INNOGAZ ELECTROFUSION SYSTEM

INSTALLATION PROCEDURE

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A. Scope

The Aliaxis INNOGAZ Electrofusion System is designed and qualified for joining various electrofusion fittings to medium (PE 2708) or high density (PE 4710) polyethylene pipe of SDR 9 through 17 commonly used in natural gas distribution systems rated to MOP allowed per SDR 11.

This installation procedure provides the approved and qualified process to perform safe, secure, and successful fusion in gas polyethylene plastic piping networks. Failure to follow these steps may result in unacceptable fusions.

B. Alert and Warning Symbols

Within this document, you will see the following symbols;

General Advisory Alert Marking – The exclamation point within a blue circle is for important or cautionary notes, information, or operational procedures, order of operation, etc. to be followed or alerted to the operator.

Safety Warning Marking – The exclamation point within an equilateral triangle is intended to alert the user to the presence of important operating and servicing instructions in the literature. It designates an action or step that may result in personal injury or death or equipment/property damage if not properly followed. Personnel performing activities should be fully aware of the hazards and take necessary steps to prevent any injuries, damage, or unsafe operating/repair conditions.

C. General Information, Guidelines, and Cautions

The following guidelines apply to all electrofusion joints whether using electrofusion (EF) couplings, tapping tees, repair or branch saddles:

1. Qualified Operators: Operators performing electrofusion should be qualified in accordance with the United States Code of Federal Regulations, Title 49, Section 192.285 (49 CFR § 192.285).

2. **Caution**: When installing electrofusion couplings, ensure the gas flow is shut-off completely and that the gas concentration in the surrounding is below critical level.
When performing the fusion process of electrofusion tapping tees or branch saddles (BS) it is not necessary to shut off the gas flow. For repair saddles (RS), if the area of pipe is leaking gas make SURE the gas flow has been shut off.

3. Fitting Code Compliance and Qualification
The INNOGAZ electrofusion fittings have been qualified and manufactured in compliance with;
   - Code of Federal Regulations, Title 49, Part 192.285 (49 CFR § 192.285)
   - ASTM F1055 – Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing
   - ASTM D2513 – Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings
   - ASTM F2897 – Standard Specification for Tracking and Traceability Encoding System of Natural Gas Distribution Components (Pipe, Tubing, Fittings, Valves, and Appurtenances)
   - Qualification tests were performed with electrofusion fittings on medium density (PE2708) and high density (PE4710) polyethylene pipe that meet the requirements of ASTM D2513.

4. Environmental Conditions

   Fitting temperature limits: **–22°F (-30°C) to 122°F (+50°C).**
   When fusing below 0°F, special care must be exercised. Portable heating of the immediate work area is recommended. When fusing in extreme warm temperatures, the pipe and the fitting surface temperatures must not be allowed to exceed 122°F. Portable shades may be required.

Humidity: The INNOGAZ Electrofusion System is effective at any level of humidity.

Note: The PE pipe and Electrofusion fitting fusion surface areas must be kept dry, including the possibility of condensation forming during the fusion, such as on cold pipe and warm humid air. Portable shelters and additional cleaning with an isopropyl alcohol (>90%) impregnated approved towel may be necessary. Make sure the PE pipe and EF fitting fusion surface areas have been dried thoroughly before assembly. Use an approved lint-free cloth or clean drying towel.

5. Out-of-Round and Curved Pipe

Pipe out-of-round by more than 1.5% / maximum .12 inches (3 mm) or coiled pipe with a radius of curvature less than 30 times the pipe OD, a suitable clamping tool must be used during fusion of the fitting.

The PE pipe must be within ASTM D2513 minimum pipe OD limits and maximum out-of-round limits. The out-of-round value of pipe is the difference between the maximum measured OD minus the minimum measured OD. The table below summarizes the maximum out-of-roundness allowed according to the pipe standard ASTM D2513;

Nominal Pipe Size*	Maximum Pipe Diameter Out-of-Round inches (mm)
1/2 CTS	0.016 (0.41 mm)
3/4 IPS – 1-1/4 IPS	0.020 (0.51 mm)
1-1/2 IPS – 2 IPS	0.024 (0.61 mm)
4 IPS	0.03 (0.8 mm)
6 IPS	0.07 (1.8 mm)
8 IPS	0.08 (2.0 mm)
12 IPS	0.10 (2.5 mm)

* Except where specifically referenced otherwise, the word "pipe" encompasses both IPS pipe and CTS tubing.

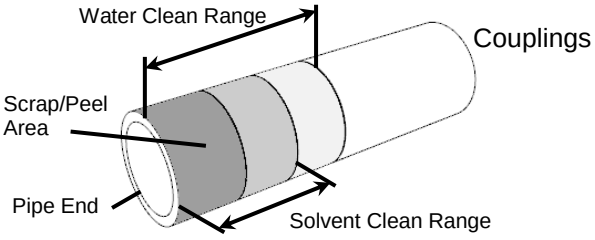
6. Equipment and Tools

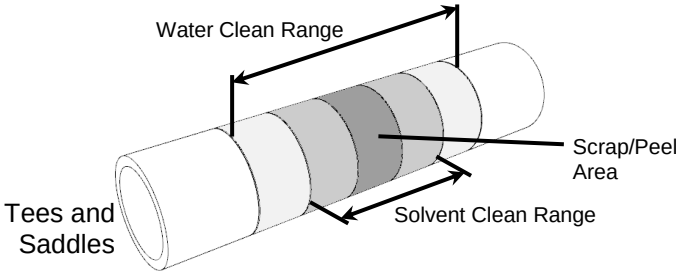
. The following items should be available and in good working order before installation begins;

- Innogaz Electrofusion Fittings as originally packaged and stored as detailed in 0 below.
- Electrofusion Control Box with Innogaz tips (4.0 mm).
- Power Source and required Extension Cords rated for the Control Box and the fitting power needs
- PE Pipe Scrapers/Peelers (see *Attachment A: PE Pipe Peelers and Tapping Tee Scrapers*)
- PE Pipe Cutters (see *Attachment C: Tapping Tee Tools, PE Pipe Cutters, and Test Caps*)
- Fitting Clamps (see *Attachment B-1: Clamping Devices for Couplings* and *Attachment B-2: Clamping Devices and Nylon Belt Straps and Metal Reusable Underclamps for Tap Tees, Branch and Repair Saddles*
- Tapping Tee Tools (see *Attachment C: Tapping Tee Tools, PE Pipe Cutters, and Test Caps*)
- Cleaning Materials
  - Clean water
  - Isopropyl alcohol (90% or greater concentration of alcohol in water)
  - Clean lint-free cloths or clean drying towels
- Measuring Tape or Ruler
- Calipers to measure peel thickness (optional)
- Marker Pen (such as Sharpie®) visible on pipe being marked. No paint pens or other types that contain oil or other contaminates that would impact fusion should be used.

