# FUSION MANUAL

Professional Technician Installer Program (Pro-TIP)

PURE PROGRESS / poloplast

## General information

The information provided in this installer's guide and technical operations manual is intended to help you select our products for your application and to safely and properly install and use the product. The following text and images were prepared for your benefit with utmost care. Nevertheless, errors cannot be entirely excluded. POLOPLAST does not warrant the completeness or accuracy of the information contained herein. POLOPLAST assumes no responsibility for any loss, however arising, from the use of or reliance on the information in this document. This document is not a substitute for in-person or hands-on training. POLOPLAST is grateful for any suggestions or comments.

We are happy to provide further information. Please contact the POLOPLAST America's sales office at support@poloplast.us.

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# GENERAL DIRECTIVES

## SAFETY INSTRUCTIONS

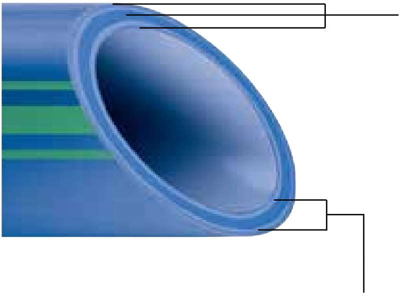
- This Installer's Guide has been prepared to help ensure safe installation of POLOPLAST piping materials.
- Carefully read this Installer's Guide and all warning and operating instructions before installing or working with POLOPLAST piping materials.
- POLOPLAST installation systems may only be planned, assembled and commenced as described in this guide. Only POLOPLAST system components can be used in connection with this guide. The use of other components will void all warrantees.
- For any deviating fields of application, make sure to obtain POLOPLAST's advice.
- You must always observe all national and international safety and accident prevention regulations and industry safety standards when working with POLOPLAST products.
- Always wear proper safety equipment and take appropriate precautions. Failure to follow the manufacturer's instructions, warnings, and operating instructions may result in personal injury, property damage, product damage, or death.

# 1.1 PP-R/PP-RCT

### Brief Introduction

The POLOPLAST pipe system made of PP-R (polypropylene random) offers a non-corrosive and long-lasting solution for conveying water in enclosed mechanical systems for residential and commercial buildings, such as hotels and shopping centers, as well as for hydronic heating and cooling purposes in industrial facilities.

Multilayer composite technology known as ML5 gives PP-R excellent linear expansion and deformation properties, as well as good resistance to impact load at low temperatures.



**PP-R layers**
Layers made of high-grade PP-R provide the color code and reliable welding of pipe and fitting. Use of quality material from I.D. to O.D. reduces sound and heat transfer. Smooth, inert inner surfaces prevent surface buildup and encrustations.

**Fiber composite layers**
Expansion-control technology is made of HPCE, a special POLOPLAST compound material. This PP-R glass fiber compound material has been specially developed by POLOPLAST Polymer Engineering and represents the result of many years of research in this field. The perfect connection of glass fiber and PP-R provides excellent linear expansion and deformation properties, as well as good resistance to impact load at low temperatures.

## 1.2 Handling and Storage

**SAFETY INSTRUCTIONS**

POLOPLAST PP-R pipes can generally be stored at any ambient temperature.

Do not drop the pipes when unloading them.

Avoid sharp impacts and blows to the pipes, especially at low temperatures (</= 40° F)

Make sure that the pipes are always supported over their entire length.

Observe cleanliness. Do not remove the packaging before the material is to be installed. Protect stored pipes from UV rays and outdoor elements.

Check the pipe and pipe ends for damage. Do not use cracked or damaged material.

Do not expose pipes to UV radiation for more than four months.

Only cut pipes with sharp cutters.

## 1.3 Fittings

POLOPLAST offers molded socket fusion fittings 20–125 mm (1/2"–4") and segmented miter-cut fittings from 125–355 mm (4"–14"). All fittings are labeled or marked in indication of size and material (PP-RCT).

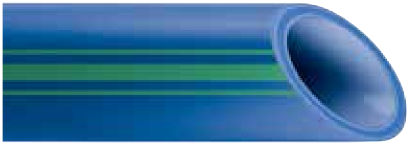
## 1.4 Sizing

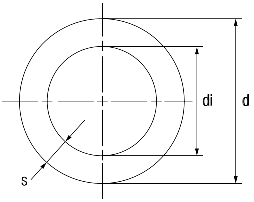
### SDR and Metric Diameter

POLOPLAST piping systems are manufactured to a metric diameter and standard dimensional ratio (SDR) wall thickness.

