

3020 - Fusion Procedures

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1. General

1. All fusion joints in plastic piping systems should be made in accordance with these written procedures. These procedures are designed to produce joints that are gas tight and that resist forces encountered in normal operating conditions. Only Qualified persons shall prepare (i.e. alignment, facing) or perform any fusion procedures (e.g. butt, saddle, socket or electrofusion).
 1. Heating tool temperatures are specified for each heat fusion procedure. Butt fusion and saddle fusion heating tool temperatures are different. The specified temperature of the heating tool's surface should be obtained by using a pyrometer, infrared thermometer, or temperature indicating crayons, not by reading the heating tool's thermometer. If temperature indicating crayons are used, they should not be applied to a surface that contacts the pipe or fitting. If crayons are used, the temperature should be checked at the upper and lower range with two separate crayons.
 2. Heating tool faces that come into contact with the pipe or fitting should be clean, oil-free, and covered with a factory-applied coating to prevent molten plastic from sticking to the heater surfaces. Molten plastic that can interfere with fusion quality should be removed. Only clean, dry wooden implements, non-synthetic cloth, or paper towels should be used to clean heating tool faces. Spray chemicals should not be used on heating tool faces.
 3. These procedures are based on tests conducted under controlled ambient temperature conditions. Environmental conditions on a job site could affect heating and cooling times. Regardless of job site conditions or ambient temperature, the prescribed heating tool temperature is required. Heating tool temperature should not be increased or decreased to compensate for ambient temperature conditions.
 4. Generally, 1-1/4" and larger pipe should not be joined by socket fusion. Socket fusion may be used on 5/8", 3/4", and 1-1/8" plastic pipe.
 5. For additional information concerning fusion joining procedures, refer to the pipe and fitting manufacturers' installation manuals.
 6. Mechanical joints should be utilized where fusion joints cannot be made in clean, stress-free conditions.

7. Medium density polyethylene (MDPE) and high density polyethylene (HDPE) pipe should be joined using electrofusion couplings. If installing an electrofusion coupling is not practical, contact the General Manager of Engineering to approve an alternate solution.

2. Safety Precautions

1. Electrical heating tools used for plastic fusion are potential sources of ignition. Therefore, appropriate precautionary measures should be taken before using the equipment in areas where combustible conditions may be present. Do not operate electrical fusion equipment or other devices that are not explosion proof in flammable atmospheres.
2. Heating tools should be handled carefully to avoid injury to personnel or damage to plastic pipe surfaces.
3. Suitable non-synthetic gloves should be worn when making fusion joints.

3. Butt Fusion

1. Butt fusion machines are required to make butt fusion joints. The butt fusion machine must be able to secure and precisely align the pipe ends during the fusion process. No butt fusion joints should be made unless the free end of pipe is one joint or less and is free to move longitudinally.

Note: Pups should be installed on fittings (e.g. ells and line tees) to allow for line-up clamp to be used.

2. Butt fusion shall not be made in bell holes.
3. In the event that two sections of pipe, each consisting of several joints, need to be joined by butt fusion, pipe section which is slid back and forth for fusing should be on rollers and should not exceed 5 joints. Pipe should remain in butt fusion machine for 30 minutes after fusing to avoid subjecting the joint to any pulling force.
4. The steps listed below should be followed when making butt fusion joints.
 1. Clean the inside and outside of the pipe to be joined by wiping with a clean lint-free cloth. Remove all foreign matter. Securely fasten the components to be joined in the clamps of the butt fusion machine. Check alignment of the ends and adjust as needed.
 2. Face the pipe ends to establish clean, parallel mating surfaces. Look for continuous circumferential shavings from both pipe ends. Continue facing until a minimal distance exists between the fixed and movable jaws of the machine. If stops are present on the machine, face down to the stops. Check for a square face that is perpendicular to the pipe centerline with no detectable gaps. Remove any shavings from the pipe ends. Do not touch the pipe ends after facing.
 3. Bring the pipe ends together and check for proper alignment. Look for complete contact all around both ends with no detectable gaps. Make sure the outside diameters of the pipe ends match. If necessary, adjust the high side by tightening its clamp. Do not loosen any clamps because the pipe may slip during fusion. Re-face if high-low alignment is adjusted.
 4. Check the heating tool. Make sure that the surface temperature on each side of the heating tool is 400-450°F. Make sure that the heating tool is equipped with alignment guides to center it on the pipe ends.
 5. Melt the pipe faces by installing the heating tool in the butt fusion machine and bringing the pipe ends into contact with both sides of the heating tool. Make the initial contact under moderate pressure. Ensure that full contact is made between the pipe ends and the heating tool. Hold at moderate pressure very briefly. At first sign of melt around the pipe ends, release the pressure without breaking contact. Continue to hold the components in place, without force, while a bead of molten polyethylene (PE) develops between the heating tool

