MTD
ELECTROFUSION SYSTEM
Training & Installation Manual

ISCO®

www.isco-pipe.com | 800-345-4726

NOTICE

Any operation involving work on pipe containing liquids or gases under pressure is potentially hazardous. To ensure a safe working environment, always follow proper procedures including those available from the equipment manufacturer and your company.

No person is authorized to make plastic pipe joints for natural gas service unless that person has been qualified through training, assembling, fusing and testing specimens in accordance with 49 CFR 192.285.

It is the responsibility of the operator to establish a method to determine that each person making joints in pipelines in their system is qualified to make those joints.

This manual does not serve to replace but should be used as a supplement to hands-on training. This manual is not intended to be used for system design purposes and does not take the place of the advice of a professional engineer.

Should any issue or difficulty arise while operating this equipment, contact MTD.

Edition 23R0

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SAFETY

OVERVIEW

JOINING PROCEDURES FOR SOCKET-TYPE FITTINGS

JOINING PROCEDURES FOR SADDLE-TYPE FITTINGS

APPENDIX

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Safety

Safety Alerts

Various safety alerts appear in this manual. When you see one of the below safety alerts, YOUR SAFETY IS AT STAKE.

⚠ DANGER ***Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.***

⚠ WARNING ***Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.***

⚠ CAUTION ***Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury. Also used to indicate restrictions***

Proper Grounding

Polyethylene pipe often creates internal and external electrostatic charges that can be hazardous to personnel and equipment, particularly in dry conditions. When pipe is excavated, take steps to ensure the surface of the pipe and equipment are effectively 'grounded' or 'earthed' to prevent the potential of static arcing which could result in ignition of natural gas when present. The following are effective ways to dissipate static charges on exposed PE pipe:

- *Use an earthed wet tape conductor laid in contact with the entire length of exposed pipe surface, interrupted only where work must be performed.*
- *Periodically re-dampen wet tape conductors with a very dilute water and detergent solution to maintain electrical conductivity.*
- *If ambient conditions are below freezing, add antifreeze (glycol) to the water solution to prevent freezing.*
- *Use a purpose-designed electrically conductive tape such as 3M 9707, applied to the entire length of exposed pipe and connected to a metallic grounding pin driven into the ground.*

⚠ WARNING ***Do not vent natural gas through any non-grounded section of plastic pipe. This can cause rapid buildup of static charge and/or arcing which can lead to ignition.***

Material Storage & Shelf Life

All MTD molded fittings have an unlimited shelf life, so long as they are stored in a warehouse environment and out of direct sunlight. Storage conditions should ensure that fittings on lower levels are not crushed by fittings above. This loading can cause deformation to occur on large diameter socket fittings, and especially saddle fittings. Fittings should be kept in the original sealed packages until time of installation. Do not allow packages of fittings to be stored outside, or to become wet. Take care to ensure FIFO inventory management practices are in place to reduce unnecessarily long storage cycles for your on hand fittings.

Read & Understand

All persons intending to make joints on plastic pipe systems using the MTD electrofusion system should study and become familiar with the contents of this manual prior to conducting field operations, even if they have been previously qualified to make joints.

Your safety and the safety of others around you depends upon your judgment and care in the operation of this and any additional equipment.

Follow all applicable federal, state, local and industry-specific regulations pertaining to these products.

General Safety

This manual does not purport to address every possible circumstance that might involve a potential hazard. The warnings in this manual and on the products are not all-inclusive.

This manual does not include procedures for excavation, evacuation of water, trench shoring or other work site tasks. Refer to and follow all applicable company procedures, local and industry regulations regarding work site safety.

Be aware of anything unusual during set up or operation:

LISTEN *for thumps, bumps, rattles, squeaks, leaks or other unexpected sounds.*

SMELL *odors like burning plastic, hot metal, or natural gas.*

FEEL *any unexpected changes in the way the equipment operates.*

SEE *problems with equipment, loose bolts or fittings, partially open valves, etc.*

REPORT *anything you see, feel, smell or hear that is different from what you expect or that you think may be unsafe.*

Wear a hard hat, safety shoes, safety glasses and other applicable personal protective equipment (PPE).

Remove jewelry and rings. Do not wear loose-fitting clothing. Tie back long hair that could get caught in tools or obstruct your vision.

Do not position yourself or any other personnel under supported or raised pipe. Pipe is heavy and could fall unexpectedly.

Do not leave equipment with unauthorized personnel. Do not allow any unauthorized personnel to operate this equipment.

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Overview

Introduction

For over 30 years, electrofusion has proven to produce repeatable, high-quality joints in plastic piping systems. Many ASTM specifications and methods have been published and maintained, providing a reliable backdrop to this joining practice. The steps contained in this manual have been proven through destructive testing, nondestructive testing and field use to yield strong, consistent, gas-tight joints in PE piping systems when working with the MTD line of electrofusion products. There are two primary types of electrofusion fittings: Socket and Saddle. Socket fittings include couplings, reducers, elbows, end caps, three-way tees, etc. Saddle fittings include branch saddles, tap tees, repair saddles, etc. This manual will provide steps to address the installation of both types in main sizes ½"CTS through 16"IPS.

This manual provides written procedures which have been qualified pursuant to 49 CFR 192.283, and when followed satisfy requirements of 49 CFR 192.273(b).

MTD does not purport to address every possible combination of field environment variables, and as such makes no guarantee of fusion joint results and assumes no liability.

About MTD Electrofusion Fittings

MTD electrofusion fittings are molded from black PPI-listed virgin PE4710 HDPE resin. All MTD fittings are equipped with 4.7mm fusion terminals with embedded identification resistors. This resistor enables MTD fittings to be fused in 'dedicated' mode in addition to barcode and manual modes.

The fitting identification barcode contains basic information about the fitting for the purpose of identification, as well as electrical information which instructs the processor how to fuse the fitting.

The white fusion barcode (ISO 13950 Compliant) is scanned by the fusion machine and defines the fusion parameters for each fitting. All MTD fittings are labeled to include temperature compensation. The lot number of the fitting is the first four digits of the string of numbers to the top right of the barcode, in this example "2109"

WARNING ***Never scan a fusion barcode of any fitting other than the fitting to which the control box is connected, whether similar or identical. This could result in improper fusion parameters being calculated by the control box and applied to the fitting.***

The yellow traceability barcode can be scanned by any device which supports the ASTM F2897 traceability program, and contains detailed traceability information about the fitting including date of manufacture, material, size, etc.

MTD fittings are individually sealed in plastic bags which help prevent contamination and damage during storage. All packaged electrofusion fittings should be stored indoors, out of direct sunlight.

