SPECIFICATION: G-8123-17

TITLE: HEAT FUSION JOINING OF POLYETHYLENE (PE) PLASTIC PIPE/TUBING AND FITTINGS FOR GAS MAINS AND SERVICES

VOLUME: 2 (Section 7.0) and 10

REGISTRATION NO: GAS0452

TARGET TRAINING GROUPS: Gas Construction, Emergency Response Force (ERF), Gas Development Lab, Construction, Per Diem, and Gas Contractors

REVISIONS (See ★):

1) Sections 3.1 B, C, D, and 3.2 - Reference Specification G-8121 now covers all joining of PE plastic pipe/tubing and fittings (e.g. heat fusion, electrofusion, and mechanical fittings)

2) Section 6.7 - Added requirement to clean pipe with alcohol wipes prior to facing.

3) Section 7.1 - Revised reference section (9.3.B) for heating tool surface temperature

4) Table 1 - Revised title of table to clarify melt bead size on the heating tool surface.

5) Section 8.2 - Revised reference section (9.3.B) for heating tool surface temperature

6) Table 2 - Revised title of table to clarify melt bead size on the heating tool surface.
# Gas Operations Standards

**TITLE:** HEAT FUSION JOINING OF POLYETHYLENE (PE) PLASTIC PIPE/TUBING AND FITTINGS FOR GAS MAINS AND SERVICES

**EFFECTIVE DATE:** December 3, 2015

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1.0 **SCOPE**

This specification details the requirements for heat fusion joining of polyethylene (PE) plastic pipe, tubing, and molded fittings for gas mains and services by butt fusion and branch saddle fusion.

See Gas Specification IP-27, “Installation of Electrofusion Fittings on Plastic Pipe/Tubing and Molded Fittings Using a Universal Electrofusion Processor” for the requirements to join PE plastic pipe, tubing, and molded fittings by electrofusion.

See Gas Specification IP-20, “Installation of Mechanical Fittings for Plastic Pipe and Tubing” for the requirements to join PE plastic pipe and tubing with mechanical fittings.

2.0 **LEGAL REQUIREMENTS**


3.0 **OPERATOR QUALIFICATION**

3.1 Installers of PE Plastic Pipe

A) Installers who tap an energized pipeline, weld steel, and join PE plastic pipe by heat fusion (butt fusion or branch saddle fusion), electrofusion, or with mechanical fittings shall be Operator Qualified.

All other “covered tasks” shall be completed by either Operator Qualified individuals or individuals under the direct observation of one who is Operator Qualified. “Direct observation” means that the Operator Qualified individual remains in direct visual and verbal contact at all times with the individual performing the task.

B) Installers who join PE plastic pipe/tubing and fittings by heat fusion (butt fusion or branch saddle fusion) shall be Operator Qualified and in compliance with the annual requalification requirements of Gas Specification G-8121, "Qualification of Installers Joining Polyethylene (PE) Plastic Pipe/Tubing and Fittings for Gas Mains and Services."

All heat fusion joints must be fabricated in accordance with the fusion procedures outlined in this specification, the 2015 Northeast Gas Association (NGA) Plastic Pipe Joining Manual, and the manufacturers’ operating manual for the approved heat fusion joining equipment. (See Sections 7.1 and 8.2)
3.0 **OPERATOR QUALIFICATION** (Continued)

- C) Installers who join PE plastic pipe/tubing and fittings by electrofusion shall be Operator Qualified and in compliance with the annual requalification requirements of Gas Specification G-8121.

  All electrofusion joints must be installed in accordance with the electrofusion procedures outlined in Gas Specification IP-27.

- D) Installers who join PE plastic pipe/tubing with mechanical fittings, shall be Operator Qualified and in compliance with the annual requalification requirements of Gas Specification G-8121.

  All mechanical joints must be installed in accordance with the installation procedures outlined in Gas Specification IP-20.