and the pipe ends. When the proper bead size (see following table) is formed against the heating tool surfaces, remove the heater and quickly inspect the pipe ends to ensure that they are flat, smooth, and completely melted.

Pipe or Fitting Size	Approximate Melt Bead Size
1-1/4" IPS or smaller	1/32" - 1/16"
> 1-1/4" IPS to 3" IPS	1/16"
> 3" IPS to 8" IPS	1/8" - 3/16"
> 8" IPS to 12" IPS	3/16" - 1/4"

6. Immediately join the heated pipe ends together in a continuous motion. Do not slam. Apply enough force to form a double rollback bead against the pipe wall. This is a visual determination for manually operated fusion machines. For hydraulically operated fusion machines, follow the manufacturer's instructions to obtain the proper fusion force.
7. Hold the molten joint immobile under pressure until the surface of the bead is cool to the touch. Allow the joint to cool for approximately 5 minutes before removing the clamps of the machine. Avoid pulling, installing, or rough handling of the pipe for an additional 30 minutes.
8. Inspect the joint. Look for a double bead rolled back over to the pipe's surface on both sides of the joint. The double bead should be uniformly rounded and consistent in size all around the joint. The width of the double bead should be 2 to 2-1/2 times its height, and the v-groove depth between the beads should not be more than half the bead height.
9. After the joint is inspected and deemed satisfactory, record the date and installer's name (first initial and complete last name) on the pipe with a permanent felt-tip marker.

4. Socket Fusion

1. Socket fusion equipment is required to make socket fusion joints. This equipment includes chamfering tool, depth gauge, cold ring clamp, and heating tool with male and female socket faces. The steps listed below should be followed when making socket fusion joints.
 1. Squarely cut the pipe end using a plastic pipe cutter or hand saw.
 2. Chamfer the pipe end to remove the sharp outer edge. Remove all burrs from inside of pipe end. Make sure the pipe end is clean, dry, and free of foreign substances. Wipe with a clean lint-free cloth. Do not touch pipe surface after it is cleaned.
 3. Place the depth gauge snugly over the chamfered end of the pipe, and clamp the cold ring clamp on the pipe immediately behind the depth gauge. Remove the depth gauge.
 4. Wipe inside the fitting socket with a clean lint-free cloth. Do not touch the inside fitting surface after it is cleaned.
 5. Check the heating tool. Make sure that the temperature on each surface of the heating tool is 490-510 °F.
 6. Push the socket fitting onto the male socket face. Make sure the socket fitting bottoms out completely against the back surface of the male heater face.
 7. Push the pipe end into the female socket face. Make sure the cold ring clamp is completely against the female socket face, and hold in place. Start the heating time when the cold ring is against the female heater face.
 8. Hold the fitting and the pipe in place against the heater faces for the total heating time. See table below. Do not twist the pipe, fitting, or

Pipe Size	Total Heating Time (Seconds)	Initial Cooling Time (Seconds)
1/2" CTS	6-7	20
1/2" IPS	6-7	20
3/4" IPS	8-10	20
1" CTS	9-10	20
1" IPS	10-12	30
1-1/4" IPS	12-14	30
2" IPS	16-19	30

