.

Note: ***When installing EF Couplers, it is critical to ensure that both ends of the pipe/fitting meet in the center of the coupler's cold zone. In addition, the installer must make sure that any gap between the two pipe/fitting ends does not exceed 1". If pipe/fitting ends are off center, or if there is an excessive gap between the two, this can cause a short stab situation, and may result in a failed fusion.***

See pages 32-34



There are some instances where a large diameter Flange Adapter with Backup Ring is not long enough to reach the center of the EF Coupler. The installer must be aware of this common industry issue and take the proper steps to address this challenge. In these instances, the installer must fuse a pup piece of pipe onto the end of the flange adapter stub to provide the necessary flange adapter length needed to ensure the flange can reach the center cold zone.

- To provide a straight, unstressed, non-binding joint assembly, it is recommended to use a suitable restraint device or holding system. This straight, stress-free, non-binding condition must be maintained all the way through the cooling period. An assembly, which is stressed, may result in defective joint. Achieving this may require some creativity and ingenuity on the installer's part.



(14) Check for Excessive Gaps

- Using a flashlight and a 7" long electrical tie or something similar; check the gap around the entire circumference of the pipe and fitting. The gap should be evenly spaced and no wider than 5mm (approx. 1/4"). The electrical tie will help you determine where the gap is unevenly spaced. Using the re-rounding clamp, adjust the hydraulic pressure to make the necessary adjustments**.**


Beginning the Fusion Sequence

- **Verify that the electrofusion processor switch is in the off position.**
- **Make sure that you have plenty of extra fuel on-hand due to the longer fusion times for large diameter couplers, that your generator is fueled, operating normally, and running at full throttle.**
- **Make sure that your processor is plugged into the correct outlet and that all breakers or relays are in the correct voltage output position.**
- **Turn on the processor and wait for software initialization to complete. When prompted, press START to begin.**
- **When prompted, connect the processor leads to the IntegriFuse coupler making sure that both connections are tight and secure. Loose lead tips or failure to make a secure connection can result in unwanted arcing at the loose connection and result in an interrupted fusion cycle and potentially blown fuses, or a damaged processor.**

- **At the prompt, scan the bar-code.**

- **Depending on the level of traceability chosen, follow the prompts and answer the questions on the processor screen and press OK to proceed to the next screen.**
- **On the final screen you will be prompted to choose between beginning the fusion or to abort the process.**
- **Press Start to Begin.**

- **When the fusion cycle is completed, the processor will beep indicating it is done and it is time to remove the leads from the coupler.**

- **Repeat the electrofusion sequence for the next fitting.**
- **Let the coupler cool for the recommended cooling time indicated on the label and then use a flashlight and a 4" electrical tie to verify that the pipe and coupler interface gaps are closed and that adequate melt in the fusion zones has taken place.**

- **Once the recommended cooling time is complete, your IntegriFuse Electrofusion Coupler is ready for pressure testing.**
- **For traceability purposes, we highly recommend that the Installer use the approved marker to record on the pipe surface next to the fitting; the Installers initials, the time the fusion cycle completed, and the date of the install.**

L-2 Large Diameter Electrofusion Branch Saddle Installation

NOTE: Electrofusion Branch Saddles are surface mounted fittings. The same considerations, information and required tooling regarding the installation of electrofusion couplings should be applied to the installation of electrofusion branch saddles as well.

(1) Before Starting

- Inspect the work site making sure the area is dry and free of obstructions and potential hazards.
- In the event of bad weather, follow established inclement weather procedures before proceeding. Conditions can be improved with tents and/or blanketing equipment. Pipe surfaces must be dry during fitting assembly and fusion and should be protected from moisture due to heavy rain or snow. **IntegriFuse electrofusion fittings can be installed at ambient temperatures ranging from 14° F (-10° C) to 114° F (44.5° C) without change to the fusion procedure**.
- If the Branch Saddle is to be installed in an excavated pit, on the underside of the pipe, the technician must ensure that the area is adequately exposed and free of mud and contaminates. If the Branch Saddle is to be installed in an overhead application, the installer must make sure there is adequate space for cleaning, securing, and restraining the fitting in place for the entirety of the fusion cycle.
- Initial cleaning of the pipe surfaces can be done with clean water using a pressure washer or a brush prior to pipe preparation.

(2) Confirm the Base Size & Pipe Diameter Are Compatible

- Before proceeding, confirm that the pipe diameter and the Branch Saddle base are the correct sizes.

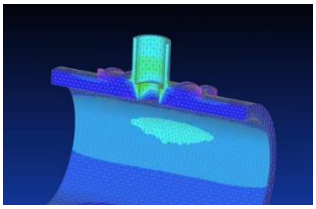
(3) *Identify the General Location the Fitting is to be Installed*

- Take note of the location and orientation that the branch saddle will have on the pipe (top, side, or bottom) and mark an area **3 times the width of the Branch Saddle.** This is your go – no go zone. Do not wipe outside of this initially cleaned area during the pipe preparation procedures.

(4) Check Pipe Surface for Excessive Gouges and Flat Spots

- Check the surface condition of the pipe in the immediate proximity of the area to be fused. Make sure there are no deep gouges, flat spots, or other significant surface imperfections in that area of the pipe that could have an impact on your fusion. If they exist – move the installation location to another location.
- Take note as well, to possible out-of-round conditions on the surface of the pipe due to long term storage or buried earth load conditions. Many electrofusion branch saddles have fixed bases, and even with proper clamping, the flexibility of the branch saddle base may not be sufficient to overcome this out-of-round condition and it can be very possible to have excessive gaps in the fusion zone due to a pipes out-of-round condition on its surface. Re-rounding Clamps may be required.

NOTE: On electrofusion Branch Saddles, the fusion zone is in the area where the embedded wires in the base of the electrofusion saddle meet the surface of the pipe. Avoid having flat spots, gouges, and excessive scrapes going through this area.



(9) Mark the Fitting Location

- Keep the Branch Saddle in its original packaging when marking where it will be placed. If it is not possible, take care to not contaminate the saddles base.

- Place and orient the Branch Baddle on the pipe surface where it is to be installed and clearly outline the Branch saddle base. Make the marked area slightly larger than the size of the fittings base.

- Remove the packaged fitting from the pipe surface and use your marker to highlight the area of the pipe surface needing to be scrapped. These marks will serve as a visual indicator of the effectiveness of your scraping.

(10) Scrape the Fusion Zone

***NOTE*: We repeat our emphasis on pipe scraping because of its crucial importance.**

Proper pipe preparation requires the complete removal of a minimum of .007" of an inch of material from the surface of the pipe in the area that is to be fused. That is roughly the thickness of 2 sheets of paper. This outer layer or "skin" must be removed by scraping or peeling it away from the surface of the pipe to expose non-contaminated, virgin resin. This is accomplished by using tools that have been tested and are acceptable for use.

OXIDATION IS A PHYSICAL BARRIER!! Oxidation cannot be wiped away with any cleaner. Oxidation cannot be removed by simply roughing or scratching the pipe surface area. Pipe surface areas that have oxidation on them CAN NOT BE HEAT FUSED!!

Mechanical "Peeling" tools are commercially available tools specifically designed for electrofusion pipe preparation and are recommended for use whenever possible. The "peeling" type of tool is preferred and recommended because they provide a consistent level of pipe surface preparation that allows the installer to visually verify adequate surface material removal. By monitoring the thickness of the ribbon being removed from the surface of the entire circumference of the pipe and by looking for skipped or missed paths between revolutions; the installer can quickly identify low spots and missed areas on the pipe surface that may require more careful attention.