Testing & Conformance

The MTD family of electrofusion fittings are manufactured, sampled, tested and labeled in accordance with applicable material standards including but not limited to the following:

- **Materials: ASTM D3350** - *Standard Specification for Polyethylene Plastics Pipe and Fittings Materials*
  All fittings are molded from PPI-Listed PE4710 (Cell Classification 445574C, Black, High Density)
- **Design: ASTM D2513** - *Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings*
  All fittings meet dimensional requirements to ensure compatibility with PE piping systems.
- **Performance: ASTM F1055** – *Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing*
  All fittings are subject to a wide battery of validation and production tests which include hydraulic burst, long-term static pressure, tensile strength, melt flow index, chemical resistance and more.
- **Traceability: ASTM F2897** - *Standard Specification for Tracking and Traceability Encoding System of Natural Gas Distribution Components (Pipe, Tubing, Fittings, Valves, and Appurtenances)*
  All fittings include yellow barcode labels which comply with traceability requirements for integration with GIS / Data Acquisition Systems.
- **Fusion Parameters: ISO 12176-2** - *Plastics pipes and fittings—Equipment for fusion jointing polyethylene systems — Part 2: Electrofusion*
  All fittings include white barcode labels which can be read by any universal electrofusion control box to set fusion parameters including temperature compensation.
- **Fusion Parameters: ISO 13950** – *Plastics pipes and fittings — Automatic recognition systems for electrofusion joints*
  All fittings include embedded identification resistors which can be read by electrofusion control boxes which support automatic or 'dedicated' fusion modes.

Fitting Parameters

Parameter	Value
Operating Temperature Range	*10˚F to 120˚F*
Compatible Materials	*PE4710, PE3408, PE2708, PE2406*
Short Stab Sensitivity	*20% Δ resistance over 5 seconds*
Operating Pressure Range	*DR 11 / 125psi Gas / 200psi Water*
Fusion Mode[1]	*Barcode, Dedicated or Manual*

WARNING ***Hydrocarbon permeation causes significant reduction in fusion performance and joint integrity for electrofusion joints. Unless otherwise specified, MTD fittings are not intended for fusion of hydrocarbon permeated pipe. Refer to ASTM D2513 Appendix X.1 for additional guidance regarding hydrocarbon permeated pipe.***

1 *MTD Recommends fusing in barcode mode whenever possible.*

Power Sources

A stable, appropriately sized power source is an important factor in fusing electrofusion fittings. Ensure power sources (generators, inverters, batteries, etc.) are inspected and maintained per manufacturer's guidance to ensure expected performance.

- *Inverters may or may not be acceptable power sources for some processors. Consult your processor's manufacturer to verify whether inverters are compatible with your processor.*
- *Generators must have an adequate power output and outlet circuit breaker to provide energy to an electrofusion processor. Consult your processor's manufacturer to determine minimum generator requirements.*
- *If using a battery-powered processor, ensure there is adequate charge remaining in the battery pack for fusion prior to use.*
- *If using a generator, always ensure there is adequate fuel to run the generator for the time needed to complete fusion.*
- *'Pigtail' power adapters may or may not be acceptable for use with your processor. Consult your processor's manufacturer to verify whether pigtails are acceptable for use with your processor.*

In many field cases, the use of extension cords may be required. The following list of extension cord requirements has proven adequate in most situations, but always consult your processor's manufacturer for guidance specific to your processor:

Cord Length	Minimum Wire Gauge
Up to 25 ft.	*12*
Up to 50 ft.	*10*
Up to 100 ft.	*8*

Clamping

All electrofusion joints should be clamped. During the fusion cycle, heat inside the joint causes material expansion and results in significant pressure. Clamping electrofusion joints serves three important purposes:

1. *Clamps prevent fittings from moving out of their intended position during the fusion process.*
2. *Clamps transfer bending stresses away from the fitting, especially with coiled pipe.*
3. *Clamps can aid in re-rounding oval pipe.*

WARNING ***Never attempt to restrain any fitting by hand. Pressing pipe into a fitting by hand causes the pipe to wrinkle / deform and pull away from the fitting. This will result in a failed fusion joint.***

WARNING ***In the event of a melt-out joint failure, extremely hot molten plastic may be violently ejected from the fitting interface. Always stand clear of clamps and fittings during the heating cycle, and never closely observe the edge of a fitting during fusion.***

Re-Fusion

NOTICE *Although MTD provides guidance for re-fusion, not all operators allow it. Do not proceed with re-fusion if your company's procedures prohibit it.*

MTD electrofusion fittings can only be re-fused if the original fusion cycle suffered a power interruption. Power interruptions include:

- *Processor leads are accidentally unplugged from fitting during fusion cycle.*
- *Generator runs out of fuel during fusion cycle.*
- *Battery powering processor dies during fusion cycle.*
- *Operator accidentally pressed emergency stop button on processor during fusion cycle.*

⚠WARNING ***Fusions that experience any error other than power interruption during fusion should never be re-fused and should either be removed from the system or abandoned in accordance with the system operator's procedures.***

If re-fusion is considered viable, take the following steps to re-fuse the fitting.

1. *Ensure the fitting has not moved, and the clamping device holding the joint has not been removed or repositioned. If the joint has moved or if the clamping device has been removed or repositioned, do not re-fuse.*
2. *Allow the joint to cool completely to ambient temperature. The joint must be completely cooled throughout. Published cooling times are not sufficient and must be exceeded. In most cases, when the pipe surface temperature is within 5˚F of the fitting surface temperature, the joint is cooled sufficiently for re-fusion.*
3. *Once cooled, reconnect processor and re perform entire fusion cycle.*

Cooling Times

Cooling MTD fittings is a two-stage process which consists of 'Clamping Time' and 'Rough Handling Time'.

1. *Clamping time is the amount of time that the clamping tool must remain on the joint. This phase of cooling allows the pipe and fitting materials to co-crystallize into a single structure.*
2. *Rough handling time is the amount of time that must pass before backfilling, pressure testing, tapping, etc. This phase of cooling allows the joint material to harden to the point where it is as strong or stronger than the pipe itself, and can stand up to stresses induced by rough handling.*

The cooling time printed on and molded into MTD fittings is 'Clamping Time'. For 'Rough Handling Time', double the printed time on socket fittings, and triple the printed time on saddle fittings.

NOTICE *In most cases, electrofusion operators do not have multiple sets of clamping tools available at the time of installation. Due to this, the operator should be able to remove a clamping tool so that it may be used on another joint. This is the reason for the two-stage cooling process. Observing clamping time allows the tool to be removed as soon as possible after the heating cycle has been completed.*

⚠WARNING ***Never force joints to cool by any external method such as dousing with water. Cooling an electrofusion joint too quickly will cause the material to become brittle and will drastically reduce joint integrity.***

Pipe Ovality

Ovality is a critical factor affecting electrofusion joint integrity. Electrofusion fittings require a certain amount of gap between the pipe surface and fitting. During fusion, this gap is filled as the molten plastic expands. If the pipe is oval or out of round and the gap is too big, the surface of the pipe may not properly contact the fusion zone of the fitting. This can result in electrofusion failures including ejection of molten plastic and/or wire from the joint, and smoking from inside the fitting.

MTD fittings are designed to be fused to pipe under 5% oval[1].

- *For 3" and smaller pipe, ovality must not exceed 5%. Generally, applying clamping tools when installing the joint will bring oval pipe within requirements at the time of installation.*
- *For coiled pipe sizes larger than 3", the pipe should always be processed through re-rounding equipment prior to electrofusion joining to ensure ovality is kept below 5%.*

To determine percent ovality:

1. *Take a minimum of 4 measurements of pipe diameter using a Vernier caliper or a measuring tape. Record these 4 values.*
2. *Calculate the average diameter using the measurements from step 1 above.*
3. *Calculate percent ovality as follows:*

$$\%Ovality = \left[\frac{d1 - d2}{d_{avg}}\right] 100$$

Where: d1= "Largest Measured Diameter"
d2= "Smallest Measured Diameter"
d_{avg}= "Average Diameter"

1 *Refer to ASTM D2513 for additional guidance on pipe ovality.*

Pipe Surface Removal (Peeling / Scraping)

Insufficient pipe surface removal is a leading cause of field fusion issues with electrofusion fittings. Surface oxidation is inherent to the polyethylene pipe extrusion process, and must be removed prior to electrofusion joining. MTD recommends the use of tools which 'peel' the pipe. Tools that 'scrape' the pipe are not recommended.