9. At the end of the heating time, quickly remove the pipe from the heating tool, then the fitting from the heating tool. Snap them straight off from the heating tool faces. Do not displace the melt. If the pipe or fitting are removed at an angle or twisted, melt can be displaced, and the joint may leak or fail. Grasp the pipe behind the cold ring clamp. Pulling on the cold ring clamp handle can cause slippage or displace the melt.
10. Quickly check the melt pattern on the pipe end and the fitting socket. Look for completely melted surfaces with no cold spots. If the melt is not complete, do not continue with the joint. Cut off the melted pipe end, use a new fitting, and start over from Step 1. Do not re-use a melted fitting. If the melt is correct, continue the joining procedure.
11. Within 3 seconds after removing from the heating tool, firmly push the pipe end and the fitting socket straight together until the cold ring clamp makes firm contact with the end of the socket fitting. Grasp the pipe behind the cold ring clamp. Pushing on the cold ring clamp handle can cause slippage or a crooked joint.
12. Hold the pipe and fitting firmly together for the initial cooling time. See table under step 8. Do not twist the pipe or fitting. Push the pipe and fitting straight together. If joined at an angle or misaligned, the joint may leak or fail.
13. Relax holding force after initial cooling time ends. After an additional 3 minutes undisturbed cooling time, remove the cold ring clamp. Allow an additional 10 minutes undisturbed cooling time before testing, backfilling, or stressing the joint.
14. Inspect the joint. Visually check the end of the socket fitting at the pipe. There should be a clear impression of the cold ring clamp into the melt ring at the end of the fitting, with no visible gaps or voids around the pipe at the socket melt ring. The pipe and fitting should be aligned straight with each other.
15. After the joint is inspected and deemed satisfactory, record the date and installer's name (first initial and complete last name) on the pipe with a permanent felt-tip marker.

5. Saddle Fusion

1. Saddle fusion machines are required to make saddle fusion joints. The saddle fusion machine must be capable of holding and supporting the main pipe, rounding the main pipe for good alignment between the pipe and fitting, holding the fitting, and applying and indicating the proper force during the fusion process. See Reference Drawing [2.01.120 for Plastic Tapping Tee - Conventional Fusion](#).
2. Saddle fusion shall not be performed on any DuPont / Uponor Aldyl A mains. This would include all mains that are tan, pink, or gray. Additionally, saddle fusion shall not be performed on PE 2306 mains. These would generally be PE mains that are orange in color. Fusing a saddle type fitting to any tan, pink, gray, neon yellow, or orange colored PE main shall be performed using the electro-fusion joining method.
3. When saddle fusing, PE 2406 fittings shall be fused to PE 2406 pipe, and PE 3408 fittings shall be fused to PE 3408 pipe. Approved mechanical and electro-fusion tees are acceptable alternatives to saddle fusion.

4. The steps listed below should be followed when making saddle fusion joints:

1. Install the saddle fusion machine on the main pipe according to the manufacturer's instructions. Center the machine over a clean, dry location where the fitting will be fused. Secure the machine to the main pipe. Use a bolster or support under the main pipe on 6" IPS and smaller main pipe.
2. Abrade the main pipe, where the fitting will be joined, with a 50-60 grit utility cloth until a thin layer of the pipe surface is removed. The abraded area must be larger than the area covered by the fitting base. After abrading, brush residue away with a clean lint-free cloth.
3. Abrade the fusion surface of the fitting with 50 to 60 grit utility cloth. After abrading, brush residue away with a clean lint-free cloth. Insert the fitting in the saddle fusion machine loosely. Using the saddle fusion machine, move the fitting base against the main pipe and apply moderate force (about 100 pounds) to seat the fitting. Secure the fitting in the saddle fusion machine.
4. Check the heating tool. The heater must be fitted with the correct heater adapters. The temperature of the heater adapter fusion surfaces must be 490-510°F.
5. Place the heating tool on the main pipe centered beneath the fitting base. Immediately move the fitting against the heater faces, apply the initial heat force (see note below), and start total heating time. Apply the initial heat force until melt is first observed on the crown of the main pipe. This usually takes 3-5 seconds. Then reduce the force to the heat soak force. Maintain the heat soak force until the total heating time is complete. See table below.
 1. Saddle fusion machines must be equipped with a gauge to measure the proper forces required to join plastic pipe. On most saddle fusion fittings, the proper forces should be listed in the lower right hand corner of the fitting's label (initial heat force / heat soak force / fusion force, example 280/0/140). When the proper forces are not indicated on the fitting's label, installation instructions supplied by the fitting's manufacturer must be referenced to determine the correct forces.
 2. Initial heat force (or bead-up force) is the term used to describe the initial heating force required to develop a melt bead on the main pipe.
 3. Heat soak force (or heating force) is the term used to describe the minimum force, essentially zero pounds, that ensures that the fitting, heater, and main stay in contact with each other.
 4. Total heating time is the term used to describe the time that starts when the heater is placed on the main pipe and ends when the heater is removed. See table below.