3.2 Peer Inspectors of PE Plastic Joints

- A) Peer inspectors who inspect PE plastic pipe joints (heat fusion, electrofusion, or with mechanical fittings) shall be Operator Qualified and in compliance with the annual requalification stipulated in Gas Specification G-8121 OR Operator Qualified to visually inspect PE plastic joints (e.g. CCM 0003, GAS6016) and current with 3 year requalification.

- B) Peer inspectors who are required to wear corrective lenses, must wear same to ensure proper inspection of PE plastic joints.

4.0 **REQUIREMENTS FOR INSTALLERS AND PEER INSPECTORS**

4.1 All installers (Company, Contractor, Per Diem) of heat fusion joints on PE plastic pipe, tubing, and molded fittings shall identify the installer by marking the plastic pipe, tubing, or fittings adjacent to the heat fusion joint at 12 o'clock (or as close to 12 o'clock as is possible) with a Company approved marker (e.g. Class/Stock # 024-7106).

- A) Company installers shall clearly print their 5 digit employee number and “J” for joiner.

- B) Contractor and Per Diem installers shall clearly print their respective Learning Center Operator Qualification identification number (as noted on Con Edison Operator Qualification card) and “J” for joiner.
4.0 REQUIREMENTS FOR INSTALLERS AND PEER INSPECTORS (Continued)

4.2 After the heat fusion joints have cooled and solidified, the Operator Qualified installer and the Operator Qualified peer inspector shall visually inspect all heat fusion joints around the entire circumference of the joint and compare against visually acceptable butt fusion joints in the 2015 Northeast Gas Association (NGA) Plastic Pipe Joining Manual and the manufacturers’ recommended appearance guidelines.

A) Butt fusion joints should have uniform double fusion beads rolled over to the surface, be uniformly rounded, and consistent in size all around the joint. The PE plastic pipe, tubing, and fittings must be properly aligned (NOT angled or mitered).

NOTE (1): 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.

NOTE (2): This bead configuration DOES NOT apply to joints made with Dupont Aldyl A MDPE, Uponor Aldyl A MDPE or Phillips Driscopipe 7000 and 8000 HDPE.

B) Branch saddle fusion joints should have a characteristic three (3) bead shape and all beads should be uniformly sized all around the fitting base. The first bead (fitting base melt bead) and the third or center bead (main pipe melt bead) should be about the same size all around the fitting base. The PE plastic pipe must be properly aligned.

4.3 All peer inspectors (Company, Contractor, Per Diem) of heat fusion joints on PE plastic pipe, tubing, and molded fittings shall identify the inspector by marking the plastic pipe, tubing, or fittings adjacent to the heat fusion joint at 12 o’clock (or as close to 12 o’clock as is possible) with a Company approved marker (e.g. Class/Stock # 024-7106).

A) Company inspectors shall clearly print CE (for Con Edison), their 5 digit employee number and “P” for peer inspector.

B) Contractor and Per Diem inspectors shall clearly print their respective Learning Center Operator Qualification identification number (as noted on Con Edison Operator Qualification card) and “P” for peer inspector.

4.4 All PE plastic joints, joiners, and peer inspectors shall be documented as per DOJT GAS6006, “Documentation and Inspection of Polyethylene (PE) Plastic Joints on Gas Mains and Services.”
5.0 **QUALIFICATION OF HEAT FUSION JOINING PROCEDURES**

The heat fusion joining procedures outlined in this specification have been qualified in conjunction with:

- TR-33, “Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe”
- TR-41, “Generic Saddle Fusion Joining Procedure for Polyethylene Gas Piping”
- the 2015 NGA Plastic Pipe Joining Manual, and
- the fusion procedures established by our approved manufacturers’ of PE plastic pipe/fittings and heat fusion joining equipment.

**NOTE:** Con Edison's joining procedures have historically used a heat fusion temperature of 500°F +/- 25°F. This temperature differs from the procedures listed above, but has been proven to produce strong gas-tight joints.