- *Always use an approved tool to remove pipe surface oxidation.*
- *Do not use abrasives or files to remove pipe surface oxidation.*
- *A minimum of 0.007" of pipe surface must be removed to ensure absence of oxide layer, about the thickness of two sheets of ordinary copy paper.*
- *Multiple peeling passes may be required to achieve proper fit when pipe is out of round (under 5%).*
- *Ensure peeling tools are inspected and maintained in accordance with manufacturer's recommendations. Consult manufacturer for expected peel depth, and periodically measure shavings / ribbons with a Vernier caliper or anvil micrometer to ensure tool is performing as expected.*

⚠WARNING ***Never remove more than 10% of the pipe's original wall thickness. If gouges or scrapes in the pipe are too deep to be removed during preparation, ensure they are thoroughly cleaned and free of debris or contamination. Gouges / scrapes in pipe may cause fusion failures or leaks. Any pipe with gouges deeper than 10% of the pipe wall thickness must be cut out and replaced.***

Solvent Cleaning

Cleaning the pipe and fitting surfaces with solvent ensures that no moisture or contamination is present which could prevent the joint from fusing properly. MTD recommends using lint-free premoistened alcohol wipes, but alcohol and a cloth may also be used.

- *Ensure cloth is clean and free of lint, dyes, pigments and moisture.*
- *Lint-free, dye-free paper towels may also be used in place of cloth.*
- *Use a new prepackaged wipe, new paper towel or clean portion of cloth for each successive cleaning step.*
- *Always use 90% or higher concentrated isopropyl alcohol.*
- *Always make sure alcohol is totally evaporated from pipe and fitting surface before installation.*
- *Research shows acetone is a suitable alternative to alcohol, however validation testing has been performed using Alcohol, which is the preferred solvent for joining MTD electrofusion fittings.*

⚠ CAUTION ***Use of solvents other than isopropyl alcohol or acetone should be avoided. Use of any solvent other than isopropyl alcohol is at the installer's own risk.***

⚠ CAUTION ***Lower concentrations of alcohol contain more water. This water may freeze to pipe in cold weather, or may not completely evaporate prior to fitting the joint. Remaining water in an electrofusion joint will usually cause joint failure which may be immediate or delayed.***

Freezing Weather Precautions

When local ambient temperature falls below freezing (32˚F / 0˚C), additional precautions should be taken into consideration.

Take care to ensure water is not freezing to pipe surface during initial cleaning steps when pipe surface temperature falls below freezing.

1. *Fusing fittings in barcode fusion mode enables the processor to add extra fusion time in cold weather. Although this is not a requirement for MTD fittings, it is recommended for increased confidence in joint integrity.*
2. *Alcohol should not be applied directly to pipe in freezing weather. The evaporative cooling effect of alcohol can act to further lower the temperature of the pipe's surface and cause the moisture content in the alcohol to freeze to the pipe.*
3. *Take extra care to ensure alcohol and moisture are evaporating completely from pipe surface and fitting surface during installation.*
4. *Never pre-heat an electrofusion processor in a vehicle or building prior to performing fusion. Electrofusion fittings and processors are both rated for safe, reliable operation within a certain temperature range. Falsely elevating the temperature of the processor may also cause fusion time to be adjusted incorrectly which may result in fusion failure.*
5. *If possible, remove mud, dirt and debris from pipe surface using mechanical means rather than applying water. Any introduction of water to the pipe surface gives opportunity for ice to form on pipe surface.*

Required Equipment

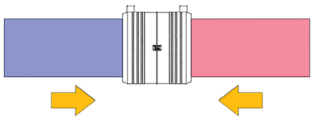
The following tools and equipment are necessary for preparation and installation of electrofusion fittings:

- **Marker**
  A properly functioning, petroleum-free, non-greasy, fast-drying marker. A Sharpie® or similar marker of contrasting color is recommended. If using a paint marker, take care to not over mark the area close to the fitting, and ensure all marks are completely dry.
- **Cutter**
  A tool capable of making square cuts on plastic pipe. It is best practice to use tools made specifically for cutting plastic pipe.
- **Peeler**
  An approved tool purpose-designed to peel away the top layer of pipe surface.
- **Solvent**
  At least 90% concentrated isopropyl alcohol in a prepackaged wipe or with a clean, lint and dye free cloth.
- **Processor**
  An approved electrofusion control box or 'processor'.
- **Clamps**
  Approved electrofusion clamping and restraint tools or methods for each size and type of fitting to be installed.
- **Power Source**
  A reliable power source capable of providing the energy required by your electrofusion processor.
- **Tape measure, Caliper or Pi Tape**
  Tape measures will be used to take measurements and make marks for stab depth. Calipers and pi-tapes are useful in measuring and calculating pipe ovality, wall thickness and DR when in question.
- **Square, Angle Ruler or T-Bevel**
  A square, angle ruler or T-Bevel can be used to verify whether cut ends of pipe are square or not.

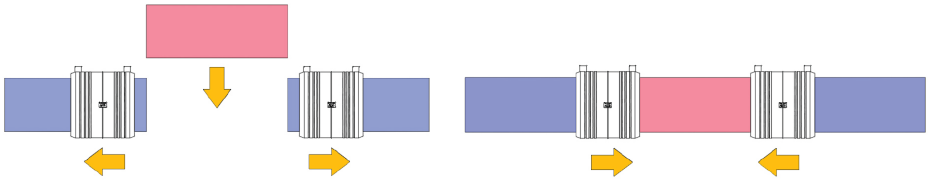
Socket Joint Types

The steps in this manual for joining socket-type fittings are broken into two sections: Running Joints and Slip Joints.

A running joint is required when working with new construction and the pipe being fused is free to move. Examples of running joints are new service lines being installed or new transmission lines being fused together.



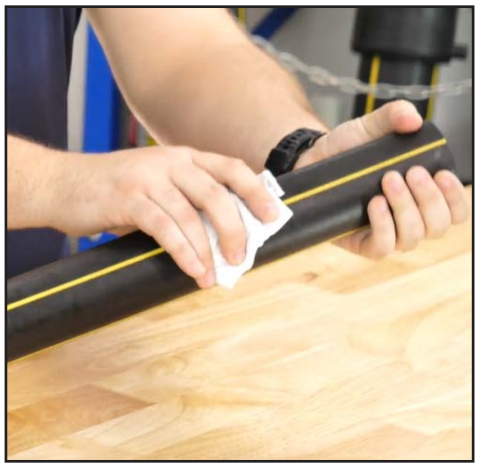
A slip joint is required when working with existing pipe where a section is being added, and the pipe is not free to move. Examples of slip joints are valve cut-ins and installations of repair sections to damaged pipe.



