3.0 PLASTIC PIPE JOINING

3.300 PLASTIC PIPE FUSION PROCEDURE

A. SCOPE: The purpose of this procedure is to provide instructions for the fusion of polyethylene natural gas pipe. This procedure follows the requirements outlined in ASTM F2620 Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.

B. REFERENCE: 16NYCRR Part 255.281

C. MATERIAL THAT CAN BE USED FOR THIS PROCEDURE
Use this procedure to join the following pipe and fittings to themselves or to each other: PE2406/2708, PE 3408/3710/4710 and PE100.

D. GENERAL
In heat fusion joining, mating surfaces are prepared and simultaneously melted with a hot-plate heater. The heater is then removed and the melted surfaces are pressed together and held under pressure. As the molten materials cool, they mix and fuse into a permanent, monolithic joint. Heat fusion procedures require specific tools and equipment based on the fusion type and the sizes of pipe and fittings being joined.

1. Butt fusion is used to make end-to-end joints between “butt” or plain-end pipes and fittings that have the same outside diameter and “like wall thickness”.

    a. “Like wall thickness” means that the pipe or fitting ends being butt fused do not exceed one SDR difference (e.g. SDR 9.0 to SDR 11.0). Per ASTM, standard dimension ratio (SDR) is when the outside diameter divided by the minimum wall thickness equals one of the following values: 5.0, 6.0, 7.3, 9.0, 11.0, 13.5, 17.0, 21.0, 26.0, 32.5.

CAUTION - Polyethylene piping products cannot be joined with adhesives or solvent cement. Joining by hot air (hot gas) welding or extrusion welding techniques and joining by pipe threading are not recommended for pressure service.

E. PRECAUTIONS

1. Static Electricity

WARNING – Fire or Explosion – Static electricity discharge can ignite a flammable gas or combustible dust atmosphere.

a. Polyethylene plastic pipe does not readily conduct electricity. A static electricity charge can build up on inside and outside surfaces and stay on the pipe surface until some grounding device such as a tool or a person comes close enough for the static electricity to discharge to the grounding device.

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b. Discharging one part of the pipe surface will not affect other charged areas because static electricity does not flow readily from one area to another. Polyethylene pipe cannot be discharged by attaching grounding wires to the pipe.

c. A static electricity discharge to a person, a tool or a grounded object close to the pipe surface can cause an electric shock or a spark. That can then ignite a flammable gas or combustible dust atmosphere causing fire or explosion.

d. Static electricity can be a potential safety hazard. Where a flammable gas-air mixture may be encountered and static charges may be present, such as when repairing a leak, squeezing-off an open pipe, purging, making a connection, etc., arc preventing safety precautions are necessary. Company and contractor employees are to follow Company procedures for static electricity safety and control, including procedures for discharging static electricity and requirements for personal protection.

e. Take steps to discharge static electricity from the surface of a polyethylene gas pipe. Such steps include wetting the entire exposed pipe surface with a conductive anti-static liquid or a dilute soap and water solution, then covering or wrapping the entire wetted, exposed pipe surface with grounded wet burlap, conductive poly film or wet tape conductor. The external covering should be kept wet by occasional re-wetting with anti-static solution. The covering or tape should be suitably grounded such as to a metal pin driven into the ground.

f. Steps that discharge the outer surface do not discharge the inner surface of the pipe. Squeeze-off, purging, venting, cutting, etc., can still result in a static electricity discharge. When appropriate, ground tools and remove all potential sources of ignition.

g. Appropriate safety equipment shall be used.

h. Do not use polyethylene pipe for handling dry grain, coal or pneumatic slurry applications where a static electricity discharge may ignite a combustible dust atmosphere and cause an explosion or fire.

2. Electric Tools

WARNING – Fire or Explosion – Electric tools or fusion equipment may not be explosion proof and may ignite a flammable gas or flammable dust atmosphere.

a. **DO NOT** operate electrical devices that are not explosion proof in a flammable gas or flammable dust atmosphere. When a flammable gas-in-air mixture may be present, observe all gas system operator (company employee or contractor) safety procedures for the use of electric tools and equipment.