6.0 **GENERAL GUIDELINES**

6.1 The preferred methods to join PE plastic pipe and tubing are heat fusion and electrofusion. (See Gas Specification IP-27)

When heat fusion or electrofusion is not practical or available, only approved restraining-type mechanical fittings shall be installed on PE plastic pipe and tubing per Gas Specification IP-20. All steel mechanical fittings shall be cathodically protected per Gas Specification G-8209, "Field Coating of Steel Pipe and Fittings Installed Underground and in Subsurface Structures."

6.2 All approved manual and hydraulic heat fusion joining equipment are for Performance Pipe 8300, JM Eagle UAC 3700, and ENDOT PE-100/PE-4710 high density PE pipe/tubing (PE 3408/4710).

See "Operation of Fusion Equipment" for approved manual and hydraulic heat fusion joining equipment and detailed manufacturers’ operating manuals.


**NOTES:** M8000 pipe was all black and replaced in 1997 with Performance Pipe 8100.

**Performance Pipe 6800** is black with two thick yellow stripes at three different points on the pipe’s surface.
6.0 GENERAL GUIDELINES (Continued)

Performance Pipe 8100 has a “yellow shell” around black pipe. This is the equivalent of Performance Pipe 8300 and JM Eagle (US Poly) UAC3700.

Performance Pipe 8300 is black with one thick yellow stripe at three different points on the pipe’s surface. This is the equivalent of Performance Pipe 8100 and JM Eagle (US Poly) UAC 3700.

JM Eagle (US Poly) UAC3700 is black with one thin yellow stripe at three different points on the pipe’s surface and the print line states PE100. This is the equivalent of Performance Pipe 8100 and 8300.

6.3 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, or not following the procedure (omitting steps or performing steps out of sequence).

6.4 PE plastic molded fittings (without pup lengths) can only be joined to PE plastic pipe, tubing and other molded fittings by butt fusion or electrofusion. Mechanical fittings cannot be installed directly onto a PE plastic molded fitting without pup lengths of pipe or tubing.

6.5 Heat fusion of PE plastic pipe, tubing, and fittings of different SDR wall thickness shall only be performed between one change in SDR.

| SDR   | 7 | 9/9.3 | 11 | 13.5 | 15.5 |

Joining of PE plastic pipe, tubing, and fittings with SDR wall thickness greater than one change in SDR shall be electrofused. Approved restraining-type mechanical couplings may only be used for joining PE plastic pipe and tubing when an electrofusion coupling is unavailable. See Gas Specifications IP-20 and G-8209.

A) PE plastic pipe in sizes 1” IPS through 8” IPS, and 12” IPS are SDR 11.

B) Prior to 1990, 4” and smaller IPS PE plastic pipe was SDR 9.3.
6.0 **GENERAL GUIDELINES** (Continued)

C) Medium density Aldyl-A PE plastic pipe (tan or green) shall only be joined by electrofusion.

D) In the 1970’s, thin walled 6” IPS SDR 23.5, SDR 26, and SDR 32.5 plastic pipe was installed on the low and medium pressure gas distribution systems. **Do not heat fuse 6” IPS SDR 23.5, SDR 26, or SDR 32.5 PE plastic pipe.**

- 6” IPS SDR 23.5 PE plastic pipe shall **only** be joined by either an electrofusion coupling or a mechanical restraining coupling with SDR 23.5 stiffener (color coded orange). Reduce electrofusion fusion time by 10% of the time displayed when the coupling is scanned.

- 6” IPS SDR 26 or SDR 32.5 PE plastic pipe shall **only** be joined by an electrofusion coupling. For SDR 26, reduce electrofusion cycle time by 15%. For SDR 32.5, reduce electrofusion fusion time by 25% fusion time of the time displayed when the coupling is scanned.

**EXCEPTION:** 6” IPS SDR 26 installed as a sleeve for Trenchless Technology may be joined by either butt fusion or an electrofusion coupling.