### POLOPLAST Mechanical fiber pipe SDR 7.4/11/17.6

| | |
|---|---|
| Material: | PP-R |
| Pipe structure: | Fiber-reinforced five-layer structure |
| Color: | Blue with three green stripes |
| Standards: | ASTM 2389, DIN 8077/78,<br>EN ISO 15874 ICC-ES PMG-1458, NSF14 |
| Pipe series: | SDR 7.4/S 3.2, SDR 11/S5, SDR 17.6/S8.3 |
| Product line: | SDR 7.4; Ø 20–25 mm (1/2"–3/4")<br>SDR 11; Ø 32–355 mm (1"–14")<br>SDR 17.6; Ø 125–355 mm (4"–14") |
| Available pipe length: | 20–125 mm = 4 m (1/2"–4" = 13')<br>160–355 mm = 5.8 m (6"–14" = 19') |
| Fields of application: | Hydronic, mechanical, and industrial |





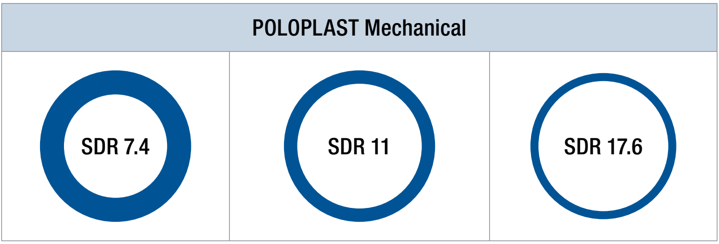
| Dimensions, Weights, and Quantities | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SDR | Item No. | Inch N.D. | Outer diameter (d) mm | Wall thickness (s) mm | Inner diameter (di) mm | Water content gal/ft | Weight lb/ft | Package quantity ft |
| 7.4 | 980322 | 1/2" | 20 | 2.8 | 14.4 | 0.013 | 0.10 | 328 |
| | 980323 | 3/4" | 25 | 3.5 | 18.0 | 0.020 | 0.16 | 197 |
| 11 | 980324 | 1" | 32 | 2.9 | 26.2 | 0.043 | 0.18 | 131 |
| | 980325 | 1 1/4" | 40 | 3.7 | 32.6 | 0.067 | 0.28 | 66 |
| | 980326 | 1 1/2" | 50 | 4.6 | 40.8 | 0.105 | 0.43 | 66 |
| | 980327 | 2" | 63 | 5.8 | 51.4 | 0.167 | 0.68 | 39 |
| | 980328 | 2 1/2" | 75 | 6.8 | 61.4 | 0.237 | 0.95 | 26 |
| | 980329 | 3" | 90 | 8.2 | 73.6 | 0.343 | 1.36 | 13 |
| | 980331 | 4" | 125 | 11.4 | 102.2 | 0.660 | 2.63 | 13 |
| | 980333 | 6" | 160 | 14.6 | 130.8 | 1.082 | 4.31 | 19 |
| | 980334 | 8" | 200 | 18.2 | 163.6 | 1.693 | 6.72 | 19 |
| | 980335 | 10" | 250 | 22.7 | 204.6 | 2.646 | 10.48 | 19 |
| | 980346 | 12" | 315 | 28.6 | 257.8 | 4.203 | 16.56 | 19 |
| | 980347 | 14" | 355 | 32.2 | 290.6 | 5.341 | 20.97 | 19 |
| 17.6 | 980351 | 4" | 125 | 7.1 | 110.8 | 0.776 | 1.71 | 13 |
| | 980353 | 6" | 160 | 9.1 | 141.8 | 1.272 | 2.80 | 19 |
| | 980354 | 8" | 200 | 11.4 | 177.2 | 1.986 | 4.37 | 19 |
| | 980355 | 10" | 250 | 14.2 | 221.6 | 3.105 | 6.79 | 19 |
| | 80366 | 12" | 315 | 17.9 | 279.2 | 4.930 | 10.75 | 19 |
| | 80367 | 14" | 355 | 20.1 | 314.8 | 6.267 | 13.64 | 19 |

DEFINITION

**SDR (Standard dimensional ratio)**
The ratio of the nominal outside diameter to the nominal wall thickness.

SDR is a simple concept, in that the number given represents the amount of wall widths it would take to make up the diameter length. SDR 11, for example, simply means that wall thickness is 1/11 the diameter. So, the wall thickness of any SDR stays proportional to diameter, no matter what diameter is being used. Just like gauge wire, the larger the number gets, the thinner the product. Lower numbers = thicker walls.

