



Butt Fusion Joining for Polyethylene Pipe

SOP

Issued

Effective:
3/30/2018

Reviewed:
4/2/2021

Purpose and Scope

The purpose of this document is to enable the user to perform butt fusion joining of polyethylene pipe.

This procedure is applicable for butt fusion joining MDPE to MDPE, HDPE to HDPE, and MDPE to HDPE pipes where pipe or fitting ends do not exceed one standard dimension ratio (SDR) difference.

Responsibility

To complete this task, you must have Operator Qualification (OQ) Certification under Tasks:

- F01.1.0751 – Joining of Plastic Pipe - Butt Heat Fusion: Manual
- F01.1.0761 – Joining of Plastic Pipe – Butt Heat Fusion: Hydraulic
- F05.5011 – Visually Inspect Butt Fused Polyethylene Pipe
- G02.0641 – Visually Inspect Pipe and Components Prior to Installation

Definitions

Ambient Temperature	The temperature of the surrounding environment
(Pipe) Damage	Scratches, gouges, and deformations present where the pipe wall thickness is compromised greater than 10%
FR	Flame Resistant
HDPE	High Density Polyethylene
MDPE	Medium Density Polyethylene
NGUS	Natural Gas Utility Sheet
OQ	Operator Qualification
PPE	Personal Protective Equipment
QRG	Quick Reference Guide
SDR	Standard Dimension Ratio

Safety

Wear KUB standard personal protective equipment (PPE) (i.e., hard hat, safety glasses, safety toed footwear, and appropriately rated traffic vest). Per the *Flame Resistant Personal Protective Equipment for UGC Natural Gas Events* QRG, flame resistant (FR) PPE is required in an actual or potential gaseous environment. If butt fusion is in or near an actual or potential gaseous environment, at a minimum, the FR clothing required is as follows:

- HRC2 coveralls or HRC2 long sleeve shirts and pants
- Balaclava (sock)
- Leather gloves

Equipment and Materials

- MDPE and/or HDPE pipe manufactured to ASTM D 2513, with the exception of Uponor Aldyl A MDPE products or Driscopipe 7000/8000 HDPE products
- McElroy machine or KUB-approved equivalent
- McElroy Slide Rule Pressure Calculator or KUB-approved equivalent
- Pyrometer
- Clean lint-free cloth
- Isopropyl alcohol (96% or greater)
- Permanent (non-greasy, non-petroleum) marker

References

- Plastic Pipe Institute TR-33 – *Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe*
- Performance Pipe Heat Fusion Joining Procedures and Qualification Guide
- McElroy Chart (i.e. McElroy Slide Rule Pressure Calculator or McElroy Nomogram Pressure Calculator) for the specific McElroy machine or KUB-approved equivalent

- ASTM D3261.16 – Standard Specification for Butt Heat Fusion PE Plastic Fittings for PE Plastic Pipe and Tubing
- ASTM F2620 – Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
- 49 CFR 192.283, *Plastic Pipe: Qualifying Joining Procedures*
- TCHS-PPE-L03-QIK014 *Flame Resistant Personal Protective Equipment for UGC Natural Gas Events*
- *Grounding Polyethylene Pipe and Tools SOP*

Instructions

► To complete this task, follow these steps:

1. Conduct a job safety briefing and perform the following:
 - Inspect pipe and fittings for unacceptable cuts, gouges, scratches, or other surface damage. Damaged products should not be used.
 - Check electrical cord for any damages. If any damages are present, take equipment out of service until repairs are made.
 - Shield fusion equipment and surfaces from inclement weather and winds, if needed. Butt fusion joining shall not be performed when temperatures are below 0°F. Tool and pipe surfaces must be clean and dry before fusing.
 - Check heating tool surface cleanliness and temperature. Do not use the heat plates if they are damaged.
 - Determine pressures (joining, heating, and fusion) for pipe size(s) per McElroy Chart.
2. Ensure that proper safety precautions were taken to reduce static electricity in accordance with *Grounding Polyethylene Pipe and Tools SOP* prior to fusing to active pipe sections.
3. Prepare the heating tool.
 - a. Attach the proper size heater plates to the heating tool.
 - b. Visually inspect heating tool to ensure that the correct heater plates are attached and that it is clean, oil-free, and coated with nonstick coating as recommended by the manufacturer to prevent molten plastic from sticking to the heater surfaces.
 - c. If the heater plates do not pass visual inspection due to contamination, they shall be cleaned with alcohol and a lint-free cloth. If heater plates have coating damage, they shall be removed from service.
 - d. Heat the tool so that the surface temperature is between 400-450°F.
4. Secure and clean the components to be joined.
 - a. Clean the inside and outside of the component(s) (pipe and/or fitting) by wiping with a clean, lint-free cloth and isopropyl alcohol.
 - b. Clamp the components in the machine.
 - c. Check alignment of the ends and adjust as needed.
5. Face the pipe ends to establish clean, parallel mating surfaces.
 - a. Face off slightly.
 - b. Recheck alignment. If PE pipe surface becomes contaminated, the surface shall be re-cleaned with alcohol as stated in 3. a.
 - c. Continue facing a minimal distance between the fixed and movable jaws of the machine.
 - d. Open the jaws and remove the facer.