- Using an appropriate "peeler" type of scraper, position it on the pipe using the "witness marks" as your guide to adjust the cutting head accordingly. Remove the surface material from the pipe, carefully inspecting the entire circumference of the of the area as it is being scraped, visually checking for high and low spots that may need special attention and to make sure that that your scraper is providing you with adequate scraping coverage.

- Inspect the scraped surface to make sure that the oxidation layer has been removed and only virgin resin has been exposed. Visually confirm that all of your "witness marks" have been removed. Take care to not re-contaminate the scraped area.

NOTE: ***Hand scrapers (paint scrapers, scrapers with serrated blades, etc.) have been successfully used for many years, and they can still be used effectively in some cases. Particularly when working in situations where space is limited and where pipe scratches or gouges in the pipe require the use of a hand tool.***

However, as a best practice, the use of hand scrapers is not recommended due to the significant operator experience needed to know when adequate pipe surface material has been removed. Installers using hand scrapers are required to spend more time, exert more effort and be more diligent in their work habits in order to ensure that the entire fusion area is being completely scraped.

CAUTION: In The Event A Hand Scraper Has To Be Used, make sure that you have a good scraper that uses replaceable blades. The blades need to be sharp and made of tungsten carbide. You must take your time, pay close attention to your scraping procedure, scrape material off while pulling in only one direction, and you must closley monitor your scraping pattern.



(11) Clean the Fusion Zone & Branch Saddle Base

- Clean the freshly scraped fusion zone on the pipe using a 90% or greater solution of Isopropyl Alcohol with no additives using a clean, non-dyed, lint free cloth or wipe. This will remove any residual surface contaminates, such as dirt and moisture, from the fusion zone that may have inadvertently come in contact with the pipe. Take care not to re-contaminate your cleaned area by touching them.

- Remove the electrofusion fitting from its protective packaging and wipe down the fusion zone on the inside of the fitting using the same 90% or greater solution of Isopropyl Alcohol with no additives and a clean, non-dyed, lint free cloth or wipe. Make sure that the cleaning solution has completely evaporated before installing the fitting. Re-mark the area where the Branch Saddle is to be placed.

(12) Begin Joint Assembly

- Place the cleaned Branch Saddle onto the scraped and cleaned pipe surface.
- Secure the Branch Saddle to the prepared pipe surface using the designated restraint device for your particular saddle fitting, making sure that the Branch Saddle is oriented where you need it to be. ***DO NOT tapp the pipe before installing the Branch Saddle!***


- With a small wire tie, check the secured fitting for excessive gaps around the saddle base.

Restraint devices are always required when fusing branch saddles and ***MUST be left in place*** until the fitting has completed its cooling cycle. Typical restaint devices used to hold Branch Saddles onto the surface of the pipe are going to be; reusable mechanical clamps, intergrated bolt-on clamps or ratchet straps. Each electrofusion manufacturers saddle fitting has pecific restraint requirements that have been designed and qualified for use - ***substitutions are not acceptable***.

Beginning the Fusion Sequence

- **Verify that the electrofusion processor switch is in the off position.**
- **Make sure that your generator is fueled, operating normally, and running at full throttle.**
- **Make sure that your processor is plugged into the correct outlet and that all breakers or relays are in the correct voltage output position.**
- **Turn on the processor and wait for software initialization to complete. When prompted, press START to begin.**
- **When prompted, connect the processor leads to the IntegriFuse Branch Saddle, making sure that both connections are tight and secure. Loose lead tips or failure to make a secure connection can result in unwanted arcing at the loose connection and result in an interrupted fusion cycle and potentially blown fuses, or a damaged processor.**

- **At the prompt, scan the bar-code.**

- **Depending on the level of traceability chosen, follow the prompts and answer the questions on the processor screen and press OK to proceed to the next screen.**
- **On the final screen you will be prompted to choose between beginning the fusion or to abort the process.**
- **Press Start to Begin.**

- **When the fusion cycle is completed, the processor will beep indicating it is done and it is time to remove the leads from the fitting.**

- **Repeat the electrofusion sequence for the next fitting.**
- **Let the Branch Saddle cool for the recommended cooling time indicated on the label and then use a flashlight and an electrical tie to verify that the pipe and coupler interface gaps are closed and that adequate melt in the fusion zones has taken place.**

- **Once the recommended cooling time is complete, your IntegriFuse Electrofusion Saddle is ready to have the restraining device removed and be pressure tested**.
- **For traceability purposes, we highly recommend that the Installer use the approved marker to record on the pipe surface next to the fitting; the Installers initials, the time the fusion cycle completed, and the date of the install.**

L-2 Large Diameter Flex Restraint Installation

NOTE: Electrofusion Flex Restraints are surface mounted fittings. The same considerations, information and required tooling regarding the installation of electrofusion couplings should be applied to the installation of electrofusion branch saddles as well.

What You Need to Know Before Starting

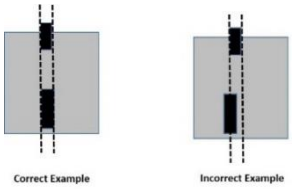
The design engineer for the Flex Restraint project is responsible for:

- ***calculating the amount of anticipated thrust force that will result from expansion & contraction***
- ***determining the correct number of Flex Restraints required for each application.***

For equal distribution of axial resistance forces to be achieved, the Flex Restraint installer is responsible for:

- ***Installing Flex Restraints (a minimum of 2,) that must be equidistantly spaced around the circumference of the pipe surface, and***

- ***Installing the Flex Restraints equally aligned in a straight line around the circumference of the pipe.***



The data provided in this table is for use only as a guideline for the designer. The maximum number of restraints per pipe OD only reflects the total number of Flex Restraints that can be installed in a straight line around the circumference of a specified pipe OD. The designer is responsible for determining all expansion/contraction forces in their specific application and for calculating the appropriate number of flex restraints to be used for restraining those forces. The designer should consider all other additional affecting factors.

Pipe OD	Max. # of Restraints**	Pipe OD	Max. # of Restraints**	Pipe OD	Max. # of Restraints**	Pipe OD	Max. # of Restraints**	Pipe OD	Max. # of Restraints**
6″	3	16″	8	26″	13	36″	18	46″	24
8″	4	18″	9	28″	14	38″	19	48″	25
10″	5	20″	10	30″	15	40″	20	--	--
12″	6	22″	11	32″	16	42″	21	--	--
14″	7	24″	12	34″	17	44″	23	--	--

(1) Before Starting

- Inspect the work site making sure the area is dry and free of obstructions and potential hazards.
- In the event of bad weather, follow established inclement weather procedures before proceeding. Conditions can be improved with tents and/or blanketing equipment. Pipe surfaces must be dry during fitting assembly and fusion and should be protected from moisture due to heavy rain or snow. **IntegriFuse electrofusion fittings can be installed at ambient temperatures ranging from 14° F (-10° C) to 114° F (44.5° C) without change to the fusion procedure**.
- Initial cleaning of the pipe surfaces can be done with clean water using a pressure washer or a brush prior to pipe preparation.

Important Note: ***Keep the Flex Restraints in their original packaging until ready to place and secure it.***

(2) *Identify the Location the Flex Restraints are to be Installed*

- Identify the desired location where the Flex Restraints are to be placed. If the Flex Restraints are to be installed in an excavated pit, the technician must ensure that the area is adequately exposed and free of mud and contaminates. If the Flex Restraints are to be installed in an overhead application, the installer must make sure there is adequate space for cleaning, securing, and restraining the fitting in place for the entirety of the fusion cycle.