Joining Procedures for Socket-Type Fittings

STEP 1: Wash Pipe - 3x

Wash pipe with water and a cloth to remove mud, dirt, etc. Do not use soap or detergent. The length of the washed zone should be 3 times the length required by the fitting. Ensure contaminants will not be introduced in future steps. Repeat this step for both segments of pipe to be joined.



STEP 2: Prepare Pipe Ends

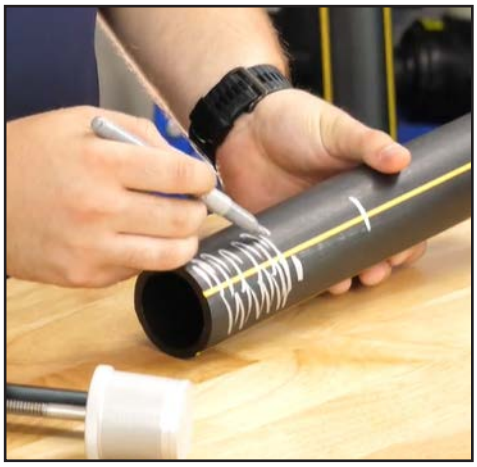
Both pipe ends must be cut relatively square, within 5˚. Remove any burrs or shavings created during cutting. If installing new pipe, it may be helpful to cut pipe back from end to remove toe-in.

STEP 3: Clean Pipe - 2x

Use alcohol to clean an area of pipe at least double (2x) the length required by the fitting. This step helps avoid introduction of contaminants to the pipe surface revealed during peeling. Repeat this step for both segments of pipe to be joined.

NOTICE *Refer to solvent cleaning requirements on page 17. Recommended: 90%+ isopropyl alcohol.*

STEP 4: Set and Mark Fusion Area



Make a distance mark on the pipe equal to the stab depth of the fitting plus one inch. Do not remove the fitting from its bag. Filling inside these distance marks with cross-hatched witness marks can help give visual indication that your peeling tool is removing adequate material. Repeat this step for both segments of pipe to be joined.

NOTICE *All MTD socket-type fittings include a molded stab depth mark on the exterior of the fitting. This mark indicates how far the pipe needs to be inserted into the fitting. This mark can either be aligned with the pipe edge, or can be measured with a tape to determine stab depth marking distance.*

STEP 5: Peel Pipe

Using your pipe preparation tool, remove the top layer of pipe surface up to the distance mark made in the previous step. Make sure all witness marks are removed, and the ribbon from your tool is continuous and about as thick as two sheets of ordinary copy paper. Repeat this step for both segments of pipe to be joined. DO NOT USE hand scrapers.

STEP 6: Clean Pipe - Final 1x Pass

Use appropriate solvent to clean the area that was peeled in the previous step. Make sure to wipe only inside the peeled area, not beyond. This helps avoid dragging contaminants from the unpeeled area to the peeled area. Repeat this step for both segments of pipe to be joined.

NOTICE *Refer to solvent cleaning requirements on page 17. Recommended: 90%+ isopropyl alcohol.*

⚠WARNING ***Ensure alcohol and moisture have completely evaporated, and surface of pipe is dry before continuing.***

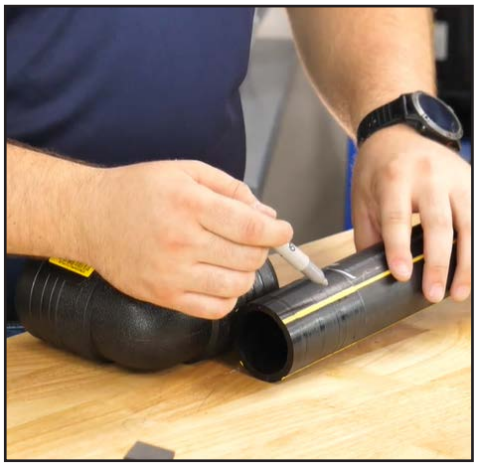
STEP 7: Clean Fitting

Remove fitting from packaging and use alcohol to clean the fusion area inside the fitting socket. Although the fitting has been in its original package, cleaning the inside of the fitting is a simple step to help ensure successful fusion and joint integrity. Take care not to touch the inside of the fitting socket with anything other than the cleaning cloth or wipe.

NOTICE *Refer to solvent cleaning requirements on page 17. Recommended: 90%+ isopropyl alcohol.*

⚠WARNING ***Ensure alcohol and moisture have completely evaporated, and fitting socket is dry before continuing.***

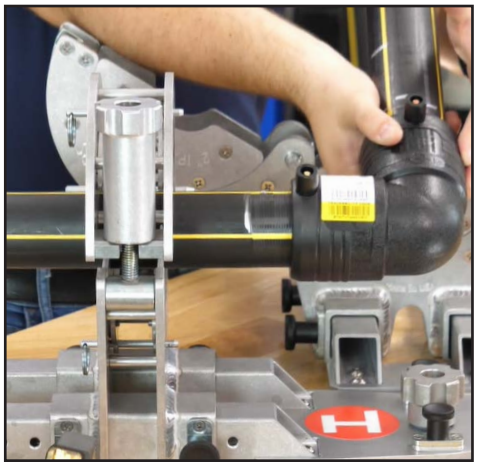
STEP 8: Re-Mark Stab Depth



Use the stab depth mark on the fitting, or take a measurement to properly mark the stab depth on the peeled section of pipe. Take care to mark this length as accurately as possible. The more accurate the stab depth mark, the less likely the joint will experience a short-stab or misalignment failure. Repeat this step for both segments of pipe to be joined.

⚠WARNING ***Avoid touching the prepared pipe surface. Introduction of contamination to pipe surface after peeling and cleaning can result in failed fusion.***

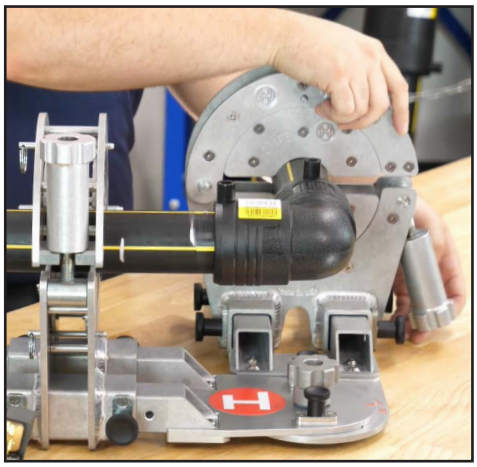
STEP 9: Fit Joint



Slip pipe ends into fitting until fully stabbed. Use stab depth marks made in previous step to help ensure pipe ends are fully stabbed and situated within the internal cold zone of the fitting.

STEP 10: Clamp Joint

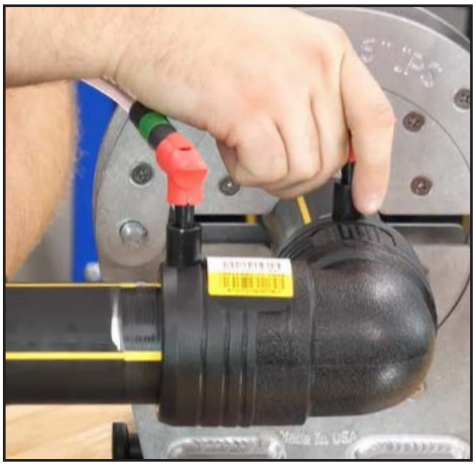
Install your approved clamping device around the joint. Ensure fitting has not moved away from the stab depth marks. Clamp should hold pipe still, providing force into the joint.



