HOME-FLEX™

UNDERGROUND

Polyethylene (PE) Fusion Joining Procedures

811

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HOME-FLEX™ Underground Polyethylene (PE) Pipe Fusion Joining Procedures

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HOME-FLEX™ Underground PE Fusion Joining Procedures

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Chapter 1: Introduction

HOME-FLEX™ Underground Polyethylene gas pipe is for use with natural gas and LP (propane) gas. Also referred to as PE or poly pipe, polyethylene gas pipe may only be installed out-doors and underground. PE pipe may never be used above ground, in a building or under a building. This guide covers the heat fusion bonding of PE pipe pursuant to ASTM F2620-19 "Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings" using socket fusion, butt fusion, and saddle fusion techniques.

Heat fusion joining connects two surfaces, like runs of PE pipe, by simultaneously melting them with a hot-plate heater and then holding them together under pressure. A permanent joint is created as the materials cool. There a three different types of heat fusion, requiring specific tools and equipment depending on the technique and sizes of pipe and fittings being joined.

Butt fusion is used when making joints between plain-end (butt) pipe and fittings. The segments being joined must have the same outside diameter and standard dimension ratio (SDR) value. In butt fusion, the ends to be joined are held to a heated plate and, when the proper melt is achieved, are promptly brought together with appropriate force while they cool to form the join.

Saddle (sidewall) fusion is commonly employed when installing a branch off of a pipe main on the top or side of the pipe main. When installing on top of the pipe main, a tapping tee fitting is usually used while side installations usually use a saddle (branch) fitting. In saddle fusion, a fusion tool matching the curve of the pipe and fitting is used to simultaneously heat the sidewall of the pipe and the base of the fitting and then bring them together with appropriate force. Once the joint has cooled, the main pipe can be punctured to open flow through the newly joined branch.

Socket fusion is used when joining socket fittings to PE piping with an outer diameter of four inches or less. In socket fusion, the outside of the pipe and in the inside of the fitting socket are simultaneously heated and then joined by inserting the pipe into the fitting. Alignment devices can be used to hold the pipe and fitting in proper alignment.

HOME-FLEX Underground gas pipe is Medium Density Polyethylene (MDPE PE2406/2708) gas pipe, also referred to as PE or poly gas pipe. It is made in accordance with the ASTM D2513 standard. It is approved for direct burial into the ground in accordance with the local plumbing code at the installation location. It is flexible, lightweight, easy to work with and easy to install. Unlike metallic gas pipe, it will not rust or corrode when properly installed. HOME-FLEX Underground PE gas pipe is iron pipe size (IPS). It is approved for use with Natural Gas or LP gas. It is never to be installed in a building or house. It is never to be installed under a building or house. It is never to be installed above grade.

1.1 User Warnings

WARNING! THIS PRODUCT IS FOR *UNDERGROUND* USE ONLY.

Always call 811 prior to digging.

811 Know what's **below.** **Call 811 before you dig.**

WARNING!

Improper installation or operation of the system may result in fire, explosion or asphyxiation. Only the compo-nents provided or specified by IPEX USA LLC, for use as part of the fuel gas system are to be used in the installation.

1.2 Limitations of Guide

While every effort has been made to prepare this document in accordance with all region-al model codes in effect at its printing, IPEX USA LLC cannot guarantee that the local administrative authority will accept this. It is the ultimate responsibility of the installer to determine the suitability and acceptance of any building components including gas pip-ing. IPEX USA LLC, manufacturer of HOME-FLEX Underground® Gas Distribution System, assumes no responsibility for labor or material for installations made without prior determination of local code authority acceptance.