7. Storage
Electrofusion Fittings are packaged in plastic bags to protect against dirt, water, and other contaminates. Fittings should be stored indoors in their original packaging and not exposed to sources of UV or high heat. Shelf life when stored properly is up to 10 years. If you are unsure as the storage history of fittings, a test fusion can be made and evaluated through destructive testing. If the fusion quality is poor, the fittings should NOT be installed in a network and should be discarded.

8. Cleaning and Drying
The PE pipe and electrofusion fitting fusion surface areas must be free of all contaminants such as mud, oil, grease, water, etc. For initial cleaning of pipe, water may be used to remove heavy dirt and debris. Clean an area much larger than the area of the fitting and then dry the pipe. Next, clean with an isopropyl alcohol (≥90%) impregnated approved towel in an area smaller than the area cleaned with water but larger than the scrape/peel area. It is recommended to clean the fusion zone directly before installation after scraping of the pipe and also the fitting fusion surface. Make sure the PE pipe and EF fitting fusion surface areas have been dried thoroughly before assembly. Use an approved lint-free cloth or clean drying towel. The figures below show the cleaning and scraping regions for coupling, tee, and saddle fusion installation.





Clean pipe and clean fittings will have no visible debris, oils, or greases on the fusion surfaces. Some contaminants, such as bentonite clay, used extensively during horizontal drilling, can prohibit making an effective fusion joint and the integrity of the fusion joint. This contamination can be invisible to the eye. Proper cleaning, including the use of clean towels and the practice of avoiding cleaning beyond the areas cleaned in prior steps, will result in a high quality fusion.

As an alternative to isopropyl alcohol (due to availability or restricted usage), acetone is acceptable for use. Testing should be done to make sure there are no additives in the acetone that would make a poor fusion joint. Denatured alcohol should never be used in cleaning pipe or fittings.

9. Scraping/Peeling PE Pipe
All areas of the PE pipe to be used for electrofusion must be scraped free of surface oxidation.
Use an approved scraper (See *Attachment A: PE Pipe Peelers and Tapping Tee Scrapers*). Scrapers should remove a minimum of 0.007” but never more than 10% of the wall thickness. To verify the correct amount of pipe has been removed, a caliper can be used to measure the removed ribbon.

Tools should be inspected before use and in good and clean condition. Worn or damaged tools should be repaired or replaced before use. The use of a pipe surface witness mark tool can be a visual indicator that adequate scraping/peeling has occurred. If the marks are present after scraping, not enough material was removed. *Do not use a knife, sandpaper, or abrasive material to scrape PE pipe*

10. Protective Bag
Do not remove the electrofusion fitting from its protective bag until immediately before it is to be installed.

11. Installation Process
See Sections – D, E, and F for detailed instructions for fusing INNOGAZ electrofusion couplings, tapping tees, branch saddles, and repair saddles.

12. Product Markings
Innogaz products are marked as follows;

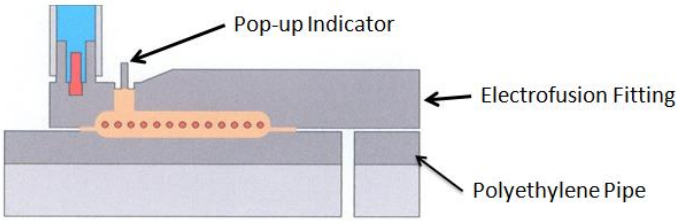
- Molded or stamped information on the coupling, tapping tee, or saddle body to be in accordance with ASTM D2513 and F1055 includes
  - Manufacturer's brand name (Innogaz)
  - Material designation (PE2708 or PE4710) and material category per D2513, such as CEE
  - "Gas" marking or "G"
  - Size (NPS) followed by IPS or CTS designation
  - ASTM D2513 and F1055

- Molded or stamped batch number to identify date of manufacture.
  - For tapping tees: 4 digits formatted as WWYY where WW is the week of the year and YY is the last 2 digits of the year
  - For couplings:
    - Sizes 1/2 through 2 NPS: 4 digits formatted as WWYY where WW is the week of the year and YY is the last 2 digits of the year
    - Sizes 3 through 8 NPS with 2 pop-up indicators: 5 digits formatted as DWWYY where D is the day of the week, WW is the week of the year, and YY is the last 2 digits of the year.
    - Sizes 3 through 8 NPS with 1 pop-up indicator: formatted as three circular stampings, two circles combine to show the week of the year and the year. The year is the number within the 2nd circle. The 3rd circle is an alpha material code (see example below for a product made during the 25th week of 2011)

- Printed information on the product tag includes
  - Fusion barcode and corresponding 24 digit number
  - ASTM F2897 traceability barcode and corresponding 16 characters (alpha and numeric) in Code 128 symbology
  - Fitting type code (C-coupling, R-reducer, LV/LVTT/MV/MVTT/HV/HVTT-tapping tee, BS-branch saddle, RS-repair saddle)
  - Fusion parameters (voltage and time) for manual machine entry
  - Cooling time in minutes until applying pressure to the fitting. It is marked as CT=xxmin where xx is the time in minutes

13. Handling and Cooling
After fusion cycle is complete, wait 15 seconds before removing the control box cables leads from the fitting. Avoid rough handling of the electrofusion fitting or removal of the alignment clamps until the required post-fusion cooling time has elapsed. (See Tables 1 and 2)

14. Pop-Up Indicators – INNOGAZ Design Feature
INNOGAZ electrofusion fittings are designed with pop-up indicators



Melt pressure of polyéthylène reaches optimum level of both fitting and PE pipe and pop-up indicator appears to show fusion has taken place

During the electrofusion cycle the melt pressure increases in the fusion zones due to the melt expanding towards the pipe surface. This movement of molten material causes the pop-up indicators to rise. The benefit of this feature is that it provides an indication that fusion has been executed. Any permanent movement of the indicators is a visual verification that fusion has taken place. If there is no movement at all in one or both of the pop-up indicators, or if the indicators fail to remain above the starting position, this indicates that there has been a problem during the fusion cycle and the joint requires further investigation and possible replacement. It should be noted that movement i.e. the height of the pop-up indicators does not guarantee the integrity/quality of the joint.