(3) Check Pipe Surface for Excessive Gouges and Flat Spots

- Check the surface condition of the pipe in the immediate proximity of the area to be fused. Make sure there are no deep gouges, flat spots, or other significant surface imperfections in that area of the pipe that could have an impact on your fusion. If they exist – move the installation location to another location.

NOTE: On electrofusion Flex Restraints, the fusion zone is in the area where the embedded wires in the base of the electrofusion saddle meet the surface of the pipe. Avoid having flat spots, gouges, and excessive scrapes going through this area.

(4) Mark the Flex Restraint Locations

- Using your marker, draw a clear line on the pipe surface completely around the pipe's circumference. This line will be used as your reference point to align the Flex Restraint in a straight line.

- Keep the Flex Restraint in its original packaging when marking where each of the Flex Restraints will be placed equidistantly around the pipe. Clearly outline the Flex Restraint and make the marked area slightly larger than the size of the fitting.

- Use your marker to highlight the area of each area on the pipe surface that will need to be scrapped. These marks will serve as a visual indicator of the effectiveness of your scraping.

(5) Scrape the Fusion Zone

***NOTE*: We repeat our emphasis on pipe scraping because of its crucial importance.**

Proper pipe preparation requires the complete removal of a minimum of .007" of an inch of material from the surface of the pipe in the area that is to be fused. That is roughly the thickness of 2 sheets of paper. This outer layer or "skin" must be removed by scraping or peeling it away from the surface of the pipe to expose non-contaminated, virgin resin. This is accomplished by using tools that have been tested and are acceptable for use.

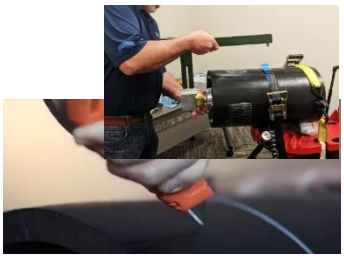
OXIDATION IS A PHYSICAL BARRIER!! Oxidation cannot be wiped away with any cleaner. Oxidation cannot be removed by simply roughing or scratching the pipe surface area. Pipe surface areas that have oxidation on them CAN NOT BE HEAT FUSED!!

Mechanical "Peeling" tools are commercially available tools specifically designed for electrofusion pipe preparation and are recommended for use whenever possible. The "peeling" type of tool is preferred and recommended because they provide a consistent level of pipe surface preparation that allows the installer to visually verify adequate surface material removal. By monitoring the thickness of the ribbon being removed from the surface of the entire circumference of the pipe and by looking for skipped or missed paths between revolutions; the installer can quickly identify low spots and missed areas on the pipe surface that may require more careful attention.

NOTE: ***Hand scrapers** (paint scrapers, scrapers with serrated blades, etc.) have been successfully used for many years, and they can still be used effectively in some cases. Particularly when working in situations where space is limited and where pipe scratches or gouges in the pipe require the use of a hand tool.*

***However, as a best practice**, the use of hand scrapers is not recommended due to the significant operator experience needed to know when adequate pipe surface material has been removed. Installers using hand scrapers are required to spend more time, exert more effort and be more diligent in their work habits in order to ensure that the entire fusion area is being completely scraped.*

- If using a rotary/peeler type of scraper, use a utility knife, or similar object, to make 2 or 3 scribes around the pipe in order to break up the peeled ribbon into smaller pieces as the scraper goes around the pipe in order to not unintentionally recontaminate the pipe surface.



- Using an appropriate "peeler" type of scraper, position it on the pipe using the "witness marks" as your guide to adjust the cutting head accordingly. Remove the surface material from the pipe, carefully inspecting the entire circumference of the of the area as it is being scraped, visually checking for high and low spots that may need special attention and to make sure that that your scraper is providing you with adequate scraping coverage.

- Inspect the scraped surface to make sure that the oxidation layer has been removed and only virgin resin has been exposed. Visually confirm that all of your "witness marks" have been removed. Take care to not re-contaminate the scraped area.

Due to the many unconventional applications and the many difficult locations Flex Restraints may be used in; Hand Scrapers may be the only viable scraping tool option available to the installer. In The Event A Hand Scraper Has To Be Used, make sure that you have a good scraper that uses replaceable blades. The blades need to be sharp and made of tungsten carbide. You must take your time, pay close attention to your scraping procedure, scrape material off while only pulling in unidirectional direction, (one direction. You must be diligent about monitoring your scraping pattern.



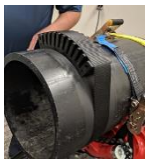
(Rasps, grinders & wire brushes/wheels are NOT allowed)

(6) Clean the Fusion Zone & Flex Restraint Base

- Clean the freshly scraped fusion zone on the pipe using a 90% or greater solution of Isopropyl Alcohol with no additives using a clean, non-dyed, lint free cloth or wipe. This will remove any residual surface contaminates, such as dirt and moisture, from the fusion zone that may have inadvertently come in contact with the pipe. Take care not to re-contaminate your cleaned area by touching them.

- Remove the Flex Restraint from its protective packaging and wipe down the fusion zone on the inside of the fitting using the same 90% or greater solution of Isopropyl Alcohol with no additives and a clean, non-dyed, lint free cloth or wipe. Make sure that the cleaning solution has completely evaporated before installing the fitting.

- Place the Flex Restraint immediately on the prepared surface where it is to be fused, minimize the movement of the flex restraint while unsecured on the pipe surface, with duct tape or gorilla tape, until all Flex Restraints are properly place and then secure them in place with a 2" ratchet strap.



Note: 2" Ratchet straps are the required application tool due to the ease of use and more reliable distribution of clamping pressures.

- While holding the Flex Restraint in place, tighten the 2" ratchet strap until the Flex Restraints are conformed to the pipe wall. It is critical to ensure that the base of the Flex Restraint contacts the pipe over the entire fusion area, and no gap can be seen between fitting and the pipe. If more than one Flex Restraint is to be fused, make sure that all fittings are in place before completely securing the ratchet straps, ensuring the ratchet buckle is equidistant between two of the Flex Restraints before tightening.

Beginning the Fusion Sequence

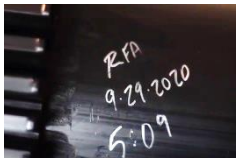
- **Verify that the electrofusion processor switch is in the off position.**
- **Make sure that your generator is fueled, operating normally, and running at full throttle.**
- **Make sure that your processor is plugged into the correct outlet and that all breakers or relays are in the correct voltage output position.**
- **Turn on the processor and wait for software initialization to complete. When prompted, press START to begin.**

- **When prompted, connect the processor leads to the IntegriFuse Flex Restraint, making sure that both connections are tight and secure. Loose lead tips or failure to make a secure connection can result in unwanted arcing at the loose connection and result in an interrupted fusion cycle and potentially blown fuses, or a damaged processor.**

- **At the prompt, scan the bar-code.**

- **Depending on the level of traceability chosen, follow the prompts and answer the questions on the processor screen and press OK to proceed to the next screen.**
- **On the final screen you will be prompted to choose between beginning the fusion or to abort the process.**
- **Press Start to Begin.**
- **When the fusion cycle is completed, beep indicating it is done and it is time to remove the leads from the fitting.**

- **Repeat the electrofusion sequence foreach of the remaining Flex Restraints to be installed.**
- **Let the Flex Restraints cool for the recommended cooling time indicated on the label and then use a flashlight and an electrical tie to verify that the pipe and coupler interface gaps are closed and that adequate melt in the fusion zones has taken place.**
- **Once the recommended cooling time is complete, your IntegriFuse Electrofusion Flex Restraint is ready to have the restraining device removed.**
- **For traceability purposes, we highly recommend that the Installer use the approved marker to record on the pipe surface next to the fitting; the Installers initials, the time the fusion cycle completed, and the date of the install.**



INTEGRITY Fusion Products, Inc.