1.3 Applicable Codes and Standards

- NFPA 54/ANSI Z223.1 - National Fuel Gas Code
- NFPA 58 - Liquefied Petroleum Gas Code
- ICC - International Fuel Gas Code
- IAPMO - U.P. Code (Uniform Plumbing Code)

1.4 Prohibited Installation Practices

⚠ ***DO NOT*** *install HOME-FLEX Underground Products in above ground installations.*

⚠ ***DO NOT*** *install HOME-FLEX Underground Products inside buildings.*

⚠ ***DO NOT*** *install HOME-FLEX Underground Products under buildings.*

⚠ ***DO NOT*** *encase HOME-FLEX Underground Products inside concrete.*

Chapter 2: Description of System Components

2.1 Gas Pipe

Application Information

For use in direct burial Natural Gas and Liquefied Petroleum (LP) Gas applications with Polyethylene (PE) gas pipelines.

Technical Data

Materials	
Pipe: Polyethylene (PE 2406/2708)	
Pressure Ratings	**Temperature Ratings**
Max Operating Pressure: 100 PSIG	Operating Temperature Range: 0°F - 140°F
Codes	**Standards**
NFPA 54/ANSI Z223.1 NFPA 58 International Fuel Gas Code U.P. Code	ASTM D2513 NSF/ANSI 14 Certified

Dimensional Information

Part Series	Size (IPS)	SDR	Dimensions (in)			Min Bend Radius
			Av. OD	Approx. ID	Min Wall Thick	
221058/59/60	½"	9.3	0.840	0.660	0.090	17.00"
221062/63	¾"	11	1.050	0.860	0.095	26.25"
221065/66	1"	11	1.315	1.075	0.120	30.00"
221067/68/69	1¼"	11	1.660	1.358	0.151	41.50"
221070/71/72	1½"	11	1.900	1.554	0.173	47.50"
221073/74/75	2"	11	2.375	1.943	0.216	59.40"

Part Number Listing

	Part No.	Size (IPS)	SDR	Length
	221058	½"	9.3	100'
	221059	½"	9.3	250'
	221060	½"	9.3	500'
	221061	¾"	11	100'
	221062	¾"	11	250'
	221063	¾"	11	500'
	221064	1"	11	100'
	221065	1"	11	250'
	221066	1"	11	500'

	Part No.	Size (IPS)	SDR	Length
	221067	1¼"	11	100'
	221068	1¼"	11	250'
	221069	1¼"	11	500'
	221070	1½"	11	100'
	221071	1½"	11	250'
	221072	1½"	11	500'
	221073	2"	11	100'
	221074	2"	11	250'
	221075	2"	11	500'

Chapter 3: Fusion Procedures

3.1 Clean Pipe After Cutting

Pipe surfaces to be joined, and fusion equipment itself, must be free of contamination like residue, dirt, cuttings, and oils. Any lubricant residue introduced from cutting tools must be removed before the joining process. Clean first with a clean, dry, lint-free, cotton (or other non-synthetic) cloth. If a dry cloth is not sufficient, wash with water, thoroughly dry with a cotton cloth or paper towel. If soap or another contaminant is transferred to the pipe as a result of the cutting (or other) process, use acetone or 90% or greater isopropyl alcohol to clean the pipe ends and outer and inner surfaces.

3.2 Butt Fusion

Gauge Pressure for Hydraulic Machines

These calculations are only required when using a hydraulic machine. The gauge pressure is the pressure required for successful butt fusion and is a function of interfacial pressure, fusion surface area, the machine's carriage cylinder size and drag pressure (the pressure required before the pipe ends begin to move in the machine). The result of this calculation is what the operator will set the machine's pressure gauge to. A slide rule or calculator provided by the machine's manufacturer can also be used for this calculation.

$$A_P = (OD - t) \cdot t \cdot \pi$$

$$TFP = \frac{A_P \cdot IFP}{TEPA}$$

$$P_G = TFP + P_D$$

A_P = Pipe Area *(in²)*
OD = Pipe Outside Diameter *(in)*
t = Pipe Wall Thickness *(in)*
π = 3.1416
TFP = Theoretical Fusion Pressure *(psig)*
IFP = Interfacial Pressure *(60-90 psig)*
$TEPA$ = Total Effective Piston Area *(in²)*
P_G = Fusion Machine Gauge Pressure *(psig)*
P_D = Fusion Machine Drag Pressure *(psig)*

Note: Total Effective Piston Area (TEPA) will be supplied by the fusion machine manufacturer. Interfacial Pressure (IFP) is not the same as the gauge pressure (P_G).