Note: INNOGAZ electrofusion couplings have one or two pop-up indicators and tapping tees and saddles have one pop-up indicator. When the electrofusion process is complete, you will observe polyethylene has risen from the pop-up indicators. For couplings it is not necessary for both indicators to rise identically in height.
If pop up indicators have not risen the fusion is not acceptable. Fitting must be discarded and replacement with a new fitting.

Note: Review Section G on re-fusion of fittings to determine if fitting qualifies for re-fusion process.

15. Test Fusion Joint
All electrofusion joints shall be pressure tested once they are cooled.
Pressure test in accordance with your Gas Company's standard procedure.

16. F2897 Tracking and Traceability Marking
INNOGAZ electrofusion fittings are marked with a barcode and text to provide information on the fitting including; company of manufacture, date of manufacture, lot identifier, material, type of fitting, and size. This code is 16 characters long and contains both alpha characters (A-Z, a-z) and numeric values (0-9).

D. Coupling Installation

1. Cut PE pipe ends square (See *Attachment C: Tapping Tee Tools, PE Pipe Cutters, and Test Caps*). Remove rough edges. While not required, a slight chamfer at the pipe OD end will ease insertion into the fitting.

2. For couplings without internal pipe stops, the PE pipe ends are intended to be inserted into the coupling until they butt together at the center. Using the coupling's external centerline or the center of the coupling as a guide, clearly mark the proper insertion depth on both ends of the pipe. Note: always scrape a slightly larger area of the pipe to be fused. In tight installations, it may ease installation if a pipe end is scrapped the entire length of the coupling to allow the cleaned coupling to slide past the pipe end before aligning pipes. However, be sure to re-mark the pipe to determine proper insertion depth.

3. The PE pipe and electrofusion fitting fusion surface areas must be free of all contaminants such as mud, oil, grease, water, etc. Clean according to Section C.8 with water first (if needed) then an isopropyl alcohol (≥90%) impregnated approved towel. Make sure that the PE pipe and EF fitting fusion surface areas have been dried thoroughly before assembly. Use an approved lint-free cloth or clean drying towel. Re-mark pipe, if necessary.

4. Use appropriate scraping tools according to Section C.9 to scrape off PE pipe surface oxidation of all the marked areas on the PE pipe. Re-mark pipe, if necessary, after scraping is complete for proper location and fit-up of the fitting. (See *Attachment A: PE Pipe Peelers and Tapping Tee Scrapers*)

5. After scraping is complete remove all shavings from the pipe. Remember, the scraped pipe and adjoining surfaces which may contact the coupling must be clean and dry. For out-of-round and/or curved pipe, refer to Section C.5 of this procedure for guidance. Re-mark pipe, if necessary.

6. Kerotest offers three different alignment clamps styles for couplings
   (See *Attachment B-1: Clamping Devices for Couplings*)

   a. When using Heavy Duty Pipe Alignment Clamp:

      1. Secure one end of the PE pipe into the alignment clamp so that the end of the PE pipe is at the centerline of the clamp fixture. (Note: If you are using straight sticks of PE pipe the coupling can be centered onto both ends of the PE pipe to be joined and then the Heavy Duty Pipe Alignment Clamp can be installed as required by centering the coupling in the clamp. Be sure to properly prepare the PE pipe and coupling before installing onto pipe.)

      2. Remove coupling from its protective bag. If contamination is present, additional cleaning with an isopropyl alcohol (≥90%) impregnated approved towel may be necessary. Make sure that the pipe and fitting fusion surface areas have been dried thoroughly before assembly. Use an approved lint-free cloth or clean drying towel.

      3. Slide coupling onto clamped pipe end to the mark (or center stop if present). In a tight situation, slide the coupling (without center stop) fully onto the clamped pipe end.

      4. Install second end of PE pipe into alignment clamp fixture until it butts against the first pipe (or center stop if present), then secure it within the clamp fixture.

      5. If necessary, center coupling by sliding it back onto second pipe. Make sure it is properly centered by viewing both of the previously made insertion depth marks on the pipe. Improper positioning of the coupling on the pipe may result in a failed electrofusion joint.

   b. When using Inline Handheld Pipe Alignment Clamp:

1. Remove coupling from its protective bag if contamination is present additional cleaning with an isopropyl alcohol (≥90%) impregnated approved towel may be necessary. Make sure that the pipe and fitting fusion surface areas have been dried thoroughly before assembly. Use an approved lint-free cloth or clean drying towel. Re-mark pipe, if necessary

2. Place coupling onto one end of PE Pipe making sure it is properly positioned with insertion depth marked on pipe (or to the center stop if present).

3. Install second end of pipe into coupling making sure it is properly positioned with insertion depth (or to the center stop if present) then install Inline Handheld Clamp.

c. When using Posistar Alignment Clamp:

1. The Posistar alignment kit consists of: 1x - 5ft square bar, 4x – belt assemblies, 4x – stars (the star is four sided and designed to fit the O.D. of PE pipe for sizes 2 through 8 NPS). Slide the four stars onto square bar and align stars on the PE pipe equally between the coupling. Recommended alignment is two (2x) stars on either side of coupling. Attach belt strap assemblies equally on square bar and securely tighten straps around PE pipe for proper alignment clamping of pipe.

2. Remove coupling from its protective bag if contamination is present additional cleaning with an isopropyl alcohol (≥90%) impregnated approved towel may be necessary. Make sure that the pipe and fitting fusion surface areas have been dried thoroughly before assembly. Use an approved lint-free cloth or clean drying towel. Re-mark pipe, if necessary.

3. Install first end of PE pipe into Posistar clamp fixture and slide coupling onto end of PE Pipe to the mark (or center stop if present). In a tight situation, slide the coupling (without center stop) fully onto the clamped pipe end.