Electrofusion Processors

110 Volt - IFuse I60
240 Volt - IFuse I105

Electrofusion Processors

Electrofusion Processors (**also known as Control Boxes**) are the little magic boxes that make the electrofusion process happen. They are portable electronic units responsible for performing several vital functions that are critical for making the electrofusion process work. First and foremost, the Electrofusion Processor provides the correct amount of energy to the electrofusion fitting by supplying a carefully regulated voltage and amperage to the fittings fusion coil that has been calculated and deemed necessary for closing interfacial gaps, generating sufficient interfacial pressures, and generating adequate melt pools.

Additionally, the Electrofusion Processor monitors the constancy and stability of the power source that is providing the processor with its operating current. Simultaneously the processor is looking for fluctuations in both the processors input and output current flow that may result in and/or indicate certain assembly or fitting errors. Errors that may result from issues such as disconnected or shorted fusion coils or excessive movements in the fusion coil wires due to short-stabbed pipe ends.

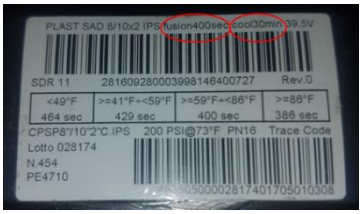
The micro-processor within each Electrofusion Processor is programed to follow carefully defined protocols with operating parameters that, when not met or exceeded, will result in the termination of the fusion process and the displaying of an error message. The micro-processor is programed to keep a record of each fusion and/or attempted fusion and will store the critical fusion data and traceability information in its memory until it is downloaded via its USB connection.

Integrity Fusion Products manufacturers two models of Electrofusion Processor; the 110-volt IntegriFuse I60 that is capable of fusing couplers up to 16”and the 220-volt IntegriFuse I105 that can fuse the entire size range of available electrofusion fittings. Both processor models have 3 data entry options to input required fusion parameters that will operate the processor.

- **Scan Barcode Mode** – Each electrofusion fitting comes with a barcode supplied by the fitting manufacturer. This barcode contains fitting information and fusion parameters specific to the design of the fitting being fused. When the barcode is scanned with the processors barcode reader, the data that is embedded on the barcode is automatically input into the Electrofusion Processor. This data tells the processor:
  - what type and size of fitting is being fused
  - how much voltage needs to be supplied to the fusion coil
  - how much time the voltage needs to be applied to the fusion coil
  - how much temperature compensation needs to be applied (or not)
  - monitors the fusions process
  - records fusion data and traceability information

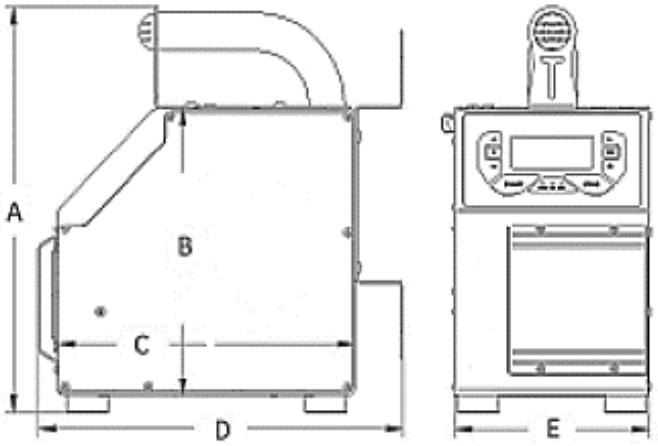
- **Manual Barcode Mode** – The Manual Barcode Mode works the same as the Barcode Mode with the only difference being how the data is uploaded. Instead of scanning the barcode data directly into the processor with a barcode reader, the data is input manually by entering each of the 24 individual barcode digits that are printed below the barcode on the processors' touchpad. This data entry mode is typically only used when the barcode has been damaged and cannot be scanned, or the barcode reader may be malfunctioning.

- **Manual Fusion Mode** – There may be circumstances where the Manual Fusion Mode needs to be used. One of the most common reasons we see is the barcode label being severely damaged or lost. If you are still able to read the label, you will find the fusion voltage and the fusion time printed in the description line. You will also find adjusted fusion times based on ambient temperature ranges. If the label is damaged beyond use or lost, IntegriFuse electrofusion fittings have this information molded directly into the body of the fitting itself



Dimensional Specifications

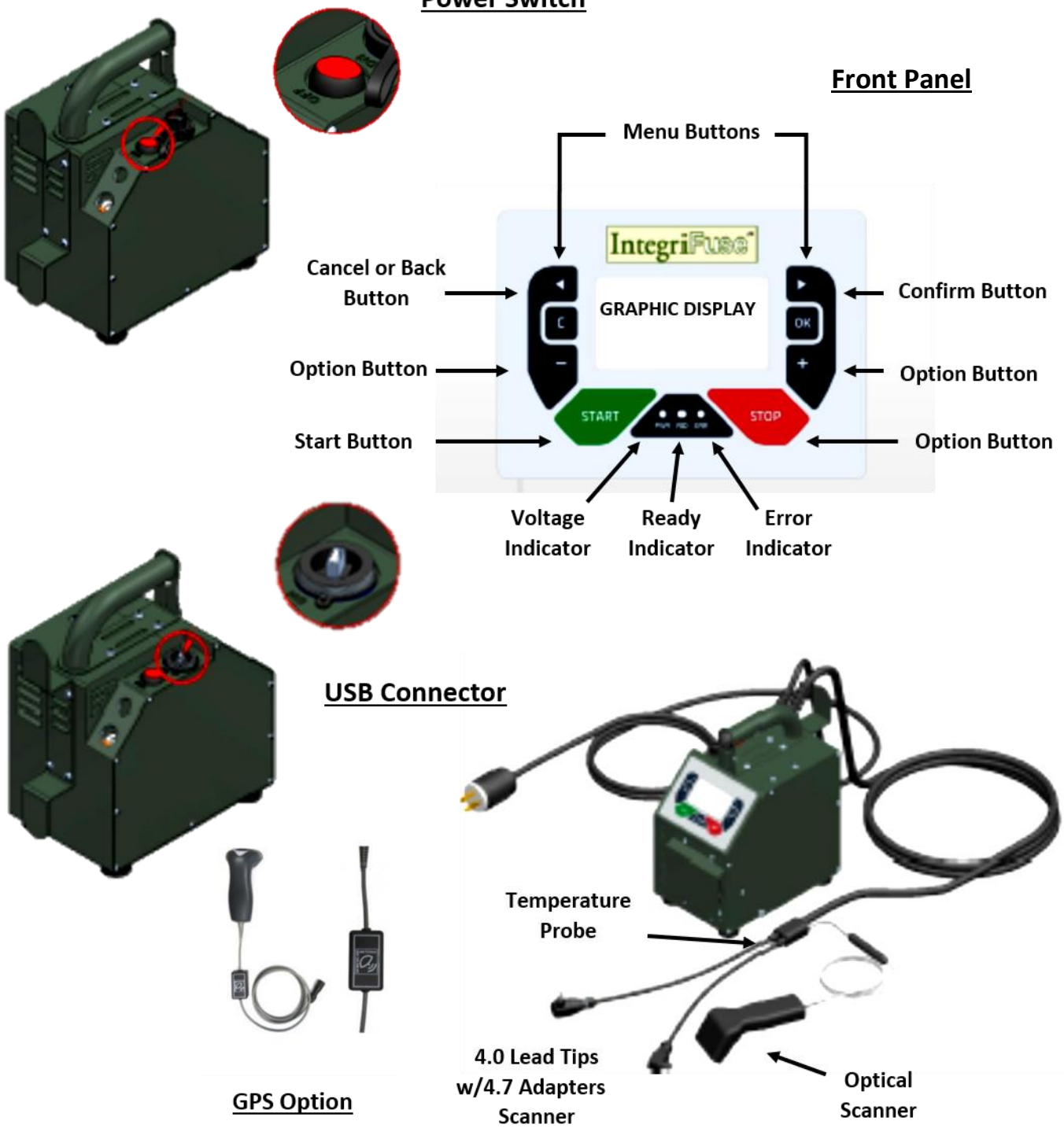
Control Box Dimensions		
Code	**I Fuse 60**	**I Fuse 105**
A	**12.95 inches (329mm)**	**12.95 inches (329mm)**
B	**9.17 inches (233mm)**	**9.17 inches (233mm)**
C	**9.92 inches (252mm)**	**9.92 inches (252mm)**
D	**12.16 inches (309mm)**	**12.16 inches (309mm)**
E	**6.49 inches (165mm)**	**6.49 inches (165mm)**