E) In the 2000’s, thin walled 6” IPS SDR 23 or thinner Subcoil pipe was installed on the low pressure gas distribution system and 22.5” IPS SDR 23 Subline was installed on the high pressure gas distribution system. **Do not heat fuse to Subcoil or Subline PE plastic pipe.**

6.6 Inspect PE plastic pipe, tubing, and fittings prior to installation to verify:

- No cuts, gouges, deep scratches, or other defects.

- PE plastic material is high density polyethylene (HDPE), PE3408/4710, and manufactured per ASTM D2513.

- PE plastic material is **NOT** older than 2 years old.

(See Gas Specification [G-8122](#), "Transportation, Handling, and Storage of Polyethylene Plastic Pipe/Tubing, and Fittings for Gas Mains and Services")
6.0 **GENERAL GUIDELINES** (Continued)

6.7 It is important that the pipe is clean and dry before installing in the fusion machine to avoid contaminating fusion machine parts that contact the pipe, such as the heating iron or the facer. If the heating iron or facer becomes contaminated, the contamination may be transferred back to the pipe, possibly compromising fusion joint quality.

A) Clean the pipe outside diameter (OD), inside diameter (ID), and ends with a clean, dry, lint-free non-synthetic (e.g. cotton) cloth or paper towel (e.g. NS0209687)

If the contamination cannot be removed in this way, wash the pipe with water and a clean, lint-free, non-synthetic cloth/paper towel to remove the contamination. Then rinse the pipe with water and dry thoroughly with a clean, lint-free, non-synthetic cloth/paper towel. **Do NOT use soap water (leak detection solution) to clean the pipe.**

B) **Prior to installing the pipe in the fusion machine, the pipe shall be cleaned with 96% alcohol wipes (Class/Stock # 689-3135 and 025-3724) or 99.9% liquid isopropyl alcohol (Class/Stock # 630-1246) with a clean, lint-free, non-synthetic cloth/paper towel. Never use alcohol wipes after facing (for butt fusion) or after abrading with emery cloth (for branch saddle fusion).**

Wear nitrile gloves when using alcohol wipes. Wear nitrile gloves and goggles when using the liquid isopropyl alcohol with a clean, lint-free, non-synthetic cloth/paper towel. When using liquid isopropyl alcohol, place plastic sheeting and absorbent pads underneath the fitting. The used wipes/cloth/absorbent pads shall be disposed as non-hazardous industrial waste. Liquid isopropyl alcohol shall be disposed as flammable hazardous waste. Contact EH&S Operations for guidance when disposing liquid isopropyl alcohol.

C) If the pipe becomes contaminated after being placed in the fusion machine, remove the pipe and clean per sections 6.7 A and B. **Do NOT use the facer to remove contamination.**

6.8 All scrap PE plastic pipe, tubing, and/or fittings that cannot be reused, shall be brought back to the workout location for proper disposal/ recycling.
7.0 **BUTT FUSION JOINING GUIDELINES**

7.1 The Butt Fusion Joining Procedure in the 2015 NGA Plastic Pipe Joining Manual and the manufacturers’ operating manuals shall be followed, with the exception of:

- heating tool surface temperature range of 475-525°F (see Section 9.3.B)
- approximate melt bead size (see Table 1)

**Table 1: Butt Fusion Approximate Melt Bead Size on the Heating Tool Surface**

<table>
<thead>
<tr>
<th>PLASTIC PIPE SIZE</th>
<th>APPROXIMATE MELT BEAD SIZE</th>
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<tr>
<td>½&quot; CTS 1&quot; CTS 1 ¼&quot; CTS</td>
<td>1/32&quot;</td>
</tr>
<tr>
<td>1&quot; IPS 1 ¼&quot; IPS 2&quot; IPS</td>
<td>1/16&quot; TO 1/8&quot;</td>
</tr>
<tr>
<td>3&quot; IPS 4&quot; IPS</td>
<td>1/8&quot; TO 3/16&quot;</td>
</tr>
<tr>
<td>6&quot; IPS 8&quot; IPS</td>
<td>3/16&quot; TO 1/4&quot;</td>
</tr>
<tr>
<td>10&quot; IPS 12&quot; IPS 16&quot; IPS</td>
<td>1/4&quot;</td>
</tr>
</tbody>
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7.2 See "Operation of Fusion Equipment" for approved manual and hydraulic butt fusion joining equipment and detailed manufacturers’ operating manuals. See Appendix A of "Operation of Fusion Equipment" for manufacturers’ hydraulic fusion machine proper fusion pressures (hydraulic chart pressure + drag pressure).