**PRO TIP**
Just like gauge wire, the larger the number gets, the thinner the product. Lower numbers = thicker walls.



The following tables help relate metric sizing to traditional IPS outside diameters and flow rates, but the conversions are not exact and best practice is to select the POLOPLAST diameter/SDR combo for the desired system performance.

| Socket Fusion | | |
|---|---|---|
| Factory OD Metric | Factory OD Inches | Nominal Diameter |
| 20 mm | 0.8” | 1/2" |
| 25 mm | 1.0" | 3/4" |
| 32 mm | 1.3" | 1" |
| 40 mm | 1.6" | 1 1/4" |
| 50 mm | 2.0" | 1 1/2" |
| 63 mm | 2.5" | 2" |
| 75 mm | 3.0" | 2 1/2" |
| 90 mm | 3.5" | 3" |
| 125 mm | 4.9" | 4" |

| Butt Welding | | |
|---|---|---|
| Factory OD Metric | Factory OD Inches | Nominal Diameter |
| 125 mm | 4.9" | 4" |
| 160 mm | 6.3" | 6" |
| 200 mm | 7.9" | 8" |
| 250 mm | 9.8" | 10" |
| 315 mm | 12.4" | 12" |
| 355 mm | 14.0" | 14" |
| 400 mm | 15.7" | 16" |
| 450 mm | 17.7" | 18" |
| 500 mm | 19.7" | 20" |
| 560 mm | 22.0" | 22" |
| 630 mm | 24.8" | 24" |

## 1.5 Pipes

POLOPLAST for Mechanical fiber pipe is offered in two primary wall thicknesses, each one offering separate temperature/pressure performance capabilities:

1. SDR 11
   a. 140° F: 110 psi for 50 years
   b. Hydronic Heating (primary function)
2. SDR 17.6
   a. 50° F: 160 psi for 50 years
   b. Hydronic Cooling (primary function)

## 1.6 Pressure/Temperature Test

A full pressure/temperature table can be found in our catalog.

| Temperature | POLOPLAST Mechanical | |
|---|---|---|
| | SDR 11 ML5 | SDR 17.6 ML5 |
| | Permissible working pressure (psi) 50 year lifecycle | |
| 50° F | 265 | 160 |
| 80° F | 200 | 120 |
| 100° F | 165 | 100 |
| 120° F | 135 | 80 |
| 140° F | 110 | 65 |
| 160° F | 70 | 40 |
| 180° F* | 50* | 30* |

*For 25-year lifecycle.

## 1.7 Quick Check (Circle the correct answers)

| | | |
|---|---|---|
| 1. POLOPLAST pipe systems are manufactured to what sizing standard? | | |
| Metric | Iron pipe size | Copper tube size |
| 2. The term “SDR“ refers to what measurement of pipes? | | |
| Length | Diameter | Wall thickness |
| 3. Extra caution is recommended when handling pipe below what temperature? | | |
| 32° F | 40° F | 58° F |
| 4. POLOPLAST 125 mm pipe is called 4“ but the actual outside diameter is: | | |
| 4.0" | 4.9" | 4.3" |
| 5. POLOPLAST pipe with ML5 fiber pipe expands most similarly to: | | |
| Copper | Steel | PVC |

## 2.1 Fusion

DEFINITION

**Fusion**
The process or result of joining two or more things together to form a single entity.

Heat fusion is a simple, strong, and reliable way to assemble a pipe system. Just like any other pipe-joining process, there exist necessary considerations and a procedure to follow. This section covers proper makeup of several types of heat-fused joints, and with a little practice a technician can quickly begin to achieve successful fusion.

DEFINITION

**Thermoplastic**
A plastic material (a polymer) that becomes pliable or moldable above a specific temperature and solidifies upon cooling.

Fusion is a process of heating and cooling two individual thermoplastic articles in a procedure that will cause the two items to become one item at the molecular level. For this joining to occur however, the two hot articles of plastic must be forced to interact at a specific amount of pressure.