Technical Specifications

Processor Specifications	IFuse I60	IFuse I105
Working Temperature Range	14° F to 113° F	
Processor Weight	50 lb. unit includes wheeled Pelican case	52 lb. unit includes wheeled Pelican case
Maximum Working Range	16" DIPS	54" IPS
Fusible Materials	PE / PEX / PP / PP-R	
Fusion Data Input	Scanner / Manual	
Input Voltage	120 V AC **(102 V – 138 V)**	230 V AC **(185 V – 260 V)**
Input Current	32 A	16 A
Input Frequency	50 Hz **(40 -70 Hz)**	
Output Voltage	8 V AC to 48 V AC	
Output Current	100% = 50 A, 60% = 70 A, 30% = 90 A	65 A > 20,000 sec, 105 A max 1,400 sec @ 68° F
Output Peak	100 A (Electronically Limited)	120 A (Electronically Limited)
Power Requirements	**5,000 Continuous Watt (non-welding) Generator**	**6,500 Continuous Watt (non-welding) Generator**
Input Cable	13 ft NEMA L5-30 125V/30A Twist Lock	13 ft NEMA L14-30 250V/30A Twist Lock
Output Cable	10 ft	
Lead Terminals	4.0 mm tips and 4.7mm adapters	
Display	Graphic, 128x64 Characters (alphanumeric), background lighting	
Language Options	English, Spanish, Italian, German, French, Russian	
Monitoring Functions		
Input	Voltage / Current / Frequency	
Output	Voltage / Resistance / Contact / Short Circuit /Current	
Other	Software / Ambient Temperature / Service	
Error Messages	Plain Text / Acoustic Signals	
Memory Storage		
No. of Reports	7,500 Fusions	
Interface	USB / RS232	USB / RS232 / Radio
Data Format	USB Format: CSV - TXT	
Data Retrieval		
Fusion Data	Voltage / Current / Nominal / Actual fusion Time / Mode / Resistance / Error Messages	
Fitting Data	Bar Code information / Fitting Type / Size / Manufacturer	
Processor Information	No. Series / No. Inventory / Last Service date / Working Hours / software	
Traceability		
Job Number or Site Information / Welder Code / Weather Conditions / Fusion Bar Code / Traceability Barcode		

Control Box Functions



Processor Error Codes

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 2.0!	**"FRQLEr"**	Main_Frequency_Lo_Error	Power Supply frequency is too low	Freq Min

Meaning: Processor cannot function due to the electrical frequency being supplied from the power supply is outside of the acceptable range on the low side.
Trouble Shooting Recommendation: Check the frequency of the current coming from the power supply to the processor is within the processors operating range while under a load. Output frequency should be **60Hz +/- 10Hz.** ***This can be done on IntegriFuse processors.***
Solution: Change Power Supply. *Make sure generators are calibrated annually.*

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 2.1!	**"FRQHEr"**	Main_Frequency_Hi_Error	Power supply frequency is too high	Freq Max

Meaning: Processor cannot function due to the electrical frequency being supplied from the power supply is outside of the acceptable range on the high side.
Trouble Shooting Recommendation: Check the frequency of the current coming from the power supply to the processor is within the processors operating range while under a load. Output frequency should be **60Hz +/- 10Hz.** ***This can be done on IntegriFuse processors.***
Solution: Change Power Supply. *Make sure generators are calibrated annually.*

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 3.0!	**"FREQEr"**	N0_Frequency	Power supply frequency is irregular or has failed.	Freq Min & Freq Max

Meaning: Processor cannot function due to irregularities or a failure in the power supply's electrical frequency.
Trouble Shooting Recommendation: Check the frequency of the current coming from the power supply to the processor is within the processors operating range while under a load. Output frequency should be **60Hz +/- 10Hz.** ***This can be done on IntegriFuse processors.***
Solution: Change Power Supply. *Make sure generators are calibrated annually.*

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 4	**"LinLErr"**	N0_Voltage_IN	Power supply input voltage does not exist.	VLine Min

Meaning: Processor cannot function because the voltage being supplied to the processor does not exist.
Trouble Shooting Recommendation: Check the Voltage output on the power supply with a multi-meter or the Processor's meter function to make sure the power being supplied meets the Processors voltage input requirements. Check the breakers or relays and make sure they are all on and in in the correct position. Make sure that an adapter or pigtail is not being used to connect the processor to the power supply. Check the Processors power cord and make sure that plug has not been modified in any way. If an extension cord is being used, make sure it is not damaged in any way and that it is the recommended length and has the recommended wire gauge.
Solution: Change Power Supply

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 4.0!	**"LinLEr"**	Main_Voltage_Lo_Error	Power supply input voltage is too low.	VLine Min

Meaning: Processor cannot function because the voltage being supplied to the processor is outside of the required range on the low side.
Trouble Shooting Recommendation: Check the Voltage output on the power supply with a multi-meter or the Processor's meter function to make sure the power being supplied meets the Processors voltage input requirements. Some generators have outlets that supply both 120v and 240v through the same outlet. Check the breakers or relays for those outlets and make sure they are all in the correct position. Make sure that an adapter or pigtail is not being used to connect to the processor. Check the Processors power cord and make sure that plug has not been modified in any way. If an extension cord is being used, make sure it is the recommended length and has the recommended wire gauge.
Solution: Change Power Supply

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 4.1!	**"LinHEr"**	Main_Voltage_Hi_Error	Power supply input voltage is too high.	VLine Max

Meaning: Processor cannot function because the voltage being supplied to the processor is outside of the required range on the high side.
Trouble Shooting Recommendation: Check the Voltage output on the power supply with a multi-meter or the Processor's meter function. Some generators have outlets that allow you to supply both 120v and 240v through the same outlet. Check the breakers or relays for those outlets and make sure they are all in the correct position. Make sure the power supply is NOT a dual-purpose generator.
Solution: Change Power Source

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 20!	**"HTAErr"**	High_Temp_Error	Ambient temperature is too high	Temperature

Meaning: Ambient temperature is out of range and Processor cannot function because the outside (ambient) temperature is too high.
Trouble Shooting Recommendation: If the outside temperature is over 115 degrees F the processor will not be able to function without taking steps to reduce the temperature in the fusion area.
Solution: Protect the work site where the fusion is taking place with a tent in order to get to a suitable ambient temperature.

