



Butt Fusion (PPI TR-33)

This procedure is intended for butt fusion joining of PE fuel gas pipe produced in accordance with (ASTM D2513). It also is intended for butt fusion joining of PE potable water, sewer and industrial pipe manufactured in accordance with ASTM F714, ASTM D3035, AWWA C-901 and AWWA C-906.

Butt Fusion Procedure Parameters

Generic Fusion Interface Pressure Range 5 60-90 psi (4.14-6.21 bar) Generic Heater Surface Temperature Range 400 - 450°F (204-232°C)

Butt Fusion Procedures

The principle of heat fusion is to heat two surfaces to a designated temperature, then fuse them together by application of a sufficient force. This force causes the melted materials to flow and mix, thereby resulting in fusion. When fused according to the proper procedures, the joint area becomes as strong as or stronger than the pipe itself in both tensile and pressure properties.

Field-site butt fusions may be made readily by trained operators using butt fusion machines that secure and precisely align the pipe ends for the fusion process. The six steps involved in making a butt fusion joint are:

- 1. Securely fasten the components to be joined**
- 2. Face the pipe ends**
- 3. Align the pipe profile**
- 4. Melt the pipe interfaces**
- 5. Join the two profiles together**
- 6. Hold under pressure**

SECURE

Clean the inside and outside of the pipe to be joined by wiping with a clean lint-free cloth. Remove all foreign matter.

Clamp the components in the machine. Check alignment of the ends and adjust as needed.

FACE

The pipe ends must be faced to establish clean, parallel mating surfaces. Most, if not all, equipment manufacturers have incorporated the rotating planer block design in their facers to accomplish this goal. Facing is continued until a minimal distance exists between the fixed and movable jaws of the machine and the facer is locked firmly and squarely between the jaw bushings. Open the jaws and remove the facer. Remove any pipe chips from the facing operation and any foreign matter with a clean, lint-free cotton cloth. Bring the pipe ends together with minimal force and inspect the face off. A visual inspection of this operation should verify that faces are square, perpendicular to the pipe centerline on each pipe end and with no detectable gap.

ALIGN

The pipe profiles must be rounded and aligned with each other to minimize mismatch (high-low) of the pipe walls. This can be accomplished by tightening clamping jaws until the outside diameters of the pipe ends match. The jaws must not be loosened or the pipe may slip during fusion. Re-face the pipe ends and remove any chips from re-facing operation with a clean, lint-free cotton cloth.

MELT

Heating tools that simultaneously heat both pipe ends are used to accomplish this operation. These heating tools are normally furnished with thermometers to measure internal heater temperature so the operator can monitor the temperature before each joint is made. However, the thermometer can be used only as a general indicator because there is some heat loss from internal to external surfaces, depending on factors such as ambient temperatures and wind conditions. A pyrometer or other surface temperature-measuring device should be used before the first joint of the day is made and periodically throughout the day to insure proper temperature of the heating tool face that contacts the pipe or fitting ends. Additionally, heating tools are usually equipped with suspension and alignment guides that center them on the pipe ends. The heater faces that come into contact with the pipe should be clean, oil-free and coated with a nonstick coating as recommended by the manufacturer to prevent molten plastic from sticking to the heater surfaces. Remaining molten plastic can interfere with fusion quality and must be removed according to the tool manufacturer's instructions. Never use chemical cleaners or solvents to clean heating tool surfaces.

The surface temperatures must be in the temperature range 400-450°F (204-232°C). Install the heater in the butt fusion machine and bring the pipe ends into full contact with the heater. To ensure that full and proper contact is made between the pipe ends and the heater, the initial contact should be under moderate pressure. After holding the pressure very briefly, it should be released without breaking contact. On larger pipe sizes, initial pressure may be maintained until a slight melt is observed around the circumference of the pipe before releasing pressure. 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. When the proper bead size is formed against the heater surfaces all around the pipe or fitting ends, remove the heater. Melt bead size is dependent on pipe size. See table below for approximate melt bead sizes.

Table A: Approximate Melt Bead Size

Pipe Size	Approximate Melt bead Size
1 1/4" and smaller (40mm and smaller)	1/32" - 1/16" (1-2mm)
Above 1 1/4" through 3" (above 40mm—90mm)	About 1/16" (2mm)
Above 3" through 8" (above 90mm—225mm)	1/8" - 3/16" (3-5mm)
Above 8" through 12" (above 225—315mm)	3/16" - 1/4" (5-6mm)
Above 12" through 24" (above 315—630mm)	1/4" - 7/16" (6-11mm)
Above 24" through 36" (above 630mm—915mm)	About 7/16" (11mm)
Above 36" through 63" (above 915mm—1600mm)	About 9/16" (14mm)

JOINING

After the heater tool is removed, quickly inspect the pipe ends (NOTE: If a concave melt surface is observed, unacceptable pressure during heating has occurred and the joint will be low quality. Do not continue. Allow the component ends to cool completely, and restart at the beginning. Except for a very brief time to seat the components fully against the heater tool, do not apply pressure during heating.), then immediately bring the molten pipe ends together with sufficient fusion force to form a double rollback bead against the pipe wall.

For larger manual and hydraulic butt fusion machines, fusion force is determined by multiplying the interfacial pressure, 60-90 psi, by the pipe area. For manually operated fusion machines, a torque wrench may be used to apply the proper force. For hydraulically operated fusion machines, the fusion force can be divided by the total effective piston area of the carriage cylinders to give a hydraulic gauge reading in psi. The gauge reading is theoretical; internal and external drags are added to this figure to obtain the actual fusion pressure required by the machine. The hydraulic gauge reading is dependent upon pipe diameter, DR and machine design. Interfacial pressure and gauge reading are not the same value.

HOLD

Hold the joint immobile under fusion force until the joint has cooled adequately to develop strength. Allowing proper cooling times under fusion force prior to removal from the clamps of the machine is important in achieving joint integrity. The fusion force should be held between the pipe ends for approximately 30-90 seconds per inch of pipe diameter or until the surface of the melt bead is cool to the touch.

Avoid pulling, installation or rough handling for an additional 30 minutes. Additional time may be required for pipes with a wall thickness greater than 2".

VISUAL INSPECTION

Visually inspect and compare the joint against the manufacturer's recommended appearance guidelines. Visually, the width of butt fusion beads should be approximately 2-2 1/2 times the bead height above the pipe and the beads should be rounded and uniformly sized all around the pipe circumference. The v-groove between the beads should not be deeper than half the bead height above the pipe surface. When butt fusing to molded fittings, the fitting-side bead may display shape irregularities such as minor indentations, deflections and non-uniform bead rollover from molded part cooling and knit lines. In such cases, visual evaluation is based mainly on the size and shape of the pipe-side bead. (See Table A for bead configuration). Visually unacceptable joints should be cut out and re-fused using the correct procedure. (See manufacturer's visual inspection guidelines)