4. Install second end of PE pipe into Posistar clamp fixture until it butts against the first pipe (or center stop if present),, then center coupling, secure both ends of PE pipe within the Posistar alignment fixture using the belt strap assemblies. (Securely tighten belt strap assemblies at this point)

5. Make sure coupling is properly centered by viewing both of the previously made insertion depth marks on the pipe. Improper positioning of the coupling on the pipe may result in a failed electrofusion joint.

7. Electrofusion of Coupling - Barcode Mode / Manual Mode

a. Connect the electrofusion control box output cable leads to the electrofusion fitting connector pins on the coupling. Innogaz fitting connectors are 4.0 mm. See *Attachment D: Electrofusion Control Boxes* for the various types of Control Boxes.

b. Scan the barcode label on the electrofusion fitting with the control box wand / scanner or manually enter the fusion code characters indicated on the barcode label. The fusion barcode is the 24 digit number. Verify the fusion time on the control box with the time listed on the EF fitting barcode label or in *Table 1: Fusion Time for Couplings, Coupling Reducers, LVTT, and MVTT*.
Some variation in the time may be observed due to temperature compensation. If this variation ***is unreasonable or considerably out of the normal range*, STOP** the process and verify the fusion time before scanning again (*See Section H to calculate the compensated fusion time*).

c. Follow the instructions on the control box screen. Start fusion of coupling.

d. After fusion is complete, wait 15 seconds before carefully removing the electrofusion control box cable output leads.

e. Visually inspect the pop-up indicator(s) on the coupling to see that fusion has taken place. Any movement of the indicators is a visual verification that fusion has taken place. If there is no movement at all in one or both of the pop-up indicators, this indicates that there has been a problem during the fusion cycle and the joint requires further investigation and possible replacement. For reference, see *Section* G *Re-Fusion of INNOGAZ Electrofusion Fittings*
Note: If there are two indicators, it is not necessary on a coupling for both to rise identically in height.

f. Visually check the pipe insertion marking to make sure that no movement has occurred during the fusion process.

g. Allow proper cooling time before removing any clamping device and before pressure testing. (see *Table 1: Fusion Time for Couplings, Coupling Reducers, LVTT, and MVTT*).

h. Pressure test couplings per Gas Company's standard procedures.

E. Tapping Tees - Low and Medium Volume Tapping Tee Installation

This section applies to low (LVTT) and medium volume tapping tees (MVTT).
For high volume tapping tees (HVTT), refer to *Section F.*

1. With the tapping tee in its protective bag, position it over the PE pipe, using a marker to trace the outline of the tapping tee saddle area of the pipe to be fused. Be generous in this initial estimate.

2. The PE pipe and electrofusion fitting fusion surface areas must be free of all contaminants such as mud, oil, grease, water, etc. Clean according to Section C.8 with water first (if needed) then an isopropyl alcohol (≥90%) impregnated approved towel. Make sure that the PE pipe and EF fitting fusion surface areas have been dried thoroughly before assembly. Use an approved lint-free cloth or clean drying towel. Re-mark pipe, if necessary

3. When scraping pipe surface for tapping tee add 1/2" (12 mm) minimum around the entire circumference of the tapping tee traced on the pipe. This enclosed area must be thoroughly scraped according to Section C.8, using appropriate tools, to remove all surface oxidation on the pipe. The depth of the scraped surface must be a minimum of 0.007 inches (.15 mm), but no more than 10% of the pipe wall thickness. See *Attachment A: PE Pipe Peelers and Tapping Tee Scrapers*).

4. Remove all shavings and re-clean pipe if necessary.

5. Remove tapping tee from its protective bag and inspect the underside for contamination. If contamination is present, additional cleaning may be necessary.

6. Secure the tapping tee to the pipe in the following manner:

a. Low Volume or Medium Volume tapping tees are supplied with a plastic under saddle or belt straps that will wrap around the bottom of the pipe. The plastic under saddle is used only on under saddle sizes: 1-1/4 and 2 NPS. The under saddle slides will engage the lips molded on the tapping tee saddle. Under saddle slides are tapered and will only properly slide on one way. The plastic under saddle must be fully engaged and centered onto the tapping tee by tapping it with a small mallet to properly function. The nylon belt strap, supplied on larger tapping tees, must be fully engaged. Tighten screws uniformly when clamping strap to pipe. See photos below showing correct & incorrect clamping engagement.

Correct clamping of belt strap

Incorrect clamping of belt strap

b. Low or Medium Volume tapping tees may use optional metal reusable underclamps as shown in *Attachment B-1: Clamping Devices for Couplings*

7. Electrofusion of Tapping Tees - Barcode Mode / Manual Mode

a. Connect the electrofusion control box cable output leads to the electrofusion tapping tee connector pins. Innogaz fitting connectors are 4.0 mm. See *Attachment D: Electrofusion Control Boxes* for the various types of Control Boxes.

b. Scan the barcode label on the tapping tee with the control box wand / scanner or manually enter the fusion code characters indicated on the label. The fusion barcode is adjacent to the 24 digit number. Verify the fusion time on the control box with the time listed on the EF fitting barcode label or in *Table 1: Fusion Time for Couplings, Coupling Reducers, LVTT, and MVTT*. Some variation in the time may be observed due to temperature compensation. If this variation ***is unreasonable or considerably out of the normal range*****, STOP** the process and verify the fusion time before scanning again (*See Section H to calculate the compensated fusion time*).

c. Follow the instructions on the control box screen. Start fusion of tee.

d. After fusion is complete wait 15 seconds before carefully removing the cable output leads.

e. Visually inspect the pop-up indicator on the tapping tee that indicates if fusion has taken place. No movement of the fusion indicator indicates that there was a problem during the fusion cycle and the fusion is not acceptable, replacement is required. Reference *Section* G *Re-Fusion of INNOGAZ Electrofusion Fittings*

f. Allow proper cooling time before removing any clamping device or any rough handling.
See *Table 1: Fusion Time for Couplings, Coupling Reducers, LVTT, and MVTT* for proper cooling times.

g. Verify tapping tee cap is secure (hand-tighten).

h. Pressure test the tapping tee assembly per Gas Company's standard procedures.