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3. Liquid Hydrocarbon Permeation

   a. When present, liquid hydrocarbon may permeate (solvate) polyethylene pipe. Liquid hydrocarbon permeation may occur when: liquid hydrocarbons are present in the pipe; where soil surrounding the pipe is contaminated with liquid hydrocarbons; or where liquid hydrocarbon condensates can form in gas pipelines. Heat fusion joining to liquid hydrocarbon permeated pipes may result in a low strength joint.

   b. Liquid hydrocarbon contamination is indicated by a rough, sandpaper like, bubbly or pockmarked surface when a fusion heating iron is removed from the pipe surface and may be indicated by discoloration or by a hydrocarbon fuel odor. See the PPI Handbook of Polyethylene Pipe for additional information on permeation and chemical resistance.

      CAUTION – Once polyethylene pipe has been permeated with liquid hydrocarbons, heat fusion or elctrofusion joining is not recommended because liquid hydrocarbons will leach out during heating and contaminate the joint. Liquid hydrocarbon permeated polyethylene pipe should be joined using suitable mechanical connection methods. Contact the mechanical joining product manufacturer for connection and installation procedures.

4. Leakage at Fusion Joints

   WARNING – Correctly made fusion joints do not leak. When pressurized, leakage at a faulty fusion joint may immediately precede catastrophic separation and result in violent and dangerous movement of piping or parts and the release of pipeline contents under pressure. Never approach or attempt to repair or stop leaks while the pipeline is pressurized. Always depressurize the pipeline before making corrections. Faulty fusion joints must be cut out and redone.

5. Pipe Handling

   a. Polyethylene piping is a tough, robust material, but it is not immune to damage. **Improper handling or abuse can damage piping, compromise system performance and result in injury or property damage.** Polyethylene piping should be unloaded and moved with proper handling and lifting equipment. Use Fabric slings. Do not use chains or wire ropes. Do not roll or drop pipe off the truck or drag piping over sharp rocks or other abrasive objects. Store piping so that the possibility of mechanical damage is minimized.

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6. Cold Weather Fusions

a. In cold weather, polyethylene becomes more sensitive to impact and less flexible. Use additional care in handling. When temperatures are cold, avoid sharp impact such as dropping the pipe from moderate heights. Cold pipes will be harder to bend or uncoil. In inclement weather and especially in windy conditions, the fusion operation should be shielded to avoid precipitation or blowing snow and excessive heat loss from wind chill.

b. Remove all frost, ice or snow from the OD and ID surfaces of areas to be fused. Surfaces must be clean and dry before fusing. When fusing in cold weather, the time required to obtain the proper melt may increase.

c. Maintain the specified heating tool surface temperature. **Do not increase heating tool surface temperature.**

d. Do not apply pressure during zero pressure fusion heating steps.

e. Do not increase fusion joining pressure.

f. In butt fusion, melt bead size determines heating time. As a result, the procedure automatically compensates when cold pipe requires longer time to form the proper melt bead size.

g. Use only the cold weather heating time required to obtain the proper melt. Avoid excessive heating time.

F. KEY FACTORS FOR QUALITY FUSIONS

Quality fusion requires using all of the required tools and equipment, and following all of the steps in the procedure in the correct sequence. Faulty fusion is caused by improper or defective equipment, omitting steps or doing things out of sequence.
Training and experience provide knowledge and proficiency in what to do, what to expect and recognizing potential problems in advance. Inadequately trained or inexperienced persons can produce poor quality fusions and may expose themselves or others to hazards. Federal safety regulations require that persons making joints in gas systems must be qualified in the pipeline operator's qualified fusion procedures (CFR 49, Part 192).

The key factors below are necessary for quality fusion:

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1. Fusion tools and equipment must be correct for the job and in proper working order. Incorrect or poorly maintained or damaged fusion tools or equipment or using the wrong tools or equipment can cause a poor fusion and may be hazardous. Use only the correct tools and equipment for the job. Do not use defective or improper tools or equipment. Follow the equipment manufacturer's procedures for equipment maintenance.

2. The fusion operator must be proficient in tool and equipment use and operation, and proficient in fusion procedure. The operator should be thoroughly familiar with the tools and equipment and their use and operation. Improper use or an incorrect operating sequence can cause a poor fusion and may be hazardous. Know how to use the equipment and observe the manufacturer's instructions.