- e. Remove any pipe chips from the facing operation and any foreign matter with a clean, lint-free cotton cloth.
- f. Bring the component ends together at fusion force to ensure the pipe is secure in the machine and inspect the face off.
- g. Visually confirm that the faces are square, perpendicular to the pipe centerline on each pipe end, and with no detectable gap.

Note: Do not touch the component ends with your hands after facing.

6. Align the pipe profile.
 - a. Tighten the clamping jaws until the outside diameters of the component ends match, if necessary.
 - b. Re-face the component ends down to the stops and remove any chips from the re-facing operation with a clean, lint-free cotton cloth.
 - c. Visually confirm complete contact around both ends with no detectable gaps and outside diameters in high-low alignment. If necessary, adjust the high side by tightening the high side clamp.

Note: Do not loosen the low side clamp because components may slip during fusion.

Note: If PE pipe surface becomes contaminated, after final facing down to the stops, start over at Step 4.

7. Inspect the heating tool.
 - a. Visually inspect heating tool to ensure that the correct heater plates are attached and that it is clean, oil-free, and undamaged.
 - b. Using a pyrometer, confirm temperature of the heating tool face is between 400-450°F prior to contacting the pipe or fittings ends.
8. Melt the pipe interfaces with the heating tool.
 - a. Install the heater in the machine and bring the pipe ends into full contact with the heater. This initial contact should be under the joining pressure, as specified in the McElroy Chart.
 - b. For the manual machine, release pressure without breaking contact.
 - c. For the hydraulic machine, use the machine's shifting sequence.
 - d. Continue to hold the components in contact with each other, without force, while a bead of molten polyethylene develops between the heater and the pipe ends.
 - e. Remove the heating tool when the proper bead size is formed against the heated surfaces all around the pipe or fitting ends. The melt bead size is dependent on the pipe size (see Table 1).

Table 1. Butt Fusion Melt Bead Size for PE Pipe

Pipe Size	Approximate Melt Bead Size
Less than 2-inch	1/32 inches
Greater than or equal to 2-inch through 3-inch	About 1/16 inches
Greater than 3-inch through 8-inch	3/16 inches
Greater than 8-inch through 12-inch	1/4 inches

9. Join the two profiles together.
 - a. Quickly inspect the pipe ends. If a concave melt surface is observed (see Figure 1), unacceptable pressure during heating has occurred and the joint will not be acceptable.

Do not continue. Allow the component ends to cool completely and restart from the beginning.

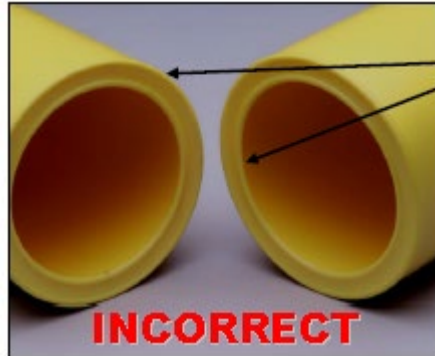


Figure 1. Unacceptable Concave Melt Appearance

- b. Immediately bring the molten pipe ends together with sufficient fusion force, as specified in the McElroy Chart to form a double rollback bead against the pipe wall.
10. Hold joining force against the ends until the joint is cool.
- a. Maintain fusion pressure against the piping component ends for a minimum of 11 minutes per inch of pipe wall thickness (Table 2).