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 21!	**"LTAErr"**	Low_Temp_Error	Ambient temperature is too low	Temperature

Meaning: Ambient temperature is out of range and Processor cannot function because the outside (ambient) temperature is too low.

Trouble Shooting Recommendation: If the outside temperature is below -10 degrees F the processor will not be able to function without taking steps to increase the temperature in the fusion area.
Solution: Use of a tent, heaters and/or heating blankets may be required to get to a suitable ambient temperature.

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 23!	**"THTErr"**	Transfo_Temp_Error	Transformer temperature is too high	

Meaning: The internal temperature of the processor is too high.

Trouble Shooting Recommendation: Temperature of the processor's transformer is too high and internal protection disables the device.
Solution: Shade the processor and leave the processor on and allow the fan to dissipate the heat.

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 24!	**"ChsHTE"**	CHSS_Temp_High	Frame temperature is too high	

Meaning: The temperature of the processor chassis is too high.

Trouble Shooting Recommendation: Typically, due to heavy use of the control unit. Poorly ventilated work environment.
Solution: Turn processor off and wait until the frame chassis has cooled down. Placing it in a cooler environment may speed up the process.

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 30!	**"NLoadE"**	Load_Open_Error	Open Circuit in fitting	

Meaning: Indicates an open circuit in the fitting due to compromised contact or a break in the fusion coil. This error can be displayed anytime within the fusion cycle.

Trouble Shooting Recommendation: Make sure the terminal pin connections are tight and secure. Make sure you are using the correct size pin adapters. Check for oxidation, wear, or bad contact. Check for continuity across the fusion coil.
Solution: Check leads to make sure tips are not dirty, are correct size, and there is not oxidation on the tips or terminal pins. Replace the damaged or failed fitting.

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 32!	**"NLoadE1"**	Load_Measure_Error1	Resistance on the fitting is too low	Nominal Resistance & Measured Resistance

Meaning: Indicates the resistance measured across the fusion coil is too low or not within range. Possible sort circuit in fusion coil,

Trouble Shooting Recommendation: Check for continuity across the fusion coil. Make sure the terminal pin connections are tight and secure. Make sure you are using the correct size pin adapters. Check for oxidation, wear, or bad contact.
Solution: If no continuity across the fusion coil, replace the damaged or failed fitting

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 33!	**"NLoadE2"**	Load_Measure_Error2	Resistance on the fitting is too high	Nominal Resistance & Measured Resistance

Meaning: Indicates the resistance measured across the fusion coil is too high or not within range.

Trouble Shooting Recommendation: Can be caused by dirty or compromised contact between the fittings' terminal pins and the processor leads. Can also be caused by increased resistance in the fusion coil in a fusion attempt and the re-fusing is attempted before the coil reaches ambient temperature again. Can also be due to incorrect data in the fittings barcode.
Solution: Check the terminal pin contacts. Allow fitting to cool to ambient temperature if attempting to re-fuse the fitting in either barcode or Manual mode. Replace the fitting if defective.

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 34.0!	**"IoutEr"**	Out_Current_Error	Current output is not correct	IMin

Meaning: Indicates the current flow (amperage draw) from the processor to the fitting is not correct.

Trouble Shooting Recommendation: If the lead tips or terminal pin connections are too loose, an arc can be produced which will result in a sudden surge in amperage draw. This can cause create an open circuit in the terminal pin area or in the fusion coil. Check for continuity across the fusion coil.
Solution: Check for continuity across the fusion coil. Replace the fitting if defective.

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 34.1!	**"I2SCHE"**	Current_SCH_Error	Before the fusion: Current output request is higher than possible	IMax

Meaning: This error will manifest before the fusion attempt due to the fitting calling more current than is possible due to the electronic limitation settings.

Trouble Shooting Recommendation: Visually check the fitting for damage in the terminal pin and/or the fusion coil area that may have caused a short circuit. Damage could have been caused by rough handling, mishandling, improper storage and transportation related issues.
Solution: Check for continuity across the fusion coil. Replace the fitting if defective.

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 34.2!	**"I1SCHE"**	Out_SCH_Curr_Error	During the fusion: Current output request is higher than possible	IMax

Meaning: This error will manifest during the fusion attempt due to the fitting calling more current than is possible due to the electronic limitation settings.

Trouble Shooting Recommendation: Visually check the fitting for damage in the terminal pin and/or the fusion coil area that may have caused a short circuit. Damage could have been caused by rough handling, mishandling, improper storage and transportation related issues.
Solution: Check for continuity across the fusion coil. Replace the fitting if defective.

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 35!	**"VoutEr"**	V_Out_Error	Possible processor issue	

Meaning: An anomaly found in the processors output voltage due to a possible short circuit, an internal system overload or the power supply fuse being damaged.

Trouble Shooting Recommendation:
Solution: Contact Technical Support at 1 -770-632-7530

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 36!	**"LoadE3"**	Load_Measure_Error3	A difference between measured resistance and parameters	

Meaning: Indicates an unacceptable difference between the resistance parameters recorded in the barcode and those measured in the fitting.

Trouble Shooting Recommendation: Can be caused by increased resistance in the fusion coil if re-fusing of a fitting is attempted before it reaches ambient temperature. Can also be due to incorrect data in the fittings barcode and/or a manufacturing defect.
Solution: After the fitting cools back down to ambient temperature, you may try to re-fuse the fitting in manual mode, or you can replace the fitting.

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 38!	**"LoadSE"**	Load_SCH_Error	Short circuit during fusion process	

Meaning: Bad fusion joint

Trouble Shooting Recommendation: Typically caused by the rapid and excessive movement of molten material during the fusion process that is often associated with excessive gaps found in the fusion zone. (short-stab, mis-stab, misalignment, binding situations)
Solution: Replace the fitting

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 39.0!	**"VCtrEr"**	Control_Voltage_Error	Output voltage not stable	

Meaning: The voltage being supplied to the processor is not consistent or stable.

Trouble Shooting Recommendation: Check the generator and make sure that the throttle control is on "full". Ensure that any throttle control switches (econ mode, throttle control) are in the off position.
Solution: May need to replace the power supply

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 39.1!	**"VoutEr"**	Out_Voltage_Error	Output voltage out of limit	

Meaning: The voltage being supplied to the processor is not within limits. It is either too high or too low.

Trouble Shooting Recommendation: Check the generator and make sure that the throttle control is on "full". Ensure that any throttle control switches (econ mode, throttle control) are in the off position. A generator with a dirty voltage output can damage the Servo Card.
Solution: Connect to a stable power source or May need to replace the power supply. May need to check the Servo Card.

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 41!	**"GenErr"**	General_Error	General error due to unexpected conditions.	

Meaning: Fusion process experienced unexpected conditions

Trouble Shooting Recommendation: If this happens 3 times in succession contact technical support. 1-770-632-7530

Solution:

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 42!	**"SrvErr"**	Servo_Error	Generic error	

Meaning: The Processors Servo Controller assisting the welding is defective.