3. Pipe and fitting surfaces must be clean and properly prepared. Dirty, contaminated or poorly prepared surfaces that do not mate together properly cannot produce a quality fusion. Clean and prepare the surfaces before joining. If contamination is reintroduced, clean the surfaces again.

4. Heating tool surfaces must be clean, undamaged and at the correct surface temperature. Heating tool faces have non-stick coatings for quick, complete release from melted polyethylene. Dirty or contaminated heating tool faces can cause poor fusion and damaged coatings may not release properly from the melt. Use only wooden implements and clean, dry non-synthetic (cotton) cloths or paper towels to clean heating tool faces. Never use spray chemicals or metal tools on heating tool faces. Heating tool temperatures are specified for each procedure. (Butt fusion and saddle fusion heating tool temperatures are different.) *The specified temperature is the temperature on the surfaces that contact the pipe or fitting being joined, not the heating tool thermometer temperature.* Use a pyrometer or infrared thermometer to check for uniform temperature across both of the component contact surfaces. *(Temperature indication crayons are not preferred. If used, temperature-indicating crayons must never be applied to a surface that contacts a pipe or fitting).* Uneven temperature may indicate a faulty heater. The heater thermometer measures the internal temperature, which is usually higher than surface temperature; however, heating tool temperature can be verified by checking the thermometer to ensure that the heating tool is maintaining temperature. When checking surface temperature with a pyrometer or infrared thermometer, note the heating tool thermometer reading. Check the heating tool thermometer reading before each fusion to verify that the heating tool is maintaining temperature properly. Incorrect or non-uniform temperature can cause poor fusion; **low heating tool temperature can lead to a blowout during hot tap saddle fusion**.

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G. FUSION PRECAUTIONS

1. Prior to Fusing:
   a. Inspect pipe lengths and fittings for unacceptable cuts, gouges, deep scratches or other deleterious defects. Damaged products should not be used.

   b. Remove surface damage at pipe ends that could compromise the joining surfaces or interfere with fusion tools or equipment.

   c. Be sure all required tools and equipment are on site, in proper working order and fueled up.

   d. The pipe and fitting surfaces where tools and equipment are fitted must be clean and dry. Use clean, dry, non-synthetic (cotton) cloths or paper towels to remove dirt, snow, water and other contamination.

   e. Shield heated fusion equipment and surfaces from inclement weather and winds. A temporary shelter over fusion equipment and the fusion operation may be required.

   f. Relieve tension in the line before making connections.

   g. When joining coiled pipe, making an s-curve between pipe coils can relieve tension. In some cases, it may be necessary to allow pipe to equalize to the temperature of its surroundings. Allow pulled-in pipes to relax for several hours to recover from tensile stresses.

   h. Pipes must be correctly aligned before making connections.

      WARNING – Impact Hazard – Do not bend pipe into alignment against open butt fusion clamps. The pipe may spring out and cause injury or damage. Pipe must be aligned before placing it into butt fusion equipment.

2. Equipment Information

   a. Refer to the Fusion Equipment Operators Manual for specific procedures regarding the operation of each type of machine (Manual or Hydraulic).

   b. HEATING TOOL SURFACE TEMPERATURE - 440° F ± 10° F
   Heating tool surfaces must be clean and up to temperature before beginning the fusion procedure. All points on both heating tool surfaces where the heating tool surfaces will contact the pipe or fitting ends must be within the prescribed minimum and maximum temperatures.

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c. GAUGE PRESSURE

Gauge pressure is the pressure required for fusion. For hydraulic machines, the gauge pressure is a function of interfacial pressure, fusion surface area, machine's carriage cylinder size and drag pressure. When calculated, gauge pressure is what the operator will input into the fusion machine. The total effective piston area can be obtained from the machine manufacturer. The drag pressure is the pressure that is required to overcome movement in the carriage. ***Interfacial pressure and gauge pressure are not the same.*** Manually operated machines do not require a calculation for gauge pressure. **A slide rule or a gauge pressure calculator obtained from the machine's manufacturer may be utilized to determine the interfacial pressure.**

H. FUSION PROCEDURE

1. **Secure.** Clean the inside and outside of the component (pipe or fitting) ends by wiping with a clean, dry, lint-free cloth or paper towel. Remove all foreign matter. Align the components with the machine, place them in the clamps and then close the clamps. Do not force pipes into alignment against open fusion machine clamps (When working with coiled pipe, if possible "S" the pipes on each side of the machine to compensate for coil curvature and make it easier to join). Component ends should protrude past the clamps enough so that facing will be complete. Bring the ends together and check high-low alignment. Adjust alignment as necessary by tightening the high side down.