WARNING ***Never attempt to restrain any fitting by hand. Pressing pipe into a fitting by hand may cause the pipe to wrinkle / deform and pull away from the fitting. This will result in a failed fusion joint.***

STEP 11: Energize Fitting

Follow your processor manufacturer's instructions to energize and fuse the fitting to the pipe.



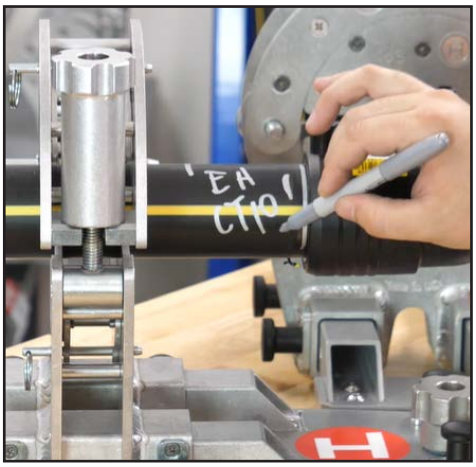
NOTICE *When utilizing ID resistor for fusion, ensure processor leads are attached correctly in accordance with manufacturer's instructions.*

WARNING ***Never scan a fusion barcode of any fitting other than the fitting to which the control box is connected, whether similar or identical. This could result in improper fusion parameters being calculated by the control box and applied to the fitting.***

STEP 12: Verify and Mark Pipe

Visually inspect joint for inconsistencies or anomalies.

On the pipe surface, write the operator's initials, time of day heating cycle was completed, clamping time and rough handling time on the pipe. See the following steps for identifying clamping and rough handling times.



STEP 13: Cooling Phase I - Clamping Time

Allow joint to remain in the clamp and cool for the time specified on the fitting label and molded into the fitting body. This is clamping time. After this time has elapsed, the clamp can be removed. If desired, write start and end time for this phase on pipe surface.

WARNING ***Never force joints to cool by any external method such as dousing with water. Cooling an electrofusion joint too quickly will cause the material to become brittle and will drastically reduce joint integrity.***

STEP 14: Cooling Phase II - Rough Handling Time

Allow the joint to continue to cool for it's rough handling time prior to pressure testing, backfilling, fusing tee outlet, etc. For socket-type fittings, rough handling time is 2x (two times) the labeled cooling time (clamping time).

WARNING ***Never force joints to cool by any external method.***

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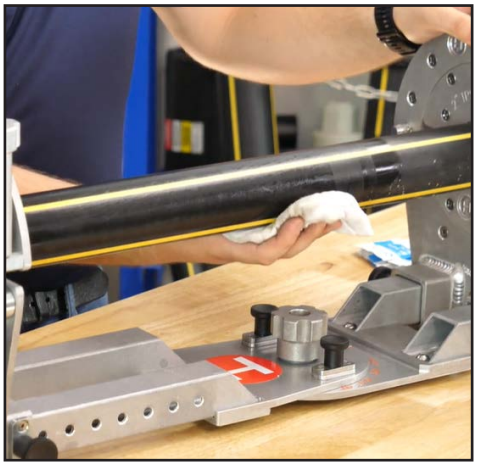
Joining Procedures for Saddle-Type Fittings

STEP 1: Wash Pipe - 3x

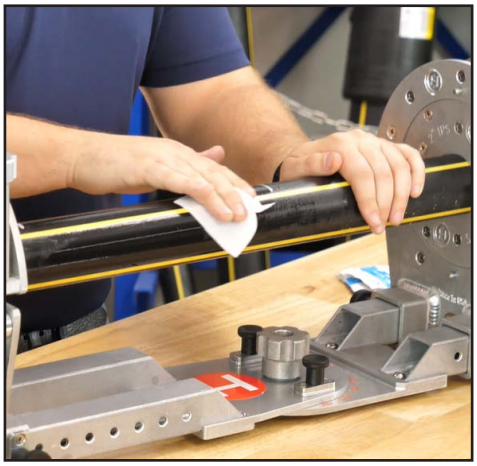
Wash pipe with water and a cloth to remove mud, dirt, etc. Do not use soap or detergent. Ensure an adequate length of pipe beyond the area to be joined has been washed to ensure contaminants will not be introduced in future steps. For saddle joints, 3x the width of the saddle is generally sufficient.



STEP 2: Clean Pipe - 2x

Use alcohol to clean an area of pipe at least double (2x) the width required by the saddle. This step helps avoid introduction of contaminants to the pipe surface revealed during peeling.

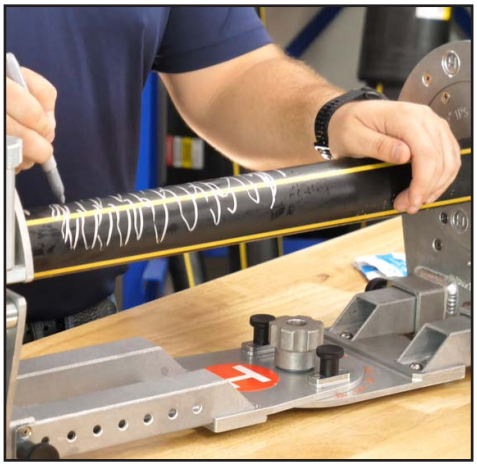
NOTICE *Refer to solvent cleaning requirements on page 17. Recommended: 90%+ isopropyl alcohol.*



STEP 3: Set and Mark Fusion Area

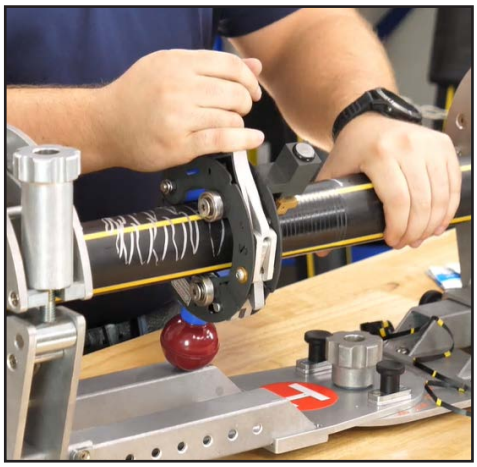
Make width marks on the pipe equal to the width of the saddle plus one inch. Do not remove the fitting from its bag. Fill inside these width marks with cross-hatched witness marks. These marks help give visual indication that your peeling tool is removing adequate material.

NOTICE *The simplest way to make these marks on the pipe prior to peeling is to hold the fitting on the pipe, without removing the bag, then making a mark beyond the edge on both sides.*



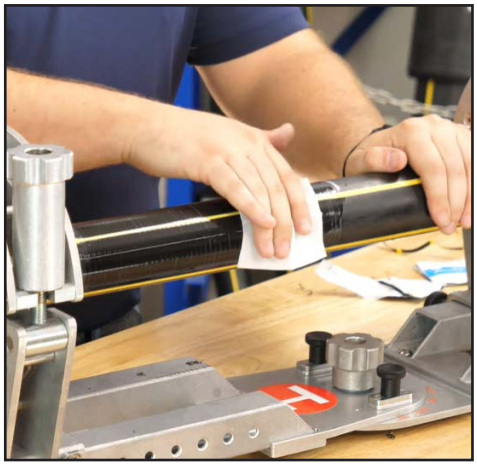
STEP 4: Peel Pipe

Using your pipe preparation tool, remove the top layer of pipe surface up to the distance mark made in the previous step. Make sure all witness marks are removed, and the ribbon from your tool is continuous and about as thick as two sheets of ordinary copy paper.