Pressure for Manual Machines

For manually operated fusion machines, enough force should be applied to the join such that the joining bead is rolled back to the pipe surface. A torque wrench may be used to apply the proper force.

Butt Fusion Tools

- **Heating Tool.** A proper melt requires a uniform temperature be maintained across the heating tool surfaces. The tool must have sufficient wattage and control to maintain the designated surface temperature of the tool faces. The tool must have a large enough surface area to cover the ends of component pipe ends and the faces must have a non-stick coating to preventing melted material from sticking.
- **Butt Fusion Machine.** Butt fusion machines vary in their design, including how pressure is applied (manually or hydraulically). In principle, however, they are composed of the same three features: a fixed clamping mechanism and a movable clamping mechanism used to align and hold the two pipe parts to be joined; a facer to prepare the faces so that they are smooth and aligned; and inserts to adjust the clamps to the pipe size to be joined.
- **Pipe Support Stands** (optional). Used to support level alignment of pipe as it enters the fusion machine.

Butt Fusion Join Procedure

Step 1 Clean components and machine. Using a clean, dry, lint-free cotton (or other non-synthetic) cloth, clean the exterior and interior of the pipe components to be joined. .

Step 2 Secure components in the machine. If fusing long runs of pipe, place support stands at the ends of the butt fusion machine and make sure they are aligned with the centerline of the fusion machine. Place the pipes or fittings being joined in the clamps of the butt fusion machine, making sure they are properly aligned with each other before closing the clamps.

Step 3 Face component ends. To establish clean, parallel mating faces between the ends to be joined, a facer is used. The facer should be run until it bottoms out on the stops and is locked between the jaws. Separate the pipe ends from the facer and remove it and all pipe shavings from the area using a clean, dry, lint-free cotton (or other non-synthetic) cloth. Bring the pipe or fitting ends together and visually inspect to confirm that there are no detectable gaps, and that there is a square mating face perpendicular to the pipe centerline on each pipe.

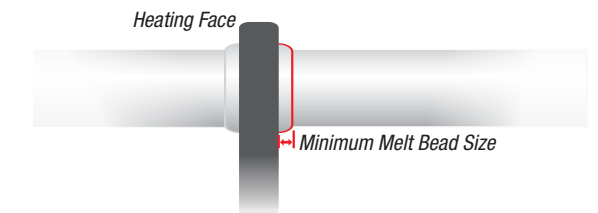
Also check the pipe ends for vertical alignment and out-of-roundness. If one end is found to be high, adjust it to be lower rather than raising the low side. If adjustment requires more than 180° of a rotation of the clamp knob, then repeat the facing procedure from the beginning. The maximum allowable vertical misalignment is less than 10% of the pipe wall thickness.

Step 4 Prepare heater. The desired surface temperature of the heater faces is 400 - 450°F (204 - 232°C). Note that the temperature setting on the heating tool is the internal temperature, and usually higher than the actual surface temperature of the faces. Because of this, a pyrometer or other heat measuring device should be used when preparing the heating tool to verify the temperature of the face surfaces. Check multiple spots on the faces to confirm uniform temperature. Repeat this check periodically throughout the day. Clean the heating tool surfaces with a clean, dry, lint-free cotton (or other non-synthetic) cloth.