8. Tapping PE pipe with tapping tee cutter. Once a satisfactory fusion has been made, proceed as follows:

a. Remove cap from the tapping tee.

b. Tapping tee has fixed stops in both directions (forward-stop and backstop) for the cutter.

c. Insert tapping tee tool (1/2" hex T-wrench, socket, or similar) into the cutter at the top of tapping tee. See *Attachment C: Tapping Tee Tools, PE Pipe Cutters, and Test Caps.* Turn tool clockwise until it bottoms out on the forward-stop. Innogaz tapping tee tools have indicator marks (either cuts into the tool shank or changes in the shank diameter) showing the cutter at the forward-stop position when in line with the top of the tapping tee stack. Use the first indicator for an LVTT and the second indicator for an MVTT. The PE pipe is tapped and the PE pipe coupon is pressed and secured into the inside of the cutter

d. Unscrew tapping tee tool counterclockwise until it comes in contact with backstop of tapping tee and add an extra 1/4 turn.

e. Prior to reinstalling tapping tee cap, visually inspect the inside area of the cap and the O-ring (located on neck of tapping tee) for being in the correct position and undamaged. These areas must be free of all contaminants. Note: the O-ring and the cap O-ring sealing surface both require a light coating of general O-ring grease, such as Parker O-Lube or a silicone grease, to properly seal. Re-apply if necessary.

f. When reinstalling tapping tee cap for LVTT & MVTT tees, tighten cap only by hand until a positive stop occurs. *Do not use wrench or other tools to tighten.*

g. Check for leak tightness of the cap.

F. High Volume Tapping Tee, Branch Saddle, and Repair Saddle Installation

This section applies to high-volume tapping tees (HVTT), branch saddles (BS) and repair saddles (RS).

1. With the EF fitting in its protective bag, position it over the PE pipe, using a marker to trace the outline of the fitting saddle area of the pipe to be fused. Be generous in this initial estimate.

2. The PE pipe and electrofusion fitting fusion surface areas must be free of all contaminants such as mud, oil, grease, water, etc. Clean according to Section C.8 with water first (if needed) then an isopropyl alcohol (≥90%) impregnated approved towel. Make sure that the PE pipe and EF fitting fusion surface areas have been dried thoroughly before assembly. Use an approved lint-free cloth or clean drying towel. Re-mark pipe, if necessary

3. When scraping the PE pipe add 1/2" minimum around the entire circumference of the fitting traced on the pipe. This enclosed area must be thoroughly scraped, using appropriate tools, to remove all surface oxidation on the pipe. The depth of the scraped surface must be minimum of 0.007 inches (0.15 mm) but no more than 10% of the pipe wall thickness (see *Attachment A: PE Pipe Peelers and Tapping Tee Scrapers*).

4. Remove all shavings and re-clean pipe if necessary.

5. Remove fitting from its protective bag and inspect the underside for contamination. If contamination is present, additional cleaning may be necessary.

6. Secure the fitting to the pipe with a reusable chain clamp or high volume belt straps (see *Attachment B-1: Clamping Devices for HVTT*)

   a. Reusable Chain Clamp – Attach clamp ends into fitting saddle holes, close clamp by pulling handle upward than tighten each bolt in equal sequence. Tighten bolts on reusable clamp until Belleville washers flatten to achieve required clamping load.

   b. Belt Strap for HVTT (Belt Strap can be used 10 times) - Attach belt strap ends into fitting saddle holes. Tighten the bolts in an equal and uniform sequence. Tighten bolts securely on belt strap as shown until the lower bars are tight against the fitting to achieve required clamping load. *Note: the belt strap has a label with*

figure numbers 1 through 10. Remove the figure number corresponding to the number of times the strap has been used off the label.

Correct visual of clamping for HVTT belt strap

7. Electrofusion of HVTT, BS, and RS - Barcode Mode / Manual Mode

   a. Connect fusion control box cable leads output leads to the fitting ensuring a proper connection. Innogaz fitting connectors are 4.0 mm. See *Attachment D: Electrofusion Control Boxes* for the various types of Control Boxes.

   b. Connect the output cable leads to the fitting. Scan the barcode label on the fitting with the wand / scanner or manually enter the fusion code characters on label and follow instructions on control box screen. The fusion barcode is adjacent to the 24 digit number. Verify the fusion time on the control box with the time listed on the EF fitting barcode label or with the time listed in *Table 2: Fusion Time for High Volume Tap Tee - Branch Saddle - Repair Saddle*. Some variation in the time may be observed due to temperature compensation. If this variation ***is unreasonable or considerably out of the normal range*, STOP** the process and Verify the fusion time before scanning again (*See Section H to calculate the compensated fusion time*).

   c. Follow the instructions on the control box screen and start the fusion.

8. These fittings have one pop-up indicator that indicates fusion has taken place. No movement of the fusion indicator indicates that there was a problem during the fusion cycle and the fusion is not acceptable. Replacement is required. Reference *Section G Re-Fusion of INNOGAZ Electrofusion Fittings*

9. After fusion is complete wait 15 seconds before carefully removing the cable output leads.

10. Allow proper cooling time before removing clamp or any rough handling.
    (see *Table 2: Fusion Time for High Volume Tap Tee - Branch Saddle - Repair Saddle*)

11. Prior to testing the fusion joint of the HVTT;

    a. Remove cap and inspect that the O-ring is properly seated in the O-ring groove and has a light grease coating.

    b. Re-install cap to tee being careful not to cross thread the cap and tee threads, hand-tighten cap until it comes into contact with the O-ring and then add an extra 1/4 turn with a nylon (non-extendable) strap wrench which will not damage the cap. *Do not use pliers, such as Channellocks®.*

HVTT Cap with O-ring Properly Seated

12. Pressure test the fitting per Gas Company's standard procedures.

13. Tapping PE pipe for HVTT only

    a. Remove cap from the tee.

    b. Tapping tee has fixed stops in both directions (forward-stop and backstop) for the cutter.

    c. Insert tapping tee tool (1" hex T-wrench, socket, or similar) into the cutter at the top of tapping tee. See *Attachment C: Tapping Tee Tools, PE Pipe Cutters, and Test Caps.* Turn tool clockwise until it bottoms out on the forward-stop. Innogaz HVTT tools have an indicator mark showing the cutter at the forward-stop position when it is in line with the top of the HVTT stack. At this point, the PE pipe is tapped and the PE pipe coupon is pressed and secured into the inside of the cutter

    d. Unscrew tapping tee tool counterclockwise until it comes in contact with backstop of the tee and add an extra 1/4 turn.

    e. Prior to reinstalling the HVTT cap, verify that the inside of the tapping tee cap is clean, the greased O-ring is in the correct position and undamaged, and the top surface area of the tee itself is free of all contaminants. Note: the O-ring and the top surface area of the tee both require a light coating of general O-ring grease, such as Parker O-Lube or a silicone grease, to properly seal. Re-apply if necessary.