STEP 5: Clean Pipe - Final 1x Pass

Use alcohol and a clean, lint free cloth to clean the area that was peeled in the previous step. Make sure to wipe only inside the peeled area, not beyond. This helps avoid dragging contaminants from the unpeeled area to the peeled area.



NOTICE *Refer to solvent cleaning requirements on page 17. Recommended: 90%+ isopropyl alcohol.*

⚠WARNING ***Ensure alcohol and moisture have completely evaporated, and surface of pipe is dry before continuing.***

STEP 6: Clean Fitting

Remove fitting from packaging and use alcohol to clean the fusion area on the underside of the saddle. Although the fitting has been in its original package, cleaning the underside of the saddle is a simple step to help ensure successful fusion and joint integrity. Take care not to touch the bottom of the saddle with anything other than the cleaning cloth or wipe.

NOTICE *Refer to solvent cleaning requirements on page 17. Recommended: 90%+ isopropyl alcohol.*

⚠WARNING ***Ensure alcohol and moisture have completely evaporated, and saddle bottom is dry before continuing.***

STEP 7: Fit Joint

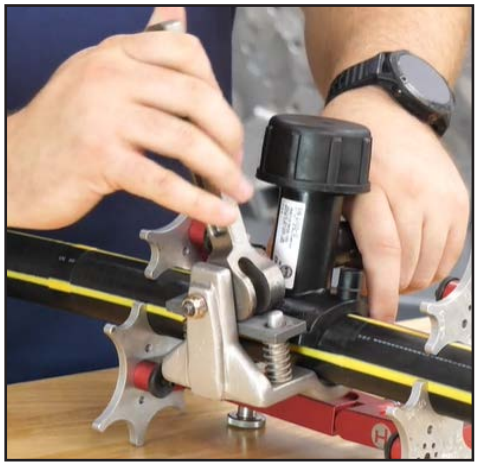
Place saddle on peeled area of pipe surface and tighten. Proper tightness has been achieved when the fitting yields no movement when reasonable force is applied attempting to rotate it around the pipe.

- *For molded under-clamps, loosen screws from base of saddle but don't remove them. Open under-clamp and snap it around the pipe. Reposition T-shaped clasps into slots in saddle base, then turn screws clockwise until fitting comes into tight contact with pipe.*

⚠WARNING ***DO NOT USE pneumatic or electric tools to tighten hex screws on MTD saddle fittings. Use of these types of tools can quickly result in overtightening which may cause fusion failure or damage to the fitting.***

- *For nylon strap under-clamps, loosen U-bolt nuts on both sides, and remove them along with the backing plate from one side. Place saddle on pipe and pass strap and U-bolt under pipe, up through holes in saddle base, then reinstall backing plate and nuts. Turn nuts clockwise until saddles comes into tight contact with pipe. When tightening nuts, ensure all four nuts are tightened evenly.*

⚠WARNING ***DO NOT USE pneumatic or electric tools to tighten U-bolt nuts on MTD saddle fittings. Use of these types of tools can quickly result in overtightening which may cause fusion failure or damage to the fitting.***



- *For 1-1/4" main size tap tees, an external under-clamp is required due to the very small profile of the saddle base. To use the under-clamp tool, place the tap tee on the main, then slip the tool around the base of the tap tee. Tighten tool by depressing lever.*

STEP 8: Re-Mark Width

Make a mark against the base of the saddle on both sides. This mark helps give visual evidence that the saddle position has not changed during or after fusion.

STEP 9: Energize Fitting

Follow your processor manufacturer's instructions to energize and fuse the fitting to the pipe.

NOTICE *MTD fittings are designed with 4.7mm fusion terminals with ID resistor. If fusing in dedicated mode is supported, ensure processor leads are properly connected in accordance with control box manufacturer's instructions.*

⚠WARNING ***Never scan a fusion barcode of any fitting other than the fitting to which the control box is connected, whether similar or identical. This could result in improper fusion parameters being calculated by the control box and applied to the fitting.***

STEP 10: Verify and Mark Pipe

Visually inspect joint for inconsistencies or anomalies.

On the pipe surface, write the operator's initials, time of day heating cycle was completed, clamping time and rough handling time on the pipe. See the following steps for identifying clamping and rough handling times.

NOTICE *Additional guidance on electrofusion joint anomalies / inconsistencies is available on page 37.*

STEP 11: Cooling Phase I - Clamping Time

MTD saddle-type fittings with integrated clamps are designed to be buried with the clamp in-place, however if you prefer to remove the clamp, allow joint to cool for the time specified on the fitting label and molded into the fitting body before removal of the clamp. If desired, write start and end time for this phase on pipe surface.

WARNING ***Never force joints to cool by any external method such as dousing with water. Cooling an electrofusion joint too quickly will cause the material to become brittle and will drastically reduce joint integrity.***

STEP 12: Cooling Phase II - Rough Handling Time

Allow the joint to continue to cool for it's rough handling time prior to pressure testing, tapping, backfilling, etc. For saddle-type fittings, rough handling time is 3x (three times) the labeled cooling time (clamping time).

WARNING ***Never force joints to cool by any external method.***

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Appendix

Tapping Tee Operation

A tapping tee is a saddle fitting with an integrated cutting mechanism which taps a hole in an existing pipe, allowing for easy installation of lateral lines such as services. There are two types of tapping tees:

Standard:

A standard tapping tee is any tapping tee with an outlet size of 1-1/4"CTS or smaller. Because of the smaller outlet, standard tapping tees also have smaller cutters which allow for a smaller profile.

High-Volume:

A high-volume tapping tee is any tapping tee with a 1¼"IPS outlet or larger. The larger outlet allows for more volume throughput, hence the name high-volume. Insertion tees are considered high-volume tapping tees.

All MTD high-volume tapping tees also include a 'Shutoff Cutter' which, in an emergency, will shut off flow through the outlet when advanced back into a pipe that has been previously tapped. The shutoff cutter is not intended to take the place of a permanent service valve.

To operate tapping tees:

1. Close Outlet

Before tapping the main, something such as a service line must be installed on the outlet of the tapping tee.

2. Leak Test Fusion Joints

Perform leak testing on the tap tee base and tap tee outlet, as well as service line. Test caps are available which allow the tapping tee fusion joint and the entire service to be pressure tested prior to tapping the main.

3. Insert Tapping Tool

Remove the cap from the tap tee and insert the appropriate tapping tool.

4. Tap Main

4a. Standard Tap Tees:

Thread the cap block onto the top of the tap tee in place of the cap, then rotate the tapping tool clockwise until the travel stop contacts the top of the cap block. Rotate the tapping tool counter-clockwise to retract the cutter back out of the pipe and into the top of the tap tee. Once cutter reaches top of tap tee, cap block and tool can be removed.