2. **Face.** Place the facing tool between the component ends and face them to establish smooth, clean, parallel mating surfaces. Complete facing produces continuous circumferential shavings from both ends. Face until there is a minimal distance between the fixed and moveable clamps. Some machines have facing stops. If stops are present, face down to the stops. Remove the facing tool and clear all shavings and pipe chips from the component ends. Do not touch the component ends with your hands after facing.

3. **Align.** Bring the component ends together, check alignment and check for slippage against fusion pressure. Look for complete contact all 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. Do not loosen the low side clamp because components may slip during fusion. Re-face if high-low alignment is adjusted.

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4. **Melt.** Verify that the heating tool is maintaining the correct temperature. Place the heating tool between the component ends and move the ends against the heating tool. The initial contact should be under moderate pressure to ensure full contact. Hold contact pressure very briefly then release pressure without breaking contact. Pressure must be reduced to contact pressure at the first indication of melt around the pipe ends. Hold the ends against the heating tool without force. Beads of melted polyethylene will form against the heating tool at the component ends. Use Table 1, which approximates the melt bead size from the pipe OD. When proper melt bead size is formed, quickly separate the ends and remove the heating tool. This process should be completed within recommended time in Table 2.

   a. When joining MDPE to HDPE the bead on the HDPE pipe will form slower than the bead on the MDPE pipe therefore use the widths specified in Table 1 for the HDPE bead.

During heating, the melt bead will expand out flush to the heating tool surface or may curl slightly away from the surface. If the melt bead curls significantly away from the heating tool surface, unacceptable pressure during heating may be indicated.

Table 1: Approximate Melt Bead Size

Pipe OD (in)	Approximate Melt Bead Size (in)
< 2.37	1/32
≥ 2.37 to 3.5	1/16
> 3.5 to < 8.62	3/16
> 8.62 to < 12.75	1/4
> 12.75 to ≤ 24	3/8
> 24 to < 36	7/16
> 36 to ≤ 65	9/16

Table 2: Maximum Heater Plate Removal Times

Pipe Wall Thickness (in)	Maximum Heater Plate Removal Time (secs)
0.20 to 0.36	8
> 0.36 to 0.55	10
> 0.55 to 1.18	15
> 1.18 to 2.5	20
> 2.5 to 4.5	25

Important:

a. For 14” and larger pipes, a minimum heat soak time of 4.5 minutes per inch of pipe wall thickness and the minimum melt bead size must be achieved.
b. The maximum heater plate removal time for ½” CTS to 1 ½” IPS is 4 seconds.

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5. **Join.** Immediately after heating tool removal, quickly inspect the melted ends, which should be flat, smooth and completely melted. If the melt surfaces are acceptable, immediately and in a continuous motion, bring the ends together and apply the correct joining force. Do not slam. Apply enough joining force to roll both melt beads over to the pipe surface. A concave melt surface is unacceptable; it indicates pressure during heating, see Figure 1 in attached manufacturer's Qualification Guide. Do not continue. Allow the component ends to cool and start over at Step 1. *Secure*.

6. **Hold**. Hold joining force against the ends until the joint is cool. Maintain fusion pressure against the pipe ends at a minimum cool time rate of 11 minutes per inch of pipe wall thickness. For ambient temperatures above 100º F, additional cooling time may be necessary. **Do not try to shorten cooling time by applying water, wet cloths or the like.**

   Avoid pulling, installation, pressure testing and rough handling for at least an additional 30 minutes.

   Heavier wall thickness pipes require longer cooling times.