DEFINITION

**Interfacial Pressure**
Referring to the pounds per square inch (psi) generated at the point where two objects come in contact under force. Simplified: put your hands together like you're praying. Now push. The pressure you feel in the palm of your hands is interfacial pressure. The harder you push, the more interfacial pressure you create.

When the appropriate times, temperatures, and pressures are applied correctly to properly conditioned thermoplastic material, the result is a joining, or fusion, of the plastic at the molecular level.

There are multiple types of fusion processes across the world of thermoplastics, and they all follow the same broad steps: Prep the material, load the material onto the equipment, let the plastic heat for a period of time, then join the heated plastic together and let it cool for a period of time. Success installing thermoplastics comes from understanding the dynamic shifting demand from hands-on work like prepping material and equipment to hands-off observation like heating and cooling—then planning the job accordingly.

## 2.2 Job Planning

### 2.2.1 Mindset

When it comes to planning a project with other materials, do you use the same installation approach with galvanized steel as you do with PEX? Do you use the same tools for threaded pipe as you do welded pipe? The answer to both of those questions is, "Of course not." This common-sense knowledge applies to PP-R as well. Effective installation of fusible plastics requires specific types and quantities of tools, along with a well thought out approach.

### 2.2.2 PP-R Material Advantages

Semi-rigid, light, and non-brittle

- Carry/fab more at a time
- Ability to snake the pipe into place creates solutions
- Low crystallinity creates higher impact resistances
- Fused joint = welded joint, providing high strength, trouble free transport

### 2.2.3 Approach Options

As with any piping system, there are methods of PP-R installation that you will find more favorable than others. It is your job as the technician to select the correct approach to the job that will maximize the speed and quality of the work. By leveraging the material characteristics of PP-R, there are few circumstances where installing a high quality fused system will be any more time intensive than other traditional trunk and branch systems.

**Here is a general overview of the thought process used in PP-R, to help get you started:**

### 2.2.4 Variable Management

Contractors know that controlling variables is the most important thing on their jobsite. Dozens of factors can set back a job—material supply, weather, utilities, other sub-contractors,… the list goes on. This has driven many firms to increase the amount of prefabrication they do on each job. Why? Less variables. More control. And that methodology pairs wonderfully with a light, welded thermoplastic like PP-R.

FYI

**POLOPLAST America offers fabrication services.** Contact us today at support@poloplast.us for help on your upcoming project.

Construction options, in order of most favorable to least favorable:

## 2.2.4.a Shop Fabrication

- You have sufficient electricity for your machines.
- Your fusion tools and accessories are quarantined.
- It's dry.
- The climate is moderated if not controlled.
- Machine set-up time is minimized if not eliminated.
- You're not missing or forgetting any equipment.
- Shop lighting is typically better than onsite.
- Material transport to work space is minimized.
- Lifts and hoists are readily available.
- No competing with other subs for space or resources.
- One crew can produce work for multiple jobs without cost of relocating.
- Don't over think this.Simply building double randoms in a shop setting can result in a large impact on the speed of an install.

## 2.2.4.b Site Fab

The number of benefits to site fab varies job to job, but are similar to many of the shop fabrication advantages.

- The biggest advantage to site fab is reduced in-line fusion, which can be cumbersome.
- The general idea is that whether you rope off a section of the job to set up a mobile fab shop, or you informally take over the side of a hallway, fuse as much as you can on the ground and lift into place.

## 2.2.4.c In-line

- Required on nearly every job.
- Proper tooling will make it as easy and efficient as possible.
- Ideal strategy would include this approach only where necessary.

## 2.2.4.d Deep Dive

Let's look at some important questions to help dial in the proper approach:

- What are the heating and cooling times required for the diameters on your job?
- How many joints are there, per diameter, on your job?
- Multiply the prior two answers together to get a look at the total fusion time, and then prepare to look for fabrication opportunities to save time.
- Long runs of pipe
- Repeated drops, offsets, ports, manifolds

- Equally important: Identify sections of the job where fabrication opportunities will be limited, and the points where fabrication will have to be joined together in place.
- Use machines! They make the work physically easier and give one technician multiple sets of hands to manage multiple joints at a time.
- REMEMBER: You cannot affect or shorten the fusion thermal cycle in any way, BUT ALSO REMEMBER: You don't have to watch a joint cool. It will cool even without supervision.