HVTT with Cap Removed

    f. Install cap onto tee being careful not to cross thread the cap and tee threads, hand-tighten cap until it comes into contact with the O-ring and then add an extra 1/4 turn with a nylon (non-extendable) strap wrench which will not damage the cap. *Do not use pliers, such as Channellocks®.*

    g. If required, perform additional pressure testing on the tapping tee per Gas Company's procedures.

G. Re-Fusion of INNOGAZ Electrofusion Fittings

1. All Innogaz electrofusion fittings are designed to be fused just once.

2. As discussed in Section C.14 above, pop-up indicators will rise at the end of the fusion cycle to provide positive, visual indication that the electrofusion was successful.

3. If the fusion cycle is completed in the normal manner and there has been no indication of a rise in the pop-up indicator, the fitting must be replaced.

4. If the normal fusion cycle is interrupted due to power failure to the fitting during the first 25% of the fusion time, do not disturb the cables, fitting, clamps or pipe. If any part of the set-up is disturbed before cooling, cut-out the fitting. The fitting must be replaced.

5. Allow fitting and pipe to cool for one (1) hour, undisturbed, before starting the re-fusion process.

6. Disconnect the control box cables to the fittings, check to insure no movement of the PE pipe within the fitting and re-check clamping. Reconnect the control box cables and restart the second fusion process.

7. If the fusion process is interrupted during the second attempt or at the conclusion of the cycle and there is no movement of the pop-up indictors, cut out the fitting and start fusion process over with new replacement fitting.

8. If there is any doubt about the electrofusion assembly quality after an absence of a non-functioning pop-up fusion indicator, the fitting must be cut out and replaced.

Table 1: Fusion Time for Couplings, Coupling Reducers, LVTT, and MVTT

Fitting	Fusion Time @ 73°F F_t (Sec)	Temperature Comp TC_H / TC_C	Max Fusion Time at Min Temp (-22°F)	Min Fusion Time at Max Temp (122°F)	Cooling Times For Clamp Removal (Total Minutes)	Cooling Times to Tap, Apply Pressure, Test, or Rough Handle (Total Minutes)
Couplings						
1/2 CTS	17	0.002 / 0.002	21	15	3	3
1 CTS	29	0.002 / 0.002	35	26	6	6
1/2 IPS	27	0.002 / 0.002	33	24	3	3
3/4 IPS	27	0.002 / 0.002	33	24	6	6
1 IPS	37	0.002 / 0.002	45	33	6	6
1-1/4 IPS	46	0.002 / 0.002	56	41	6	6
1-1/2 IPS	50	0.002 / 0.002	60	45	9	9
2 IPS	85	0.002 / 0.002	103	76	10 [A]	10 [A]
3 IPS [B]	120	0.002 / 0.002	145	107	8	8
3 IPS F-Type [C]	65	0.004 / 0.002	89	60	10	40
4 IPS [B]	160	0.002 / 0.002	193	143	10	10
4 IPS F-Type [C]	119	0.004 / 0.002	162	109	10	40
6 IPS [B]	300	0.002 / 0.002	362	268	14	14
6 IPS F-Type [C]	357	0.004 / 0.002	487	328	20	75
8 IPS F-Type [C]	481	0.002 / 0.002	656	442	20	75
8 IPS [B]	500	0.002 / 0.002	604	446	18	18
12 IPS F-Type [C]	550 [D]	0.003 / 0.003	559	506	Not Required [F]	100
Coupling Reducers						
1 CTS X 1/2 CTS	20	0.002 / 0.002	24	18	4	4
1 CTS X 3/4 IPS	27	0.002 / 0.002	33	24	5	5
1 IPS X 1 CTS	29	0.003 / 0.003	38	25	5	5
2 IPS X 1-1/4 IPS	65	0.003 / 0.002	85	58	10	10
Low Volume Tapping Tees						
LVTT 1-1/4 IPS Main	28	0.002 / 0.002	34	25	Not Required [G]	20
LVTT 1-1/2 IPS Main	60	0.002 / 0.002	73	54	Not Required [G]	20
LVTT 2 IPS Main	70	0.002 / 0.002	85	62	Not Required [G]	20
LVTT 3-8 IPS Main	70	0.002 / 0.002	85	62	10	20
Medium Volume Tapping Tees						
MVTT 2 IPS Main	70 [E]	0.002 / 0.002	85	62	Not Required [G]	30
MVTT 3-8 IPS Main	70 [E]	0.002 / 0.002	85	62	10	30

[A] For 2 IPS couplings made prior to August 2015 cooling time was 20 minutes
[B] Discontinued 2019
[C] F-Type couplings available 2019 and have 1 pop-up indicator. Cannot be fused with KTEC EF Control Box.
[D] For 12 IPS, fusion time shown is for each side
[E] For MVTTs 2-8 made prior to 2012, the fusion time will scan 95 seconds.
[F] Clamps are not required for the NPS 12 coupling
[G] Clamps for these tapping tees are included with each tee and do not need to be removed

Table 2: Fusion Time for High Volume Tap Tee - Branch Saddle - Repair Saddle

Fitting	Fusion Time @ 73°F F_t (Sec)	Temperature Comp TC_H / TC_C	Max Fusion Time at Min Temp (-22°F)	Min Fusion Time at Max Temp (122°F)	Cooling Times For Clamp Removal (Total Minutes)	Cooling Times to Tap, Apply Pressure, Test, or Rough Handle (Total Minutes)
4 IPSx2 IPS, PE 2708 [A]	150	0.003 / 0.002	197	134	16	16
6 IPSx2 IPS, PE 2708 [A]	150	0.004 / 0.002	205	138	16	16
8 IPSx2 IPS, PE 2708 [A]	160	0.004 / 0.002	218	147	16	16
4 IPSx2 IPS, PE 4710 [B]	140	0.003 / 0.003	176	121	15	45
6 IPSx2 IPS, PE 4710 [B]	150	0.003 / 0.003	187	128	15	45
8 IPSx2 IPS, PE 4710 [B]	150	0.003 / 0.003	187	128	15	45