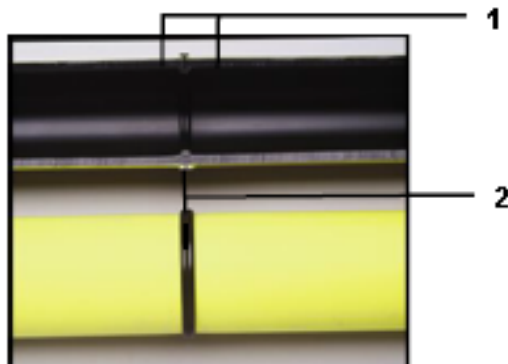
Table 2. Butt Fusion Initial Cooling Time

Pipe Size	Initial Cooling Time
Less than or equal to 2-inch	2.5 minutes
4-inch	4.5 minutes
8-inch	9.0 minutes
12-inch	11 minutes

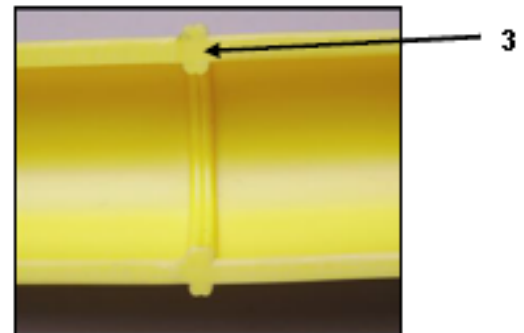
Note: If the pipe size is not shown in Table 2, use the cooling time for the next larger pipe size

- b. Avoid high stress such as pulling, installation, pressure testing, or rough handling for an additional 30 minutes after removal from the fusion machine.
 - c. Do not apply internal pressure until the joint and surrounding material have reached ambient air temperature.
11. Visually inspect the butt fusion and compare the joint against the manufacturer's recommended appearance guidelines (see Figures 2 and 3).
- a. On both sides, the double bead should be rolled over to the surface and be uniformly rounded and consistent in size all around the joint.
 - b. One bead may be larger than the other when fusing two dissimilar materials. This is acceptable provided both bead sizes are uniform around their respective pipes.
 - c. When butt fusing to molded fittings, the fitting-side bead may have an irregular appearance due to the molded part cooling and knit lines. This is acceptable provided the pipe-side bead is correct.
 - d. Visually unacceptable joints shall be cut out and re-fused by restarting this procedure from the beginning. Possible causes for unacceptable joints are provided in Table 2.

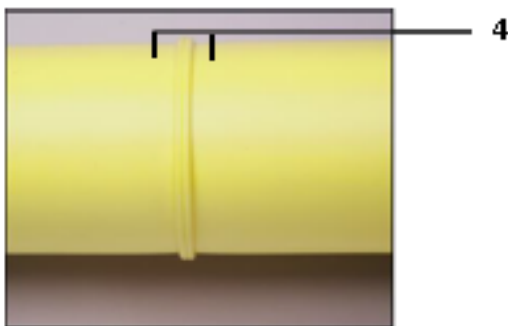
12. Once the person performing the butt fusion determines the fusion is acceptable, he/she shall sign the fusion connection with company name, employee name or ID, and date fusion was performed with an easily visible permanent marker (Example: black ink on MDPE yellow pipe and silver ink on HDPE black pipe.)
Note: Signing a visually unacceptable fusion will result in an investigation for qualification by the KUB OQ Program Administrator.
13. Document the fusion on the Natural Gas Utility Sheet (NGUS), if applicable.
Note: NGUS documentation is only required for repairs, service work, or main segments less than or equal to 50-feet.