7.3 PE plastic pipe shall not be joined by a field fabricated miter (angled) joint. Only use approved fabricated or molded fittings per Gas Specification G-8104.

7.4 Whenever practical, no more than one length (40 feet) of PE plastic pipe (properly supported with rollers at 12’ intervals) should be placed in the movable jaw of the fusion unit. If the first length (40’) of PE plastic pipe is not properly supported OR if it becomes necessary to place more than one length of pipe in the movable jaw of the fusion unit, the hydraulic chart pressure must be increased by the drag pressure to compensate for the additional weight of the pipe material.

Proper Fusion Pressure = Hydraulic Chart Pressure + Drag Pressure

The drag pressure is determined by clamping the pipe into the movable jaw, placing the travel control lever in the closed position, and slowly increasing the hydraulic pressure until the pipe just begins to move. This pressure on the hydraulic gauge is the drag pressure.
7.0 **BUTT FUSION JOINING GUIDELINES** (Continued)

**NOTE:** To minimize drag pressure when placing more than one 40' length of PE plastic pipe in the movable jaw, properly support the pipe at 12' intervals. If this is impractical (due to numerous lengths of plastic pipe extending from the movable jaw), then at approximately 60' back from the movable jaw, "droop" the plastic pipe between the rollers.

The amount of "droop" is determined by the distance the movable jaw has to travel to bring the pipe ends together for fusion. Therefore, the movable jaw will only have to drag (or pull) the 60 feet plus the "droop" of the pipe between the rollers, thereby minimizing drag pressure.

7.5 When making the final tie-in to existing PE plastic pipe in the ground, use electrofusion coupling(s) to make the final tie-in, rather than trying to butt fuse in the excavation to make the final connection.

8.0 **BRANCH SADDLE FUSION INSTALLATION GUIDELINES**

8.1 Branch saddle fusion shall **only** be performed by the Development Lab.

8.2 The Saddle Fusion Joining Procedure in the [2015 NGA Plastic Pipe Joining Manual](#) and the manufacturers’ operating manuals shall be followed, with the exception of:

- heating tool surface temperature range of 475-525°F (see Section 9.3.B)
- approximate melt bead size (see Table 2)

**Table 2:** Branch Saddle Fusion Approximate Melt Bead Size on the Heating Tool Surface

<table>
<thead>
<tr>
<th>PLASTIC PIPE SIZE</th>
<th>APPROXIMATE MELT BEAD SIZE</th>
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<tbody>
<tr>
<td>8&quot;-16&quot;</td>
<td>3/16&quot; - 1/4&quot;</td>
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</table>

8.3 See "Operation of Fusion Equipment" for approved branch saddle fusion joining equipment and detailed manufacturers’ operating manuals. See Appendix B of "Operation of Fusion Equipment" for manufacturers' proper branch saddle fusion melt and fusion pressures.
9.0 **HEAT FUSION EQUIPMENT**

9.1 All fusion equipment (i.e., fusion machines, heater irons/plates, electric facers) shall be inspected by the Gas Development Lab prior to initial use and prior to the inspection due date (once every 6 months). Otherwise, the fusion equipment shall not be used.

9.2 Prior to performing heat fusion, the fusion equipment (i.e., fusion machines, heating tools, electric facers) shall be checked for damage and to verify they are in good working order. If any part of the fusion equipment is found to be damaged or defective, the equipment shall not be used.