## 2.2.5 Quick Check (Circle the correct answers)

| | | |
|---|---|---|
| 1. Interfacial pressure is best described as: | | |
| 14.5 PSI | 1 BAR | Pressure created between two objects |
| 2. PP-R weighs 80% less than steel pipe, which makes moving the pipe: | | |
| Easier | Faster | Safer |
| 3. When evaluating a project for fabrication opportunities, first look for: | | |
| Long straight runs | Loops | Risers |
| 4. To avoid wasting time waiting for cooling joints, get more: | | |
| Material | People | Fusion equipment |
| 5. All of the mentioned benefits of prefabrication, your favorite is: | | |
| | | |

## 2.3 Equipment Equation for Success

## 2.3.1 Thermocycle: Heating and Cooling Time

**CAUTION**

If there is one absolute fact about thermoplastic fusion, it is that the material must be heated and cooled properly, and that process takes time.

Cutting corners in the process increases the possibility of joint failure.

Instead of focusing on how to reduce the heat or cool time, focus on what can be done while the change in temperature is taking place.

### 2.3.1.a Prep

Ensure that when the joint is cooled sufficiently, you can employ your equipment and attention immediately on the next joint.

**Materials**

- Measure & plan
- Procure
- Cut
- Clean & mark
- Stage

**Adjustments and Maintenance**

- Check heater temperatures
- Reposition rollers, cutters, stands, cords, power sources, etc.
- Start equipment for next diameter
- Errands

### 2.3.1.b Fuse

Analyze the job and put enough equipment onsite to ensure there is no standing around waiting for heating/cooling to take place.

General rule of thumb: The larger the diameter and the thicker the wall, the longer the fusion cycle, and thus the larger the impact of employing multiple tools onsite.

1 technician – multiple machines

- 1 machine per technician = inefficient.
- The best thing to do during cooling time of one joint is to be heating up the next one.
- ⚠CAUTION Always have enough technicians present.

We will examine examples as we learn about the different processes.

## 2.3.2 Quick Check (Circle the correct answers)

| | | |
|---|---|---|
| 1. The thermocycle of a fusion joint refers to the time it takes to completely: | | |
| Install | Heat and cool | Pressurize |
| 2. Attempts to alter or accelerate the thermocycle increases the possibility of: | | |
| Joint failure | On-time completion | Monetary bonuses |
| 3. To expedite a job while one joint is heating or cooling, a technician can: | | |
| Chat with co-workers | Use their smartphone | Prep the next joint |
| 4. To have 1 fusion machine on the jobsite will be: | | |
| Too many | Too few | Just right |

## 2.4 Getting Started

POLOPLAST provides this Installer's Guide to assist with training on the following processes: socket fusion, outlet fusion, butt fusion, and electrofusion. The following safety, environmental, and material preparation principles apply to all four processes.

### 2.4.1 Safety

POLOPLAST requires you adhere to all safety measures, procedures, and protocols associated with and dictated by working in general construction environments. Listed below are special considerations to observe while working specifically with thermoplastic material and accompanying equipment. POLOPLAST requests you use caution, good judgement, personal protective equipment, and common sense. In no event shall POLOPLAST assume any liability for injuries or other claims for damages arising out of the use or misuse of our product.

**BURN WARNING** (EQUIPMENT)

**DANGER** Fusion equipment operates between 400-500° F. Contact with human tissue will result in burns. Use proper equipment and extreme caution when handling the equipment. Assume all equipment is hot until confirmed cold. Refer to manufacturer instructions for safe operation.

**BURN WARNING** (PLASTIC)

**DANGER** When the PP-R reaches fusion temperature, it is very hot and contact with human tissue will result in burns. Wear appropriate protective clothing.

**ELECTRICITY WARNING**

**WARNING** Heat generation for fusion comes from electricity. Use proper safety precautions to prevent electrical hazards.

**CUTTING WARNING**

**WARNING** Facer blades and cutting implements.

**SAFETY**
POLOPLAST recommends use of OSHA/ANSI-approved standard-issue personal protective equipment (PPE) including a hard hat, eye protection, and footwear.