1. Proper double roll-back bead
 2. Proper alignment



3. Proper double roll-back bead

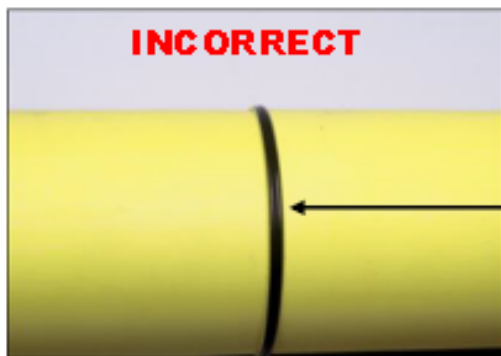


4. Proper alignment

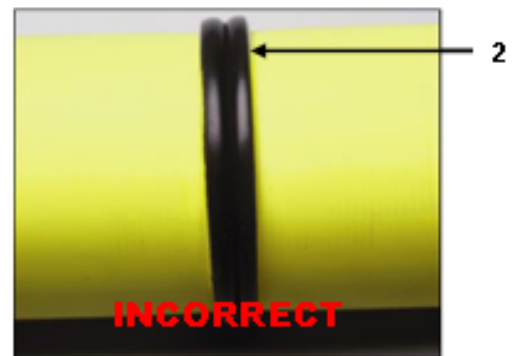


5. No gaps or voids when bent

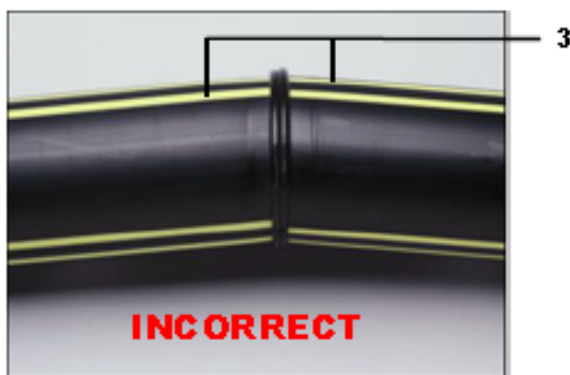
Figure 2. Acceptable Fusions



1. Insufficient heat time; melt bead too small



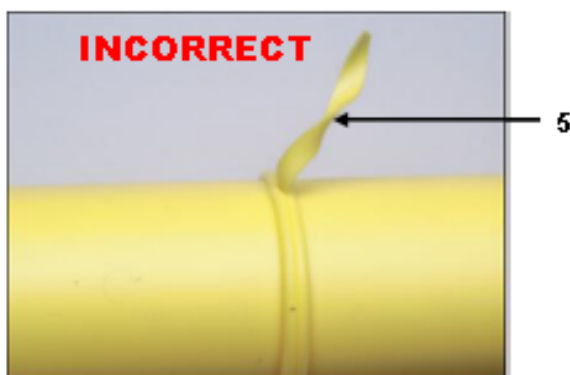
2. Excessive heat time or pressure applied during heating; melt bead too large



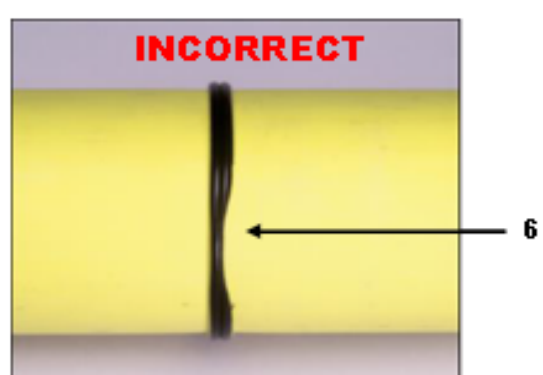
3. Pipe angled into fusion unit



4. Improper "High-Low" alignment



5. Incomplete face off or failure to remove faced off ribbons



6. Incomplete face off

Figure 3. Unacceptable Fusions

Table 2. Butt Fusion Bead Troubleshooting Guide

Observed Condition	Possible Causes
Double bead v-groove too deep	Pressure applied during the heating cycle
Non-uniform bead size around pipe	Misalignment; defective heating tool; worn equipment; incomplete facing
One bead larger than the other	Different bead sizes are expected when joining different material types, such as heat fusion joining MDPE to HDPE pipes. If the two materials being joined are the same, then having one bead larger than the other bead may be a sign that the component slipped in the clamp; that the heating tool may be defective; or that there may be incomplete facing.
Beads too small	Insufficient heating; insufficient joining force
Beads too large	Excessive heating time
Rough, sandpaper-like, bubbly, or pockmarked melt bead surface	Hydrocarbon contamination

Checklists and Forms

- Natural Gas Utility Sheet, if applicable



Butt Fusion Joining for Polyethylene Pipe

SOP**Issued****Effective:**
3/30/2018**Reviewed:**
4/2/2021

Document Information and Review History

Owner	072 – Gas Systems Engineering											
Utilities	<table><tr><td>Electric</td><td>Gas</td><td>Water</td><td>Wastewater</td></tr><tr><td>No</td><td>Yes</td><td>No</td><td>No</td></tr></table>	Electric	Gas	Water	Wastewater	No	Yes	No	No			
Electric	Gas	Water	Wastewater									
No	Yes	No	No									
Program Category	Natural Gas Construction											
Document Group Type	[Document Group Type]											
Preparer	Rebecca Rogers (Strata-G), Leslie Emison, Wes Marine, David Kyle											
Approved By	Brooke Sinclair, Chris Thomas, Jamie Davis											
Review Cycle	1 Year(s)											

Revision Date	Reviewer	Modifications
2/14/2020	<u>Reviewed:</u> B. Carey, B. Hemel, D. Kyle, A. Mann, D. Bledsoe, J. Hellard, M. Hillard, M. Bowden, B. Elmore <u>Approved:</u> D. Miller, J. McInturff, C. Thomas	No changes
5/3/2021	<u>Reviewed:</u> B. Carey, A. Mann, D. Bledsoe, J. Hellard, P. Thompson, M. Hillard <u>Approved:</u> D. Miller, J. McInturff, C. Thomas	Updated OQ task number and name