Step 5 Begin heat fusion. Install the heating tool in the designated space between the pipe to be joined. Use the butt fusion machine to move the pipe ends into fusion pressure contact with the heating tool. After full contact is established, reduce the pressure to drag pressure (the heating tool and pipe ends should still be touching). When an indication of melt is visible around the entire pipe circumference, reduce the pressure to maintain contact without force and hold to "heat soak" until a molten bead becomes visible between the heater and pipe ends. **For 0.5"-2" pipe, the desired minimum bead size is 1/32" (1 mm)** (see Table 3.1)**.**

Table 3.1 Minimum Melt Bead Size

Pipe Size	Min. Bead Size		Final Bead Width	
0.5 - 2"	1/32"	1mm	1/16" - 1/8"	1.6 - 3.1 mm



Step 6 Remove from heating tool and evaluate the melt. Once the designated bead size is established, promptly move pipe ends away from the heating tool, remove the heating tool, and inspect the pipe ends for a proper melt. The melt should be flat, smooth, and contain no unmelted areas. Improper melts may have a concave appearance (caused by excessive pressure during heating), unmelted areas, a rough or bubbly surface, or instances when PE material is stuck to heating tool surfaces. If any of these occur, stop the joining procedure, allow the pipe ends to cool and restart the process from Step 1. **For 0.5" CTS -1.5" IPS joins**

that typically use a mechanical fusion machine, the maximum permissible time for removing the heating tool and bringing the melted pipe together is 4 seconds. For 1.5" to 2" IPS pipe in hydraulic fusion machines, the maximum permissible time is 8 seconds.

Step 7 Join the pipe ends. Applying a pressure within the fusion interfacial pressure range, bring the pipe ends together. The pressure should be such that both melt beads roll over such that they are touching the OD surfaces of both pipe ends. If excessive force is used, a cold joint may occur where the melted material is pushed out of the joint. Insufficient force will lead to weak bonded areas as not enough melted material will fuse.

Step 8 Let the joint cool. The joint must be held under fusion pressure while cooling to ensure a strong join. The cooling time for 0.5" to 1" IPS pipe size is 40 seconds and 60 seconds for 1.25-2" sizes. The joined segments can now be removed from the machine, but any rough handling, pulling, or installation should be avoided until full cooling to ambient temperature has taken place (10 minutes for 0.5" - 1" pipe sizes and 20 minutes for 1.25" - 2" pipe sizes). Note that additional cooling time may be required in ambient temperatures above 100°F. DO NOT attempt to accelerate cooling by pouring water or placing wet cloths on the join.

Perform a final inspection of the beads. The beads on either side of the join should be a uniform size around the circumference of the pipe and the "v-groove" between beads at the join should not be deeper than half the bead height from the pipe surface.

3.3 Socket Fusion

Socket Fusion Tools

- **Heating Tool.** A proper melt requires a uniform temperature be maintained across the heating tool surfaces. The tool must have sufficient wattage and control to maintain the designated surface temperature of the tool faces
- **Heating Tool Faces.** There is a face for both the fitting and the pipe. A male end heats the interior socket fitting surface, while a female end heads the exterior pipe surface.
- **Rounding Clamps (cold rings).** These maintain the roundness of the pipe and control the depth of the pipe insertion into the socket during joins.
- **Depth Gauge.** Used to position the rounding clamp on on the pipe.
- **Chamfering tool.** Used to bevel the end of the pipe.
- **Tubing cutter.** Used to create square end cuts on pipe.
- **Alignment Jig** (optional). An alignment jig holds the piping components in alignment, with one side fixed and other sliding for making joints.
- **Fitting Puller** (optional). This tool holds the fitting during assembly and assists in removing the fitting from the heating tool.

Socket Fusion Procedure

Step 1 Prepare the heating tool. Attach the heater faces corresponding to the surfaces to be joined. The desired surface temperature of the faces is 490 - 510°F (254 - 266°C). Note that the temperature setting on the heating tool is the internal temperature, and usually higher than the actual surface temperature of the faces. Because of this, a pyrometer or other heat measuring device should be used when preparing the heating tool to verify the temperature of the face surfaces. Check multiple spots on the faces to confirm uniform temperature. Repeat this check periodically throughout the day.