Main Pipe Size	Total Heating Time
1-1/4" IPS	Stop heating when a 1/16" bead is visible all around fitting base. Do not exceed 15 seconds when hot tapping.
2" IPS	Stop heating when a 1/16" bead is visible all around fitting base. Do not exceed 35 seconds when hot tapping
3" IPS and Larger	Stop heating when a 1/16" bead is visible all around fitting base.

6. At the end of the total heating time, remove the fitting from the heater and the heater from the main pipe with a quick snapping action. Quickly check for an even and complete melt pattern on the main pipe and fitting heated surfaces.
7. Regardless of satisfactory melt patterns, press the fitting onto the main pipe within 3 seconds after removing the heater and apply the fusion force. Maintain the fusion force on the assembly for 5 minutes on 1-1/4" IPS main and for 10 minutes on all larger main sizes, after which the saddle fusion equipment may be removed. Never reduce the fusion force during cooling.
 1. Note: Fusion force (or joining force) is the term used to describe the force applied to establish a fusion bond between the fitting and the

8. Allow the saddle fusion joint to cool for an additional 30 minutes before rough handling or tapping the main pipe.
9. If the melt pattern observed in Step 6 was not satisfactory, the saddle should not be placed into service. Do not attempt to remove the saddle base. Leave it in place to reinforce the main pipe, and cut the saddle fitting above the base to prevent use. Move to a new location on the main pipe, and install a new saddle fitting following the complete saddle fusion procedure.
10. Visually inspect the completed joint. Visually check the fusion bead around the entire fitting base at the main pipe. The fusion bead should be uniformly sized all around the fitting base, and should have a characteristic three-bead shape. The first bead is the fitting base melt bead. The second or outermost bead is produced by the edge of the heating tool face on the main. The third or center bead is the main pipe melt bead. The first and third beads should be about the same 1/8" size all around the fitting base. The second bead is usually smaller, but should also be uniformly sized around the fitting base. If the fusion bead is unacceptable, the saddle fitting cannot be used.
11. If the joint does not pass inspection, the saddle should not be placed into service. Do not attempt to remove the saddle base. Leave it in place to reinforce the main pipe, and cut the saddle fitting above the base to prevent use. Move to a new location on the main pipe, and install a new saddle fitting following the complete saddle fusion procedure.
12. After the joint is inspected and deemed satisfactory, record the date and installer's name (first initial and complete last name) on the pipe with a permanent felt-tip marker.

6. Electrofusion Couplings

1. Electrofusion couplings must be installed with the proper fusion equipment. This equipment includes universal fusion processor, hand scraper or scraping tool, alignment tool and re-rounding clamp if needed. The steps listed below should be followed when installing electrofusion couplings.
 1. Verify the pipe O.D. with the selected coupling.
 2. Measure and mark the pipe insertion depth on the pipe surface covered by the coupling with a black felt-tip marker or silver pipe marker. Do not use a grease marker. Mark the surface to be scraped with wavy lines. Note: Most couplings have an easily removable center-stop.
 3. Wash the pipe with water and isopropyl alcohol and then scrape off the oxidized layer on the pipe using either a hand scraper or scraper tool. Inspect the scraped area. If the marker lines are not completely removed, repeat the scraping process. Localized scraping is also sometimes needed after checking the ovality with the coupling.
 4. Scrape off the edges, inside and outside. Bevel the outer edge more than the inner edge and remove shavings and debris from the pipe
 5. If needed, re-round oval pipe with re-rounding clamp.
 6. Clean only the scraped pipe surface and inside of coupling liberally with isopropyl alcohol (>96%, i.e.: Lym-Tech Wipes). Make sure surfaces are completely dry before assembly. Warning: The use of denatured alcohol is prohibited as a cleaning agent. Also, do not wipe beyond the scraped area of the pipe. Wiping the pipe beyond scraped area may contaminate the fusion zone area with bentonite or other residue.
 7. Re-mark pipe insertion depth. Insert coupling to marked insertion depth on pipe. The use of a hammer and a board placed across the open end face of the coupling is permissible to properly position coupling. If you meet excessive resistance, see step 5. Leave the plastic bag over the open end of the coupling during assembly to keep contamination out of the fusion zone area. Care should always be taken to not contaminate fusion zone area.
 8. Assembly of pipe and coupling should be in a clean, supported and stress free condition. Alignment tool is required for all electrofusion couplings except: TD Williamson SHORTSTOPP PE Bottom Branch Outlet and MT Deason Polytann Branch Saddle. Support the pipe and