## 2.4.2 Environmental Considerations

**SAFETY INSTRUCTIONS**

- **Moisture** – rain, snow, mist, dew, or moisture of any kind will defeat fusion. Dry product and a dry environment are a necessity for your welding area.
- **Direct sunlight** – can cause uneven heat in your fusion cycle. The sun-struck plastic will be warmer than the shaded plastic. Be aware of this phenomenon while evaluating heating times and procedures.
- **Wind** – watch for breezy conditions while you are fusing plastic. Wind can create a temperature imbalance on each side of the heating device, resulting in improper or difficult fusion.
- All of these conditions can be avoided with a temporary shelter.

## 2.4.3 Cutting, Cleaning, and Alignment

**SAFETY INSTRUCTIONS**

Consistent success with all types of fusion begins with proper preparation of the material to be fused.

- Using plastic-designated blades/teeth, cut the material square and with care. Avoid fractures, ragged ends, excessive burrs, or other attached debris. Remember that all materials become more brittle in low temperatures. Exercise extra caution when cutting and handling material at or below 40° F. (Recommended cutting implements are discussed with each process.)
- Any surface in need of sanitation will be wiped with a clean, lint-free cloth and isopropyl alcohol of at least 90% concentration.
- Take all measures necessary to maintain proper material alignment before, during, and after the fusion. Should you place pipe at an angle inside a fitting, you risk a leaky joint. If you are trying to accommodate a light curve on an install, weld the joint perfectly straight and then take advantage of the pipes' natural flexibility. Review the bend radius capabilities of POLO-PRO and install accordingly.

## 2.4.4 Quick Check (Circle the correct answers)

| | | |
|---|---|---|
| 1. Direct contact with fusion equipment that operates at 400-500° F may result in: | | |
| Burning | Sweating | Blushing |
| 2. Direct contact with hot plastic may result in: | | |
| Blushing | Sweating | Burning |
| 3. POLOPLAST encourages safe installation practices and promotes use of ANSI/ OSHA-approved: | | |
| ELO | PPE | HDPE |
| 4. For successful fusion to occur, environmental considerations must be taken including the complete prevention of contact with: | | |
| Cold temperatures | Direct sunlight | Moisture |
| 5. When cutting PP-R, a technician must ensure the pipe is unfractured, square, and: | | |
| Scraped | Beveled | Deburred |
| 6. Any surface needing sanitation prior to fusion will be wiped with a lint-free cloth and: | | |
| 90+% denatured alcohol | 90+% grain alcohol | 90+% isopropyl alcohol |
| 7. Placing pipe inside of fitting should always be done as close as possible to an angle of: | | |
| 2° | 0° | 5° |

# 3.1 Socket Fusion

## 3.1.1 When and Why

- 20–125 mm
- Primary method for small diameter pipe
- Most reliable process due to lack of potential leak paths or metals
- Low machine cost per unit

## 3.1.2 Concepts

- Pipe into fitting
- Heat is visible in the bead, and pressure is automatic from interference
- Alignment = <2° of deflection

**ELECTRICAL CHECK!**
How much electricity do you need for this tool and how much do you have available to you in your work zone?

## 3.1.3 Process

Select the proper size adapter (socket/spigot) for your material. Fasten it to the heater plate. The adapter should be snug and immobile, which doesn't take much torque to achieve. Do not overtighten.

**HOT/BURNING!**
**CAUTION** Plug in your tool so it may start heating. Place it somewhere safe, where no meltable, flammable, or burnable materials may reach it. Warning signs near the unit are encouraged, as the extreme 500° F temperature of the unit is not visibly obvious. Best practice is to cover the iron with a heater bag.

Prepare your material, equipment, and work area.

- Check your heating plate with a pyrometer to verify warming. Contact meters provide more accuracy than laser meters and are preferred.
- Cutting options ½"-4" (20mm–125mm)
    - o Wheel cutter/Tube cutter 63-125
    - o Shears with a pointed blade 20-63
    - o Hand saws
    - o Power equipment like chop saws and reciprocating saws

Make final preparations while the adapter reaches fusion range of 500°+/-18°F. Verify the adapter has reached this temperature before beginning any fusion.

Clean the pipe and fitting fusion areas with isopropyl alcohol, 90% or better.

Mark the insertion depth on the pipe, per the diameter on the gauge.