Step 2 Cut and slightly chamfer the pipe. Cut the pipe end squarely, being careful to clean it inside and outside by wiping with a clean, dry, lint-free, cotton (or other non-synthetic material) cloth. Slightly chamfer the outside edge of the pipe and attach the rounding clamp at the location indicated by the depth gauge.

Step 3 Heat the socket and pipe. Confirm that the heater faces are clean. Remove any contaminants by wiping with a clean, dry, lint-free cotton (or other non-synthetic material) cloth. Insert the socket fitting into the fitting tool face and then push the pipe into the tool face until the rounding clamps reach the heating faces. Consult Table 3.2 for required heating times.

Table 3.2 Socket Fusion Heating and Cooling Times (in seconds)

Pipe Size	Heating Time	Cooling Time
½" IPS	6–7s	30s
¾" IPS	8–10s	30s
1" IPS	10-12s	30s
1¼" IPS	12-14s	45s
1½" IPS	14-17s	45s
2" IPS	16-19s	45s

Note: Extreme weather affects heating and cooling time. In temperatures exceeding 100°F, more cooling time may be required.

Step 4 Insert pipe into fitting socket. When the joins have been sufficiently heated, remove the pipe and fitting from the heating tool and immediately insert the pipe into the socket of the fitting. The rounding clamp should be flush against the end of the fitting socket. Secure the joint in place for the cooling time referenced in Table 3.2.

Step 5 Inspect the melt pattern and allow to cool. Remove the clam and inspect the melt pattern at the end of the socket. There should be a uniform impression of the rounding clamp in the melt surface with no gaps, voids, or unbonded areas. Allow the joint to cool for an additional five minutes.

3.4 Saddle Fusion

Saddle Fusion Tools

- **Heating Tool.** A proper melt requires a uniform temperature be maintained across the heating tool surfaces. The tool must have sufficient wattage and control to maintain the designated surface temperature of the tool faces
- **Heating Tool Faces.** Saddle fusion faces are matched sets of serrated and smooth sets for specific pipe sizes which secure to the flat surface of the heating tool.
- **Saddle Fusion Tool.** Clamps to the main line and used to round and support it to maintain alignment between the pipe and fitting. The tool is also used to apply the correct amount of force during the join melt.
- **Flexible Heat Shield** (optional). Used with larger main lines to establish a melt pattern before heating the fitting.

Saddle Fusion Procedure

Step 1 Prepare the heating and saddle fusion tools. Attach the proper heating tool faces to the heating tool given the size of the main pipe and the base size of the fitting. The desired surface temperature of the faces is 490 - 510°F (254 - 266°C). Note that the temperature setting on the heating tool is the internal temperature, and usually higher than the actual surface temperature of the faces. Because of this, a pyrometer or other heat measuring device should be used when preparing the heating tool to verify the temperature of the face surfaces. Check multiple spots on the faces to confirm uniform temperature. Repeat this check periodically throughout the day. Prepare the saddle fusion tool by installing the proper clamps for the size of the main line and the fitting clamp corresponding to the fitting to be joined.

Step 2 Clean and prepare the main line and fitting. Using a clean, dry, lint-free cotton (or other non-synthetic) cloth, clean the exterior and interior of the pipe components to be joined. Referring to the manufacturer's instructions for the saddle fusion tool, attach the main to the tool. For mains 6" IPS or less, a main support is recommended.

Step 3 Abrade main and fitting surfaces and attach to saddle fusion tool. The surface of the main where the fitting is to be joined should be lightly scraped (approximately 0.007" or 0.18 mm) to remove any oxidation or contamination on the surface of the main. The scraped area

should be larger than the fitting base. It is permissible to make marks on the surface of the pipe to ensure proper coverage, but petroleum based markers must be avoided. Clean the scraped area with a clean, dry, lint-free cotton (or other non-synthetic) cloth, and remove all markings from the pipe surface.