Trouble Shooting Recommendation: Shut off the device and restart.
Solution: If the problem continues, contact technical support. 1-770-632-7530

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 43!	**"SynkEr"**	Sync_Error	Generic error	

Meaning: Error associated with either calibration problems or electromechanical problems in the processor.

Trouble Shooting Recommendation: A defect in the Processors hardware has been detected.
Solution: Contact technical support. 1-770-632-7530

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 44!	**"HFCEr"**	HW_Servo_Error_FCTRL	Power Controller defective	

Meaning: A defect in the Processors hardware has been detected

Trouble Shooting Recommendation:
Solution: Contact technical support. 1-770-632-7530

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 45!	**"SwErr"**	SW_Error	Code error reception.	

Meaning: Possible defective internal communication or software error.

Trouble Shooting Recommendation: No solution. Shut off the device and restart. If message displays again,
Solution: Contact technical support. 1-770-632-7530

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 50	**"UsrStp"**	User_Stop_Error	Welding error	

Meaning: The user pressed the stop button during the fusion cycle**.**

Trouble Shooting Recommendation:
Solution: Wait for the fitting to cool to ambient temperature and re-fuse the fitting.

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 50!	**"UsrStp"**	User_Stop_Error	Welding Stop	

Meaning: The user pressed the stop button during the fusion cycle.

Trouble Shooting Recommendation:
Solution: Review installation instructions before restarting fusion.

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 70!	**"MemErr"**	Memory_Writing	Full Memory or DMS Failure	

Meaning:
Trouble Shooting Recommendation:
Solution: Contact technical support. 1-770-632-7530

Code	Fusion Report Message	Code Indication	Cause	Download Report Column
ERROR 80!		Weld Authorization		

Meaning: Welder must be authorized
Trouble Shooting Recommendation:
Solution: Authorize welder or change settings in the processor

Field Reporting Protocol & Information Requirements

In the event of experiencing an electrofusion issue and/or fitting failure in the field, you should contact **Integrity Fusion Products** as soon as possible, and immediately begin implementing the following Field Reporting protocol**. Integrity Fusion Products** requires specific types of information to be submitted in order for us to.:

- accurately assess the communicated issue,
- identify the specific problem(s),
- begin and complete a root/cause analysis,
- provide an accurate answer and/or implement a corrective action if needed

In order for **Integrity Fusion Products** to accomplish this; it is imperative to have relevant data gathered and communicated back to us, in a format that we can use so that an accurate assessment can be made and a response given in a timely manner.

Start Taking Pictures

Describing electrofusion problems over the phone is confusing, difficult, and incomplete at best; that is why we are asking for pictures to be taken. It has been often said that "a picture is worth 1,000 words", and such is the case when it comes to documenting electrofusion issues in field applications. Pictures will help us see more of what is being said to us and it will provide us with a context to help us more readily visualize possible problems and/or solutions.

The pictures we are requesting you take and submit, along with the field report we will send to you when you call, will help us evaluate not only the fitting being used - but also the specific electrofusion application it is being used in. It will also help us evaluate the overall installation procedure being followed as well.

Filling out the Fitting Failure & Incident Report & RMI

When you call in to report your electrofusion issue/fitting failure, your Customer Service Representative will ask you a few questions and while talking to you on the phone will fill out a brief questionnaire. They will give you an RGA number for tracking purposes and then they will send you an electronic copy of a Fitting Failure & Incident Report & RMI form **(Return Material for Inspection)** to fill out and send back. This report needs to be filled out completely and accurately. The RMI provides us with information about the customer:

- **Company Name & Location**
- **Customer Contact**
- **Contact Phone Number & E-mail**
- **Who the Integrity Fusion contact is**
- **Details about the fitting in question; Product #, Description, Qty. Original PO#, PO Date**
- **A brief description of the problem**
- **Date & Time of Installation**
- **Location(s) of Installation**
- **Installers' Certification # and Issuer**
- **Fitting Type, Size, SDR**
- **Operating Pressure**
- **Test Pressure – Type of test, pressure peak, pressure duration**
- **Processor Used – Mfg., Model #, Serial #**
- **Scanned Bar Code Mode, Manual Mode**
- **Power Source – Brand, Model, Size**
- **Jobsite Information – (Gas, Water, Sewer, Oilfield, etc.)**
- **Weather Conditions**
- **Scraping Device Used**
- **Cleaning Solution Used**
- **Brand of Re-Rounding Tools Used (if applicable)**

You will then be asked to provide a brief recap of the fusion, describing pipe preparation, joint assembly and description of the problem.

You will need to have a USB drive available and download a copy of the fusion data to print off and attach it to the filled-out form when you send it back. Please provide as much detail as you can.

Types of pictures we are asking for:

Pictures of the Jobsite – to help us determine if environmental concerns such as excessive dust, heat, cold, rain, snow, flowing water etc., are contributing to the electrofusion issue.



Pictures of the Fitting – to help us determine if there is any apparent problem with the fitting itself or with the fusion coil. It still may be necessary to send the fitting back in to us, but pictures go a long way in helping us in the early stages of investigation.



Pictures of the Fitting Label & Fitting Time Stamps – Gives us specific information about the fitting and when it was produced that way, we know exactly what fitting we are dealing with.


Pictures of the Scraper Used & Picture of Area Scraped – This show us whether or not the proper scrapping tool was used or not and if it visually removed enough material in the fusion zone.

Pictures of the Cleaning Solution Label – We have to be able to confirm that an Isopropyl Alcohol cleaning solution of 90% or greater with no additional additive was being used.

Pictures of the Power Supply & Processor Plug End Configuration – This will help us confirm that the proper sized power source is being used as well as sowing us that the Processor Plug End has not been modified in any way.

Pictures of the Electrofusion Processor & Error Code – if possible

Destructive Testing for Electrofusion Fitting Qualification

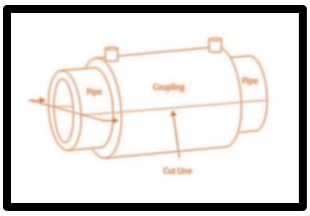
Destructive testing requirements for installer qualification and certification for **Integrity Fusion Products Level1** (L1) small diameter electrofusion fittings are conducted in compliance with guidelines specified in Plastic Pipe Institute; ***MAB Generic Electrofusion Procedure for Field Joining of 12 Inch and Smaller Polyethylene (PE) Pipe; First edition approved by Municipal Advisory Board on Nov. 5, 2015, in Casselberry, FL.***

The following test methods are useful as an evaluation of bonding strength and fusion quality between the pipe and fitting. These procedures are based on requirements from ASTM F1055 Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing Fusion Evaluation Test section. Refer to ASTM F1055 for more detailed test requirements. These tests can be used as user qualification criteria as defined in DOT CFR 49 Part 192.283 and 192.285. As these methods are destructive, they are only useful in determining joint quality of a fitting that was fused for the purpose of testing and cannot be used for testing of fusions intended for service.

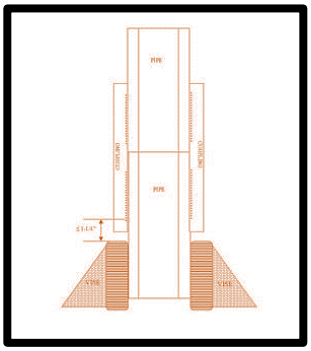
Couplings:

After all relevant information is gathered, the fitting should be cut and subjected to joint evaluation tests. Bend tests, peel tests, and crush tests are helpful in locating fusion weaknesses. It is desirable to obtain x-ray photographs of the fitting before dissection to locate any possible contact points of the fusion coil.