fitting during the fusion and cooling cycles.

9. Connect coupling to universal fusion processor and start fusion.

1. After the end of the fusion process, record the end of fusion time (time of day) and cooling time (in minutes) and Length of fusion time (in seconds) from fusion processor on the pipe with a marker. Wait for indicated cooling time. Cooling time is displayed on fusion processor or barcode on fitting.
2. Inspect the joint. Visually check the coupling and pipe to ensure that they are properly joined and aligned correctly.
3. After the joint is inspected and deemed satisfactory, record the date and installer's name (first initial and complete last name) on the pipe with a permanent felt-tip marker.

7. Electrofusion Saddles

1. Electrofusion saddles, including tapping tees, bottom outlet fittings, side outlet fittings and patching saddles, must be installed with the proper fusion equipment.

Equipment includes universal fusion processor, hand scraper or scrapping tool, and re-rounding clamp if needed. Top-loading tees also require a top-loading tool and cap adapter. Install electrofusion saddles according to the manufacturers' instructions.

1. The steps listed below should be followed when installing electrofusion fittings.

1. Verify the pipe O.D. with the selected fitting.
2. Measure and mark the pipe surface covered by the fitting with a black felt-tip marker or silver pipe marker. Do not use a grease marker, or any petroleum-based marker. Mark the surface to be scraped with wavy lines.
3. Wash the pipe with water and isopropyl alcohol before scraping and then scrape off the oxidized layer on the pipe using either a hand scraper or scraper tool. Inspect the scraped area. If the marker lines are not completely removed, repeat the scraping process. The scraped area should be larger than the area covered by the fitting base.
4. If needed, re-round oval pipe with re-rounding clamp.
5. Clean only the scraped pipe surface and inside the saddle of the tee thoroughly with isopropyl alcohol (>96%, i.e.: Lym-Tech Wipes). Make sure surfaces are completely dry before assembly. Warning: The use of denatured alcohol is prohibited as a cleaning agent. Also, do not wipe beyond the scraped area of the pipe. Wiping the pipe beyond scraped area may contaminate the fusion zone area with bentonite or other residue.
6. Install fitting on prepared surface of pipe. Care should always be taken to not contaminate fusion zone area.
 1. Top-loading tees should be installed with top-loading tool and proper cap adapter. Install tee without using excessive force until flush with pipe.
 2. Under-saddle fittings should be installed by firmly tightening all four bolts, working diagonally, without using excessive force until flush with pipe.

7. Assembly of pipe and fitting should be in a clean, supported and stress free condition. Support the pipe and fitting during the fusion and cooling cycles.
8. Connect fitting to universal fusion processor and start fusion.
9. After the end of the fusion process, record the end of fusion time (time of day) and cooling time (in minutes) on the pipe with a marker. Wait for indicated cooling time. Cooling time is displayed on fusion processor or barcode on fitting. Do not remove any top-loading tool or under-saddle fitting before the cooling time elapses.
10. Inspect the joint. Visually check the fitting and pipe to ensure that they are properly joined and aligned correctly. If the joint is not satisfactory, the fitting should not be placed into service. Do not attempt to remove the saddle base. Leave it in place to reinforce the main pipe, and cut the fitting above the base to prevent use. Move to a new location on the main pipe, and install a new fitting following the complete relevant procedure.
11. After the joint is inspected and deemed satisfactory, record the date and installer's name (first initial and complete last name) on the pipe with a permanent felt-tip marker.

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