With material prepped and equipment at temperature, refer to your heating table for proper heating, transition, and cooling times.

| POLOPLAST Socket Fusion Table | | | | | |
|---|---|---|---|---|---|
| Developed around DVS 2207-11 (2017) PP<br>Temperature heating element: 500° F +/- 18° F | | | | | |
| Pipe | Insertion depth inch | Heating period in seconds | Change-over time (seconds) | Cooling period | |
| | | | | Immobile (minutes) | Total (minutes) |
| 1/2" / 20 mm | 9/16 | 5 | 4 | 0.5 | 2.0 |
| 3/4" / 25 mm | 9/16 | 7 | 4 | 0.5 | 2.0 |
| 1" / 32 mm | 19/32 | 8 | 6 | 1.0 | 4.0 |
| 1 1/4" / 40 mm | 21/32 | 12 | 6 | 1.0 | 4.0 |
| 1 1/2" / 50 mm | 23/32 | 18 | 6 | 1.0 | 4.0 |
| 2" / 63 mm | 25/32 | 24 | 8 | 1.5 | 6.0 |
| 2 1/2" / 75 mm | 15/16 | 30 | 8 | 1.5 | 6.0 |
| 3" / 90 mm | 1 1/64 | 40 | 8 | 1.5 | 6.0 |
| 4" / 125 mm | 1 9/32 | 60 | 10 | 2.0 | 8.0 |

**NOTICE** *Reference values for fusion of PP-R/RCT pipes and fittings at an ambient temperature of 68°F with moderate air flow. Fusion can be impacted by air temperature, sunlight, wind, and relative humidity. Adjustment of heating or cooling times may be necessary to accommodate these variable combinations. POLOPLAST recommends controlling these variables as much as possible and to begin work with a test fusion joint, as well as retesting when changing worksite conditions warrant it. The freshly made joint must be immobilized for a miniumum of 25% of total cooling. The joint may finishing cooling on it's own if 1) the joint is made in controlled, workshop-like conditions and 2) no torque, load, or stress is placed the joint while removing it from the machine.*

**PRO TIP**
This is a heat process, not a force process. Loading the material fully should take roughly 75% of the stated heat soak time. This time does not count toward the heat soak. You can also perform a visual bead check on both components: if you see a bead forming, keep pushing. If not, your adapter is too cold or you're loading too fast.

Load both the pipe and fitting on to the adapter simultaneously. Stop inserting the pipe when the mark reaches the edge of the socket and the fitting stops at the raised shoulder of the spigot.

Once the material is fully loaded onto the adapters, begin the heating time countdown. As the heating time comes to an end, the beads on the components should begin to look shiny, almost appearing wet.

Refer to the transition time listed in the heating time table for a window for completion.

Quickly and calmly remove the materials from the adapter. Do not twist. Your material starts to cool immediately, and if it gets too cold, it will not fuse.

Insert the pipe into the fitting in a straight and smooth manner, stopping once the fitting bead, pipe bead, and insertion depth mark all align. Do not twist.

The joint must remain immobilized for a minimum of 25% of the cooling time to avoid deflection.

The joint should not be torqued, stressed, or pressurized until the total cooling time has passed.

Inspection of the joint

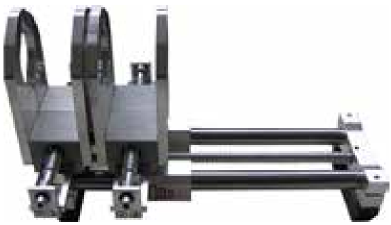
- Two beads touching each other
- Insertion mark
- <2° of deflection

## 3.1.4 Optimize Efficiency

**Tools**

Categorically, there are three types of tools to assess for a socket fusion job.

**Bench.** A bench machine is a large, stable platform that should provide maximum mechanical advantage and alignment of the fusion material. It comes with an onboard fixed heating element. With those advantages in play, bench machines are used to fabricate fast, accurate, and consistent welds that will later be positioned in line. Examples: offsets, complicated spools, pipelining, and even simple single-stick fabrication with an open-ended fitting. (Ritmo Prisma 125, Widos 3511, McElroy SmartFab 125)



**Jig.** A jig is a small, lightweight platform designed to lend as much mechanical advantage and alignment as possible for fusion joints performed in-line. Built to be able to lift overhead comfortably and assemble joints in tight spaces, the jig will shine by making final connections or on jobs where prefabrication is limited. NOTE: On such a limited prefab job, multiple jigs will be necessary. Examples: connecting any prefabricated 2"–4" material, once it has been lifted to its place in the system. (McElroy Spyder, Ritmo Jig, Widos Jig)

**Hand iron.** A hand iron is a heating element with a handle that comes in multiple sizes and is a core utensil on any socket fusion job. It is used for both hand-held and jig-assisted fusion. Examples: light small diameter bench mounted fabrication, in-line small-diameter fusion in tight places.