[A] Discontinued Dec 2018
[B] Available 2019

H. Manual Fusion Time Calculation Using Temperature Compensation

To calculate the fusion time for manual fusion operations using temperature compensation values (when scanning the fusion barcode is unavailable or the fusion barcode is damage and unreadable);

T_c = Current Ambient Temperature in °F
F_t = Fusion Time at 73°F from tables above
TC_H = Temperature Compensation value for warmer than 73°F (1st value in **Temperature Comp** from tables)
TC_C = Temperature Compensation value for colder than 73°F (2nd value in **Temperature Comp** from tables)

For temperatures ***greater than 73°F*** (F_{thot})

$T_c - 73 =$ _____ Temperature difference (TD)

$F_{thot} = F_t - (TD \times TC_H \times F_t)$ F_{thot} fusion time in seconds

For temperatures ***less than 73°F*** (F_{tcool})

$73 - T_c =$ _____ Temperature difference (TD)

$F_{tcool} = F_t + (TD \times TC_H \times F_t)$ F_{tcool} fusion time in seconds

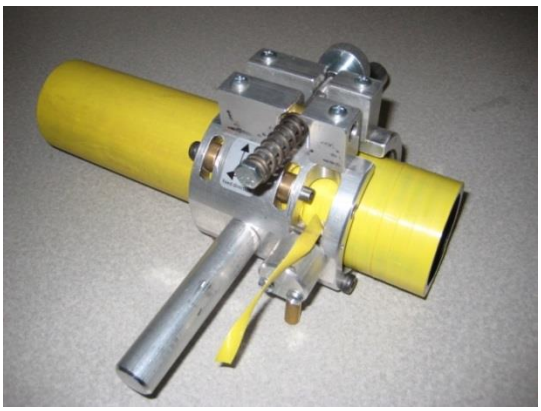
Example 1: Fuse ½ CTS coupling in a hot environment at 100°F in the shade

$100 - 73 = \underline{27}$
$F_{thot} = 17 - (27 \times .002 \times 17) = 16$ seconds

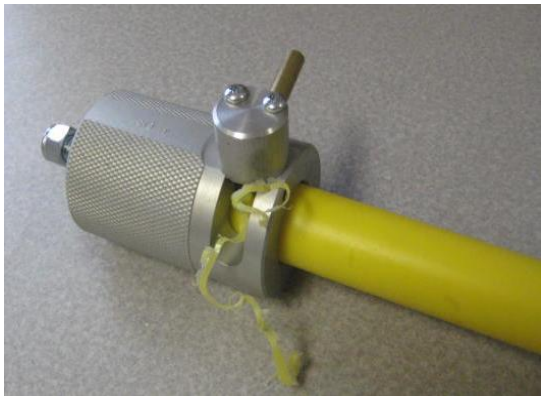
Example 2: Fuse ½ CTS coupling in a cold environment at -10°F

$73 - (-10) = \underline{83}$
$F_{tcool} = 17 + (83 \times .002 \times 17) = 20$ seconds

Attachment A: PE Pipe Peelers and Tapping Tee Scrapers



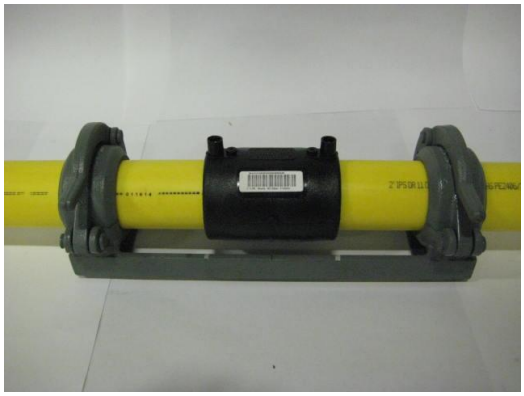
SPLIT - PEELERS for PE PIPE SCRAPING / PEELING (for Tapping Tees and Couplings)	
PART NUMBER	**FOR USE ON NOMINAL PIPE SIZE**
88414677	1-1/4 IPS
88414529	2 IPS
88414685	3 IPS
88414693	4 IPS
88414701	6 IPS
88280551	8 IPS
88280585	12 IPS



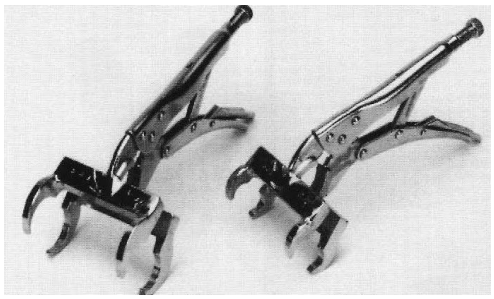
PE PIPE SCRAPERS – COUPLINGS	
PART NUMBER	**FOR USE ON NOMINAL PIPE SIZE**
88280467	1/2 CTS
88280469	1/2 IPS
88280487	3/4 IPS
88280473	1 CTS
88280475	1 IPS
88280606	1-1/4 CTS
88280477	1-1/4 IPS
88280479	2 IPS

TAPPING TEE SCRAPERS – for TEE OUTLETS	
PART NUMBER	**DESCRIPTION**
88280401	1/2 CTS LVTT
88280397	1/2 IPS LVTT
88280395	3/4 IPS LVTT
88280399	1 CTS LVTT
88280393	1 IPS LVTT
88280589	1-1/4 CTS MVTT
88280550	1-1/4 IPS MVTT
88280520	2 IPS HVTT

Attachment B-1: Clamping Devices for Couplings



HEAVY DUTY PIPE ALIGNMENT CLAMPS	
PART NUMBER	**DESCRIPTION**
88360771	BAR CLAMP - 1-1/4 IPS
88378088	BAR CLAMP - 2 IPS
88378096	BAR CLAMP - 3 IPS
88378104	BAR CLAMP - 4 IPS
88378112	BAR CLAMP - 6 IPS
88378120	BAR CLAMP - 8 IPS