4b. High-Volume Tap Tees:
Insert hex drive into tapping tee cutter and rotate tool counter-clockwise to retract cutter to the top of the tap tee. Insert and tighten backpressure safety adapter into top of cutter. Thread the cap block onto the top of the tap tee in place of the cap, then rotate the tapping tool clockwise until the travel stop contacts the top of the cap block. Rotate the tapping tool counter-clockwise to retract the cutter back out of the pipe and into the top of the tap tee. Once cutter reaches top of tap tee, indicated by the laser-engraved stop line on the shaft of the tool, the cap block and tool can be removed.

5. Replace Cap
Tighten tap tee cap by rotating clockwise. MTD caps are designed to seal when hand tight. MTD also offers a purpose-designed cap wrench for tightening caps for even application of torque and to avoid damage.

WARNING ***Do not use a pipe wrench or locking pliers to tighten tap tee caps. Caps are molded from polyethylene and may deform / leak.***

Melt-Out, Smoke Production & Wire Migration

WARNING ***Some company procedures completely and expressly disallow fusion abnormalities such as smoke production or wire migration. If this is the case, your company procedures must be followed in lieu of the guidance in this section.***

This section provides definitions, recommendations and guidance for acceptance / rejection criteria of joint abnormalities. Keep in mind that if the processor does not successfully energize the fitting for the determined amount of time, or if the heating cycle results in an error, the joint is not acceptable.

Melt Out
The term 'melt-out' refers to molten plastic that has flowed out from the joint area of the fitting and onto the surface of the pipe. Flow of molten plastic outside of the fusion joint is not acceptable. This can indicate a loss of interface pressure in one area of the joint. Joints with melt-out beyond the edge of the fitting should be cut out or abandoned. Melt visible within the edge of the fitting is not considered melt-out and is acceptable.

Smoke Production
Rarely, an electrofusion fitting will produce a small amount (wisps) of smoke during the heating cycle or shortly after. Wisps of smoke may appear when the edges of the melt pool or outer fusion coil are exposed to air as they move to fill the gap between the pipe surface and fitting.

Billowing smoke forcefully expelled from the joint area is not acceptable regardless of heating cycle result. This is an indication of loss of fusion heating energy and interfacial pressure which prevents adequate mixing and bonding of fitting and pipe materials.

Smoking from an electrofusion fitting is acceptable only if:

- *There is no accompanying melt-out.*

-and-

- *Smoke is not being forcefully expelled from the fitting.*

-and-

- *The joint passes a field pressure test after fusion and cooling is completed.*

Wire Migration

In some cases, the high pressures created inside an electrofusion joint along with the high temperature can force portions of the outermost heating wire coils to move to the outside of the fusion area. This migration of heating wire is not always cause for concern nor rejection of the joint.

Wire migration is acceptable only if:

- *There is no accompanying melt-out.*

-and-

- *The wire is within the edge of the fitting, not beyond it.*

-and-

- *The joint passes a field pressure test after fusion and cooling is completed.*

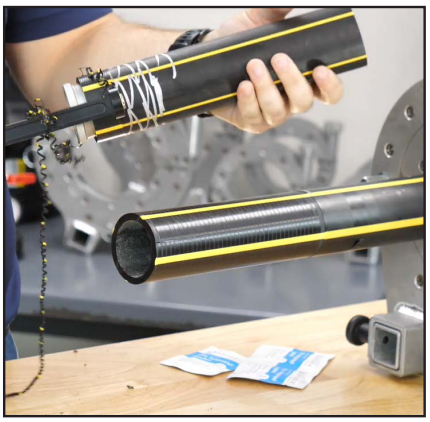
NOTICE *Visible wire inside the fusion joint that does not protrude past the edge of the fitting is not considered wire migration and is acceptable.*

Allowable Gap

MTD does not publish or recommend specific amounts of gap between pipe and fittings as acceptable limits. This is because our fittings are designed to close gaps as long all requirements and procedures set forth in this manual are followed. If pipe is within specification limits and has been prepared and clamped properly, MTD electrofusion fittings will successfully create joints when energized. Additionally, there is no proven way to quantify gap without penetrating the joint with a feeler gauge or similar tool. Insertion of any item into the joint interface after it has been peeled and cleaned presents an opportunity for introduction of contaminants and may lead to joint failure.

Coupling Slip Joints

Installing a slip joint requires different surface prep and measurement steps when compared to a running joint. To properly install a slip joint:

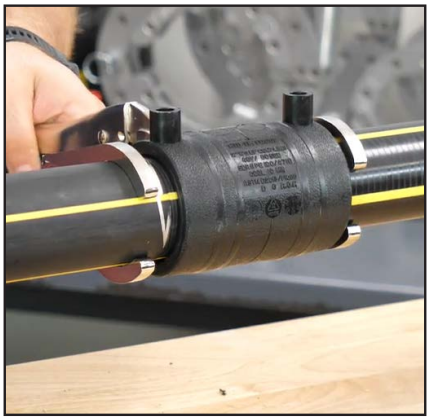


1. Ensure enough pipe has been washed, peeled and cleaned for the entire length of the coupling to make contact on one side of the joint (Pipe A). On the other side of the joint (Pipe B), the pipe end may be prepared in the same way as a running joint.

2. After cleaning the coupling, force the coupling to slip completely over the end of pipe A. For most fittings, the internal stab depth stops are small enough to be overcome simply with a mallet. On larger fittings, these stops may need to be removed with a chisel. If this is the case, perform this removal before cleaning the ID of the fitting.

3. With the coupling slipped onto pipe A, bring pipe B into position and slip the coupling over the joint. Take care to ensure the pipe ends are terminated within the cold zone of the fitting and are not short stabbed inside the fusion zone.

4. Apply a clamping device and energize the fitting to join the two pipe ends.



Common Failure Modes

*An **acceptable** socket-type joint has:*

- *Both ends of the pipe resting within the center cold zone.*
- *Homogeneously mixed material between the fitting and the pipe.*
- *Squarely-inserted pipe ends without strain or binding.*
- *Smooth interior walls of both joined pipe ends, free of wrinkles or waves.*
- *Consistent contact around the inside diameter of the fitting.*

*An **acceptable** saddle-type joint has:*

- *Even, tight gap between pipe surface and inside of saddle.*
- *Homogeneously mixed material between the fitting and the pipe.*

*A **misaligned (unacceptable)** socket joint has:*

- *One pipe end inserted too short and the other end inserted too far, placing the meeting ends in a fusion zone rather than in the cold zone.*

How to avoid:

Ensure steps for slip joints are closely followed to eliminate the possibility of a misalignment before energizing the fitting. On running joints, make sure the pipe ends are properly inserted such that the stab marks on the pipe are aligned with the edges of the fitting.

*A **short-stabbed (unacceptable)** socket joint has:*

- *One pipe end cut square and properly inserted in the fitting, but the other end not inserted far enough or cut out of square so that it terminates inside a fusion zone.*

How to avoid:

Make sure to insert the pipe ends thoroughly into the fitting, and to cut the ends of the pipe squarely.

*An **out-of-round (unacceptable)** socket joint has:*

- *Excessive ovality of pipe, resulting in binding at the high points and gapping at the low points and/or over-peeling of pipe surface in an effort to make the fitting fit on the pipe. In either case the result is the same and will often exhibit smoking, migration of wire and/or plastic outside the boundary of the fitting.*

How to avoid:

Make sure pipe is within 5% ovality prior to fusion. If pipe is beyond 5% oval, use re-rounding equipment. Always re-round coiled pipe over 3" IPS. If fitting still doesn't fit on pipe after two passes with your properly functioning peeler, pipe is likely out of ovality tolerance.