7. **Inspection.** The completed joint shall be visually inspected by the person performing the fusion and if acceptable he/she shall sign the fusion prior to any further inspections. Once signed a second inspector shall perform a visual inspection of the fusion and if deemed to pass, the second inspector shall also sign the joint. If the person performing the fusion deems the joint to be unsatisfactory, do not sign or perform the second inspection, instead immediately remove joint. Doing so does not count as a failure. If the person performing the second visual inspection fails the fusion it shall be immediately removed and will be considered as a failed fusion.

   Butt fusion bead dimensional guidelines and pictures of acceptable and unacceptable fusions can be seen in attached manufacturer's Qualification Guide.

   When butt fusing to molded fittings, the fitting side bead may have an irregular appearance. This is acceptable provided the pipe side bead is correct.

   It is not necessary for the internal bead to roll over to the inside surface of the pipe.

   <u>Qualification</u>
   The Second Inspector described in paragraph (7) shall be a person that is fully qualified to perform PE fusions.

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8. Documentation

Each acceptable fusion joint made shall be:

- Signed (on the pipe) by the person performing the fusion and by the inspector.
- Trackable. A map shall be created for each project depicting the location of each PE fusion to be utilized to facilitate the locating of that fusion after project completion. At least one fusion on each map will have swing measurements shown to it from permanent aboveground structure(s) (i.e. building, utility poles, etc.). The remaining fusions may be located by additional swing measurements or by a longitudinal measurement along the main / pipeline between fusions.
- Listed on an electronic database, see *PE Fusion Joint Inspection Log*.
- This information shall be maintained for the life of the facility.

The following shall be recorded on the *PE Fusion Joint Inspection Report* for each project which shall be completed by the person performing the second inspection (Visual Inspector):

- Project – Record the name of the project.
- WO/DDO# - Record the Work Order or DDO Number.
- Date – Record the date the fusions were made.
- Contractor – Record the name of the Company performing the construction work.
- Contractor's Foreman – Full name of person providing oversight.
- Time Started – Record the starting time for the project for the date recorded above.
- Time Quit – Record the ending time for the project for the date recorded above.
- Size & Type – Record the facility diameter and material type (i.e. PE)
- SDR – Record the SDR (Standard Dimension Ratio)
- Outside Temperature – Record the ambient temperature (^{o}F) at the time of the project.
- Wind – Record the wind speed and direction at time of the project.
- Machine – Record the model, make and type of fusion machine being used.
- Conditions – Record any other pertinent information regarding the conditions at the time of the project (i.e. snow, rain, mud, heavy wind, etc.)
- Fusion # - Record the fusion number for each fusion made on the project.
- Fuser Name – Record the full name of the person making the fusion. Must include first and last name.
- Pass/Fail Visual – Write Pass or Fail.
- GPS# - Record the Waypoint for the fusion from a GPS unit, if available.
- Page # - Record the page # of the drawing.

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- Inspector's Name – Record the full name of the person performing the second (visual) inspection.
- Company – Record the name of the Company that the second inspector works for.
- Signature & Date – The second inspector shall sign and date the form.

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CORNING
NATURAL GAS CORPORATION

PE Fusion Joint Inspection Report

3.300 PLASTIC Pipe Fusion Procedure

Project: ______ DDO: ______ Date: ______

Contractor: ______ Contractors Foreman: ______

Time Started: ______ Time Quit: ______ SIZE & TYPE ___ / ___ SDR ______

Outside Temperature: ______ F Wind: ______ Machine: ______

Conditions: ______

Fusion #		Fuser Name		Pass/Fail Visual		GPS #		Page#	
Fusion #		Fuser Name		Pass/Fail Visual		GPS #		Page#	
Fusion #		Fuser Name		Pass/Fail Visual		GPS #		Page#	
Fusion #		Fuser Name		Pass/Fail Visual		GPS #		Page#	
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Inspectors Name: ______ Company: ______

Inspectors Signature: ______ Date: ______

3.300 PLASTIC PIPE FUSION PROCEDURE

Daily Failure Summary		
Fusion Number	Explain Failure(s) Found	Confirm Failure Cutout

Remarks:

3.300 PLASTIC PIPE FUSION PROCEDURE

Corning Natural Gas Corporation

PE Fusion Joint Inspection Log

Project Name	WO/DDO	Date Made	Fusion #	Fuser Name	Inspector Name	Pass / Fail	Map Page #	GPS Waypoint	Comments