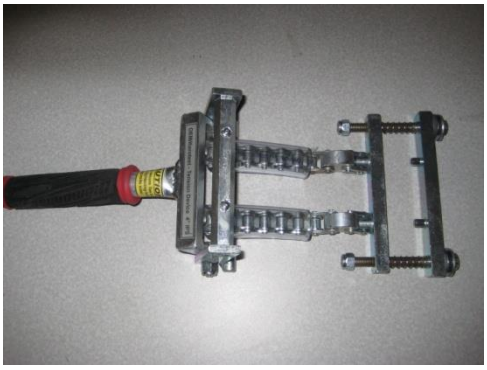


INLINE HANDHELD PIPE ALIGNMENT CLAMPS			
PART NUMBER	**DESCRIPTION**	**PART NUMBER**	**DESCRIPTION**
88364732	1/2 CTS	88364708	1 IPS
88364682	1/2 IPS	88364757	1-1/4 CTS
88364690	3/4 IPS	88364716	1-1/4 IPS
88419551	3/4 IPS x 1/2 CTS	88384292	1-1/2 IPS
88364740	1 CTS	88364724	2 IPS
88412044	1 CTS X 1/2 CTS	88365945	2 IPS x 1-1/4 IPS
88280049	1 IPS X 1 CTS		

POSISTAR ALIGNMENT CLAMP	
PART NUMBER	**DESCRIPTION**
88378070	POSISTAR 2- 8 – KIT ASSEMBLY CONSISTS OF; • 1x – 5ft. SQUARE BAR • 4x – BELT STRAP ASSEMBLIES • 5x – STARS FOR PIPE SIZES 2- 8 IPS
88371430	SPARE BELT ASSEMBLY
88379201	SPARE STAR 2-8 IPS
88365929	SPARE ALUMINUM BAR 5 FT.

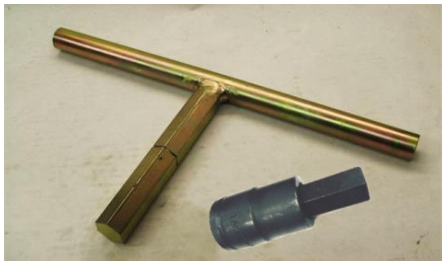
Attachment B-2: Clamping Devices and Nylon Belt Straps and Metal Reusable Underclamps for Tap Tees, Branch and Repair Saddles

HIGH VOLUME BELT STRAP (10X TIME USAGE)	
PART NUMBER	**DESCRIPTION**
88367693	4 IPS BELT STRAP, HVTT, BS, AND RS
88367685	6 IPS BELT STRAP, HVTT, BS, AND RS
88367677	8 IPS BELT STRAP, HVTT, BS, AND RS



METAL REUSABLE UNDERCLAMPS FOR LVTT - MVTT – HVTT TAP TEES – BRANCH & REPAIR SADDLES	
PART NUMBER	**DESCRIPTION**
	Low & Medium Volume
88280413	2 REUSABLE CHAIN CLAMP FOR LV AND MVTT
88280415	3 REUSABLE CHAIN CLAMP FOR LV AND MVTT
88280417	4 REUSABLE CHAIN CLAMP FOR LV AND MVTT
88280419	6 REUSABLE CHAIN CLAMP FOR LV AND MVTT
88280421	8 REUSABLE CHAIN CLAMP FOR LV AND MVTT
	High Volume
88280389	4 REUSABLE CHAIN CLAMP FOR HVTT, BS, RS
88280387	6 REUSABLE CHAIN CLAMP FOR HVTT, BS, RS
88280343	8 REUSABLE CHAIN CLAMP FOR HVTT, BS, RS

Attachment C: Tapping Tee Tools, PE Pipe Cutters, and Test Caps



TAPPING TEE TOOLS	
PART NUMBER	**DESCRIPTION**
	Low & Medium Volume
88373584	T-WRENCH TOOL FOR 1/2” HEX DRIVE CUTTER
88417043	SOCKET SQUARE TOOL FOR CUTTER USED w/RACHET WRENCH (1/2” DRIVE)
	High Volume
88387051	T-WRENCH TOOL FOR 1” HEX DRIVE CUTTER
88363940	SOCKET SQUARE TOOL FOR CUTTER USED w/RACHET WRENCH (1” DRIVE)

PE PIPE CUTTERS	
PART NUMBER	**DESCRIPTION**
88415005	1/2 CTS thru 1-1/4 IPS
88415047	1/2 CTS thru 2 IPS

TAPPING TEE TEST CAPS	
PART NUMBER	**DESCRIPTION**
72559552 or 88280620 +	LVTT – TEST CAP
84023468	MVTT – TEST CAP
72559883	HVTT – TEST CAP (PE 2708 not in picture)
83000468 +	HVTT – TEST CAP (PE 4710)

+

+ Introduced 2019

Attachment D: Electrofusion Control Boxes

PART NUMBER	UNIVERSAL ELECTROFUSION CONTROL BOX
72779988	**"SHANNON"** - ELECTROFUSION CONTROL BOX w/SMART SCANNER & GPS LOCATOR • FUSION CYCLE MEMORY REORDER for 1,000+ FUSIONS • MOUNTED in PELICAN CARRYING CASE • 90º CONNECTOR TIPS • 12FT CABLE LEADS • VOLTAGE 115V 120/V 50/60Hz 80 AMP TRANSFORMER • OPTIONAL BLUETOOTH® COMPATIBILITY

PART NUMBER	UNIVERSAL ELECTROFUSION CONTROL BOX
77319289	**"PORTAFUSE III"** - DC BATTERY BOX, ELECTROFUSION CONTROL BOX w/SMART SCANNER & GPS LOCATOR , • FUSION CYCLE MEMORY REORDER for 1,000+ FUSIONS • MOUNTED in PELICAN CARRYING CASE • 90º CONNECTOR TIPS • 12FT CABLE LEADS • RECHARGEABLE BATTERY PACK 48 VOLT 7-AMP-HOUR

Rev	Date	Written By	Eng Approval	QA Approval	Description
18	10-06-15	D Frederick	M Stovar	W Copeland	General revisions on EAN S-1207
19	05-23-19	D Frederick	Charles F. Woolley	William Copeland 2019.05.23 11:19:22 -04'00'	General document updates. Added Marking and Storage information under General Guidelines. Cooling times updated in Table 1 for LVTTs and MVTTs. Updated Table 2. Temperature comp added to Table 1 and Table 2. Section H added. Removed KTEC EF Control Box. EAN S-1470

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