*An **out-of-round (unacceptable)** saddle joint has:*

- *Excessive ovality of pipe, resulting in inconsistent or excessive gap and improper interface pressure between saddle and pipe at the widest point of the pipe. Often, ovality will result in an excessive gap somewhere in the interface between the fitting and pipe. This large gap can cause the molten material to escape, and the fitting coil to overheat and disintegrate due to the introduction of oxygen to the hot wire.*

How to avoid:

Make sure pipe is under 5% ovality prior to fusion. Use re-rounding equipment. Always re-round coiled pipe over 3" IPS. Ensure procedures are followed to ensure adequate tightness between fitting and pipe.

Common Installation Errors

Excessive Peeling:
When too much of the pipe's surface is removed, the fitting cannot achieve proper material melt, interface pressure and joint homogenization. Additionally, excessive peeling can reduce pipe wall thickness below required tolerance per ASTM D2513. Attempted fusion on pipe with reduced wall thickness can also lead to over-melting which may result in fusion failure and/or complete burn-through of pipe wall.

MTD recommends ensuring both tooling and pipe preparation procedures in use produce consistent removal of an adequate amount of pipe surface; at minimum 0.007". The installation procedures in use should require peeling an area of pipe sufficient to ensure the entire fusion coil of the fitting is situated on clean, uniform pipe.

Improper Socket Clamping:
During installation of MTD fittings, it is vital that the fitting being fused is restrained by a clamping mechanism. When fusing fittings with no restraint, the interface pressure in the joint will cause the fitting to migrate out of its original intended position.

MTD recommends utilizing a clamping mechanism on every electrofusion joint. The joint should also remain in its clamp during the clamping time to ensure the material can homogenize without interruption.

Insufficient Peeling:
During installation of MTD fittings, it is recommended to remove a minimum of 0.007" of pipe surface material by means of an approved peeling tool. This top layer of pipe material must be removed prior to fitting the fusion joint, as the fitting must be in contact with clean plastic of a uniform surface profile and free of debris or contaminants. When the pipe's surface is not sufficiently peeled, molten plastic inside the fitting is unable to bond with it.

MTD recommends ensuring both tooling and pipe preparation procedures in use produce consistent removal of an adequate amount of pipe surface; at minimum 0.007". The installation procedures in use should require peeling an area of pipe sufficient to ensure the entire fusion coil of the fitting is situated on clean, uniform pipe.

Joint Contamination:
During installation of MTD fittings, it is vital that the pipe surface be prepared such that the fitting is in contact with clean plastic of a uniform surface profile and free of moisture. Inclusion of contamination between the pipe surface and fitting fusion zone prevents material from homogenizing into a unified structure and / or acts as a barrier between the molten fitting and pipe material.

MTD recommends cleaning the pipe surface initially with water and a rag or towel before peeling to remove dirt / debris. After peeling, it is best practice to decontaminate the peeled pipe surface with 90% (or greater) concentration of isopropyl alcohol and water, or with a pre-moistened alcohol wipe of the same concentration. This step ensures that any contaminants introduced during the peeling process are removed, and the alcohol will evaporate any moisture from the pipe surface as well.

Joint Moisture:
During installation of MTD fittings, it is vital that the pipe surface be prepared such that the fitting is in contact with clean plastic of a uniform surface profile and free of moisture. When moisture is present during the fusion cycle, it acts as a barrier between the molten fitting and pipe material.
MTD recommends cleaning the pipe surface initially with water and a rag or towel before peeling. After peeling, it is best practice to decontaminate the peeled pipe surface with 90% (or greater) concentration of isopropyl alcohol and water, or with a pre-moistened alcohol wipe of the same concentration. This step ensures that any contaminants introduced during the peeling process are removed, and the alcohol will evaporate any moisture from the pipe surface as well.

Note that any concentration of alcohol does contain some amount of water. When preparing and fusing joints in ambient temperatures below freezing (32˚F), water may freeze to the pipe surface due to the evaporative cooling effect of alcohol. If this occurs, take extra steps to ensure removal of moisture by wiping pipe surface with a new, clean, lint-free, dye-free cloth.

Pipe Ovality:
During installation of MTD fittings, it is vital that the pipe being fused is within acceptable ovality (roundness) requirements.

MTD recommends fusing to pipe under 5% ovality per ASTM D2513. If measured ovality is at or greater than 5%, re-rounding equipment must be used to bring pipe within ovality requirements prior to fusion.

Saddle Overtightening:
During installation of MTD fittings, it is vital that the saddle be properly tightened to the pipe. Overtightening the saddle causes the gap between the pipe surface and fitting to become irregular, and prevents adequate movement of material into the cold zone early in the fusion cycle.

Saddle clamps must be tightened such that the fitting yields no movement when reasonable force is applied to the fitting attempting to rotate it around the pipe. MTD electrofusion saddle clamps are not intended to be tightened until the bolts bottom out, or the flange of the fitting touches the flange of the clamp. This is considered excessive tightening.

Saddle Undertightening:
During installation of MTD fittings, it is vital that the saddle be properly tightened to the pipe. Under tightening the saddle allows molten fitting material to escape the joint before it can solidify and build the required interface pressure for a successful fusion.

Saddle clamps must be tightened such that the fitting yields no movement when reasonable force is applied to the fitting attempting to rotate it around the pipe. MTD electrofusion saddle clamps are not intended to be tightened until the bolts bottom out, or the flange of the fitting touches the flange of the clamp. This is considered excessive tightening.

Barcode Contents

The following tables indicate data contained within MTD fitting Traceability & Fusion Barcodes.

Traceability:

Position	Information Contained	Given Character	Example*
1	Manufacturer	M	**MT**
2	Identifier	T	
3	Lot Number Code	d	**1310600**
4		a	
5		Y	
6		0	
7		0	
8	Production Date	n	**02313**
9		d	
10	Material	H	**PE4710**
11	Product Type	8	**EFxBF Tapping Tee**
12		9	
13	Size	3	**2IPSx1IPS**
14		K	
15		5	
16	**-**	**0**	**-**

Fusion:

Section	Digits	Information Contained	Offset	Given Digit	Example
A	1	a	-	9	
B	2	Accessory Type	-	5	**Coupling**
C	3	Name Trademark of Manufacturer	+0b	1	**MT**
	4		-	3	
	5		+0c	2	
	6		-	0	
D	7	Indication of Cooling Time	_	3	**Indication of Cooling Time**
E	8	Cooling Time	-	1	**10 Minutes**
F	9	Accessory Diameter	-	8	**1" IPS**
	10		-	1	
	11		-	0	
G	12	Expression of Resistance	-	3	**-,--K**
H	13	Nominal Fusion Voltage U	-	4	**40V**
	14		-	0	
I	15	Resistance of Heating Element	-	5	**5.00Ω**
	16		-	0	
	17		-	0	
J	18	Variation of Resistance	-	7	**±24%**
K*	19	Heating Time	-	0	**50 Seconds**
	20		-	5	
	21		-	0	
L	22	Energy Correction	-	6	**+0,6% by °C <20°C**
	23		-	5	**-0,5% by °C >20°C**
M	**24**	**Checksum**	**-**	**8**	

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