The fusion surface of the fitting should be abraded with a 50 to 60 grit utility cloth, and then cleaned with a clean, dry, lint-free cotton (or other non-synthetic) cloth. The fitting can now be loosely inserted into the saddle fusion tool. Move the fitting base to contact with the main pipe and seat the fitting by applying about 100 lb•ft of force.

Step 4 Heat the pipe and fitting. Wipe the heating tool faces clean with a clean, dry, lint-free cotton (or other non-synthetic) cloth. Place the main-end portion of the heating tool on the main, centered with the fitting base. Place the fitting against the heater faces and apply the initial heat force, as indicated on the fitting label. Apply this force until melt is observed on the crown of the pipe main (usually 3-5 seconds), and then reduce the force to the heat soak force specified on the fitting label. Maintain this force until the total heat time is achieved as indicated in Table 3.3.

Table 3.3 Total Heat Time for Saddle Fusion

Pipe Size	Total Heating Time (or visual indicator)
1¼" IPS Pressure Main	15s
2" IPS Pressure Main	25 - 35s
1¼" and 2" IPS Non-pressure Main	Heat until a 1/16" (1.6 mm) bead appears around fitting base
≥3" IPS Main (Pressure and Non-pressure)	

When the total heat time has been reached (as indicated by the time or visual indicator as stated in Table 3.3), remove the fitting from the heating tool and the heater from the main line with a quick snapping action. Note that environmental conditions at the site may impact heating or cooling times. DO NOT adjust the heating tool temperature to account for colder or hotter weather. When fusing to pipes that are under pressure, excessive heat penetration could result in a rupture of the mainline.

Step 5 Attach fitting to main line. Attach the fitting to the melt area of the main line with three seconds of removing the heater and apply the fusion force as indicated on the fitting label. Maintain this force for a duration of 5 minutes for 1¼" IPS mainline or 10 minutes for all larger sizes. After this time, the saddle fusion equipment can be removed.

Step 6 Allow to cool and visual inspection. The assembly should cool for 30 minutes after attachment before any rough handling, branch joining, or tapping of the main. A proper melt and join is indicated by the presence of three beads: one at the fitting base, one on the main from the edge of the heating tool, and one at the main pipe melt. The beads should be rounded and a size of approximately 1/8" (3 mm) around the fitting base. The heating tool edge bead may not be connected to the main pipe melt bead, but should be visible all the way around the fitting base. If melt patterns are not satisfactory or fusion bead is not acceptable, remove the saddle fitting by cutting it above its base to prevent use, and make a new saddle fusion on a different section of the main line with a new fitting.

3.5 Pressure and Leak Testing

The HOME-FLEX Underground® gas piping system must be pressure tested for leaks in accordance with all local codes. The system must pass the pressure / leak test and have passed inspection by the authority having jurisdiction (AHJ) before backfilling the trench. In the absence of a specific local code that specifies the pressure test, refer to the latest edition of the National Fuel Gas Code NFPA 54. A copy of this code can be purchased and downloaded from: *catalog.nfpa.org/NFPA-54-C3324.aspx*.

Be sure that the new installation is isolated from any existing piping and the meter or regulator supply prior to conducting a pressure / leak test. A typical pressure / leak test for

a single family residence might consist of pressurizing the newly installed pipe and fitting system with air to 15 PSI:

- Watch the needle on the pressure gauge for 15 - 30 minutes.
- If there is no detectable loss of pressure, this indicates that the system holds pressure.

NFPA 54 specifies that the system should be tested at 1.5 times the intended system operating pressure, but never less than 3 PSI. Long duration pressure / leak tests are not ideal, because the change of air temperature in the piping system will affect the reading on the pressure gauge. For each 10°F reduction in air temp, anticipate a 1.9% reduction in air pressure due to the cooling and contraction of the air in the pipe