9.3 Heating tool surfaces (i.e., heater iron/adapter plate) must be undamaged, clean, and at the correct surface temperature.

A) Prior to heating (when the heating tool is cold), the surfaces of the heater iron/adapter plates shall be cleaned to remove any plastic build-up or contaminants (e.g., dirt, grease).

1. To remove PE plastic pipe residue build-up on the heater iron/adapter plate surface, clean with a non-abrasive scotch pad (Class/Stock # 023-2181) and then wipe with a clean, dry, lint-free non-synthetic (e.g., cotton) cloth or paper towel (e.g. NS0209687).

2. To remove other contaminants on the iron/adapter, wipe the heater iron/adapter plate surface with a clean, dry, lint-free non-synthetic (e.g., cotton) cloth or paper towel (e.g. NS0209687).

B) Verify the correct surface temperature of the heater iron/adapter plate when the thermometer on the heating tool reaches approximately 500°F. Use a calibrated pyrometer or mark the surface of the heater iron/adapter plate outside the fusion area with both 475°F (white) and 525°F (red) temperature indicating crayons/sticks.

1. The 475°F (white) temperature indicating crayon/stick (Class/Stock # 024-6470) must melt and the 525°F (red) temperature indicating crayon/stick (Class/Stock # 024-6488) must not melt to assure that the heater iron/adapter is within the proper heating range.

2. To adjust the heater iron/adapter plate temperature, follow the manufacturers’ guidelines for adjusting heater temperature. Allow the heater iron/adapter plate to stabilize at the new temperature and recheck.
9.0 **HEAT FUSION EQUIPMENT** (Continued)

9.4 Heating irons and electric facers are not intrinsically safe and should not be used in a hazardous environment.

9.5 In order to prevent damage to the fusion equipment, it is important that the electrical power service and extension wires are properly sized for each unit.

10.0 **HEAT FUSION DURING COLD AND/OR INCLEMENT WEATHER**

10.1 Heat fusion during cold and/or inclement weather is permitted provided the following are observed:

A) **Temperatures below 40°F**

1. The specified heating tool surface temperature shall be maintained. **Do NOT increase heating tool surface temperature.**

2. Store heating iron in thermally insulated protective box or bag.

3. Pipe and fittings should be about the same temperature when they are fused together.

B) **During inclement weather (rain or snow)**

1. Store heater iron in protective box.

2. The pipe must clean and dry before, during, and after heat (butt or branch saddle) fusion or electrofusion.

3. Approved fire resistant tents (Class/Stock # 689-3929, 10’ x 8’ or Class/Stock # 659-3945, 6’ x 6’) shall only be used to protect the PE plastic pipe at the point of joining during inclement weather and shall **not** be used when there is escaping gas. **Gas must be allowed to rise and vent unobstructed.**
11.0 REFERENCES

ASTM F2620-13 Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings

DOJT GAS6006 Documentation and Inspection of Polyethylene (PE) Plastic Joints on Gas Mains and Services

G-8104 Polyethylene Pipe, Tubing and Fittings for Gas Mains and Services

G-8121 Qualification of Installers Joining Polyethylene (PE) Plastic Pipe/Tubing and Fittings for Gas Mains and Services

G-8122 Inspection, Handling, Storage, and Transportation of Polyethylene (PE) Plastic Pipe, Tubing, and Fittings for Gas Mains and Services

G-8209 Field Coating of Steel Pipe and Fittings Installed Underground and in Subsurface Structures

IP-20 Installation of Mechanical Fittings for Plastic Pipe and Tubing

IP-27 Installation of Electrofusion Fittings on Plastic Pipe/Tubing and Molded Fittings Using a Universal Electrofusion Processor

JM Eagle HDPE Black Gas Technical and Installation Guide (JME-014B, Jan 2009)


Con Edison Operation of Fusion Equipment


TR-33 Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe (Plastic Pipe Institute, 2012)

TR-41 Generic Saddle Fusion Joining Procedure for Polyethylene Gas Piping (Plastic Pipe Institute, 2002)