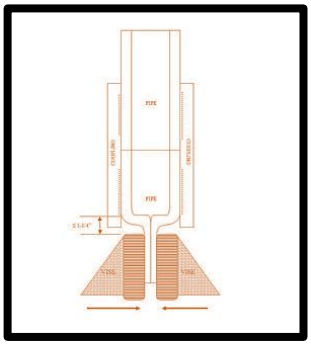
- To prepare a specimen for crush testing, it is necessary to cut the pipe and coupling longitudinally in half as near to the centerline of the pipe and coupling as possible. It is desirable to leave at least 3"(75mm) to 5"(125mm) of pipe length at each end of the coupler.



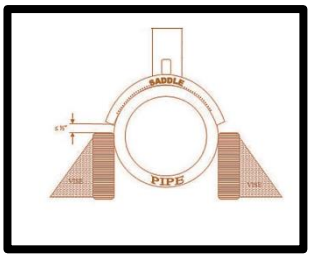
- Place a specimen half in a vise so that the outermost wire of the fusion zone is approximately 1 1/4" (32mm) from the vise jaws.



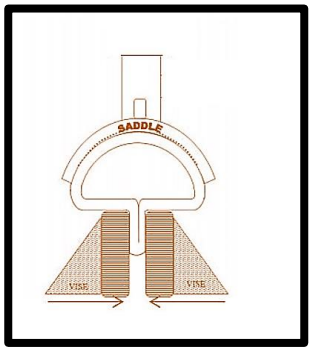
- Close the vise jaws until the pipe walls meet. Repeat this process for each end of both halves of the coupling. Inspect the crushed specimens for separation of the pipe and fitting in the fusion zone. Some minor separation, up to 15%, may be seen at the outermost region of the fusion zone, this does not constitute failure. Ductile failure of the pipe, fitting, or PE insulation around the wires is acceptable. **There should be no separation at the fusion interface of the pipe and fitting.**



Saddles



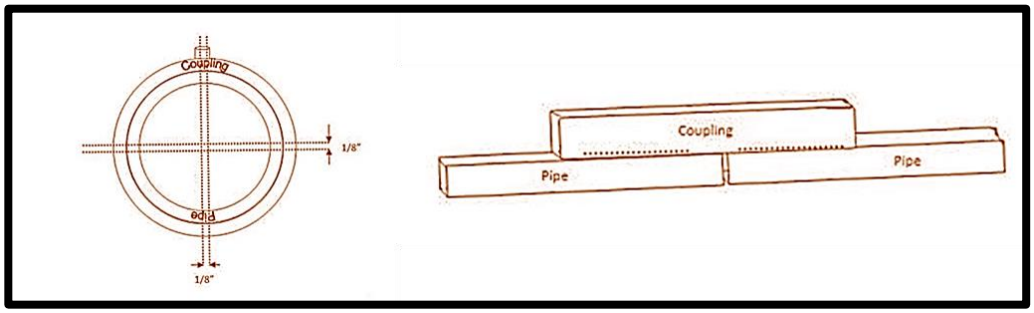
- Saddle Fittings should be left intact for crush testing. Pipe lengths can be cut to the edges of the fitting base. Place the pipe and fitting into a vise (or suitable press) so that the jaws are within 1/2" (13mm) of the bottom of the saddle.



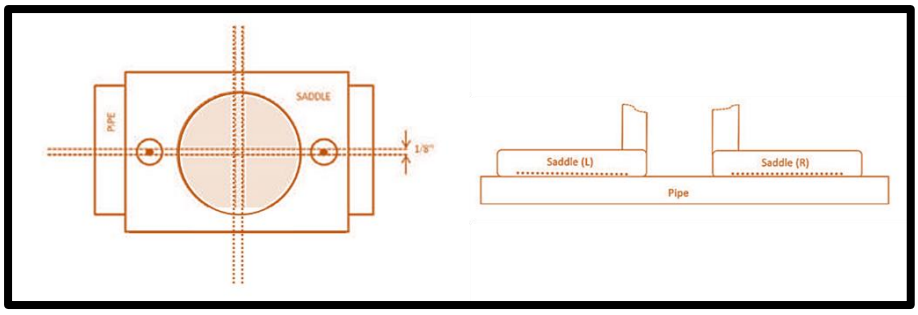
- Close the vise until the pipe walls meet. Inspect the crushed specimens for separation of the pipe and fitting in the fusion zone. Some minor separation (up to 15%) may be seen at the outermost region of the fusion zone, this does not constitute failure. Ductile failure of the pipe, fitting, or PE insulation around the wires is acceptable. **There should be no separation at the fusion interface of the pipe and fitting.**

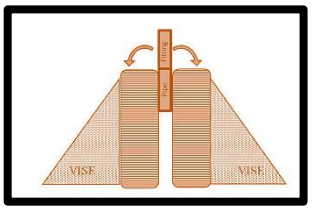
Further evaluations are possible by cutting the fusion area and surrounding pipe and fitting materials in thin longitudinal /cross sectional strips for bend tests. The strips are then placed into a vise and bent 90 degrees in both directions directly at the fusion interface and evaluated for separation. The same visual criteria are used for fusion evaluation tests as is used for crush tests.

- Couplings should have four longitudinal strips cut from the fusion interface at 90° intervals as shown. The strips should be approximately 1/16"(1.5mm) to 1/8"(3mm) in thickness



- Tapping Tees should have strips cut along the center line of the pipe (Fig. XIV-k) through the fitting fusion surface and a strip cut from the radial side of each half of the fitting, totaling 4 strips for each sample fusion made.





- The strips are then placed into a vise and bent 90 degrees in both directions directly at the fusion interface and evaluated for separation. For small specimens pliers may be used in lieu of a vise as long as the entire length of the fusion is flexed.

Separation of the specimen along the bond line constitutes failure of the specimen. Some minor separation at the outer limits of the fusion heat source may be seen or there may be voids between wires. This does not constitute failure as long as the void does not exceed 10% of the total fusion length, or in the case of multiple voids, 20% of the total fusion length when combined. Ductile failure in the pipe, fitting, or the wire insulation material is acceptable as long as the bond interface remains intact.

Training & Requalification

Required Re-Qualification and Retraining Failed electrofusion joints determined to be caused by improper installation procedures may warrant retraining and/or qualification of the installer. If an operator has failed electrofusion joint(s) under the provision previously listed or is observed using non specified or faulty equipment or not strictly adhering to all fusion procedures that operator will be disqualified from making additional electrofusion joints and will require additional training and requalification before performing any additional fusion joining.

Test Result and Qualification Test Certificate

- The operator shall be presented with a completion certificate (or card) upon successful completion of the Integrity Fusion Electrofusion Operator and Training & Qualification Test.
- Valid for two years from date of issuance.
- Operator cannot miss any questions on the written test.
    - Operator who misses two (2) questions or less can re-address the specific questions with the trainer and re-take written test in its entirety.
    - Operator who misses more than two (2) questions must re-take both the written and re-submit two (2) additional test specimens for destructive testing.
    - Operators must pass the destructive testing on all submitted electrofusion joints.
- Qualification Test Certificate
    - Certificate shall contain the following:
        - Operators Full Name
        - Date, Place of Training
        - Date of Issue
        - Expiration Date of Test Certificate
        - Signature of Authorized Trainer
- Failed electrofusion or written Test
    - Operator shall undergo further education and training prior to re-taking the qualification test.