**Adapters.** An adapter is a set of machined aluminum, Teflon-coated bushings and will be necessary for each diameter of pipe to be socket fused. It is fastened to a heating iron and transmits heat from the iron to the PPR. POLOPLAST pipe and fittings are manufactured for adapters cut to the DVS Type A standard.

When using mechanical assistance of any sort, beware of ovality in the fitting caused by overtightened jaws.

Referring to the previous section of Equipment Equation, assess your job and get the right quantity of each category tool for your job to prevent down time waiting for joints to cool.

## 3.1.5 Quick Check (Circle the correct answers)

| | | |
|---|---|---|
| 1. Socket fusion is used when the pipe diameter falls between: | | |
| 20–125 mm (1/2"–4") | 20–63 mm (1/2"–2") | 250–355 mm (10"–14") |
| 2. The first step of socket fusion is: | | |
| Gather materials | Cut the pipe | Start the heating iron |
| 3. The iron is ready to use when the adapter temperature reaches: | | |
| 400° F +/- 18° | 500° F +/- 18° | 600° F +/- 18° |
| 4. Identify three time parameters before starting the fusion process: | | |
| Heating | Transition | Cooling |
| 5. A socket fusion joint needs to be immobilized for ____% of the total cooling time. | | |
| 50° | 15° | 25° |
| 6. After heating, while bringing the pipe into the fitting do not: | | |
| Align | Hurry | Twist |
| 7. Loading pipe and fitting onto the adapters is a ____ process, not a force process. | | |
| Heating | Boring | Complexing |

## 3.2 Outlet Fusion

### 3.2.1 When and Why

- Branches and sensors
- 40–355 mm mains and 20–125 mm branches
- Fast, inexpensive, and reliable branching capability, fabricated or in-line, anywhere in the system

### 3.2.2 Concepts

- Pipe into fitting, except the fitting acts as the pipe.
- Simultaneous saddle weld
- Heat is visible in the bead, and pressure is automatic from interference
- Alignment, alignment, alignment!

## 3.2.3 Process

**ELECTRICAL CHECK!**
How much are you going to need for this tool and how much do you have available in your work zone?

Select the proper-size outlet adapter (socket/spigot) for your material. Fasten it to the heater plate. The adapter should be snug and immobile, which do-esn't take much torque to achieve. Do not overtighten.

**⚠CAUTION**

Plug in your tool so it may start heating. Place it somewhere safe, where no meltable, flammable, or burnable materials may reach it. Warning signs near the unit are encouraged, as the extreme 500° F temperature of the unit is not visibly obvious. Best practice is to cover the iron with a heater bag.

Prepare your material, equipment, and work area.

- Check your heating plate with a pyrometer to verify warming. Contact meters provide more accuracy than laser meters and are preferred.

Make final preparations while the adapter reaches fusion range of 500°+/-18°F. Verify the adapter has reached this temperature before beginning any fusion.

Clean the pipe and fitting fusion areas with isopropyl alcohol (90% concentra-te or higher)

Drill your hole. Measure twice and be precise.

**PRO TIP**
If the hole is not square, the outlet won't be either.

Clear away debris and shavings from inside and outside the hole.

Grab your outlet fitting and your heating iron and prepare to start applying heat.

There is no DVS heating time for a fusion outlet. Once fully inserted, look for a 360° visual indication of melt (bead) on both the fitting and the pipe.

No rocking—slight articulations are fine. Rocking indicates poor alignment or incorrect combination of pipe, fitting, and adapter.

Once there is a visible 360º bead on both fitting and pipe, remove the heating iron then carefully align and place the outlet fitting. You will have a short period of time to make leveling adjustments.

**50% Size Guideline**

Outlets are available in branch diameter sizes up to 50% of the main diameter. Two similar-size pieces will load on the heater simultaneously. But differing mass pieces will need to be loaded at different times. Use this guideline for determining when to load pipe vs fitting onto heating iron:

- Divide the branch diameter by the main diameter and multiply it by 100.
- This will provide you with a percentage.
- The closer that percentage is to 50, the more simultaneous the heating becomes.

Examples:
- 20 mm outlet on a 630 mm pipe
- 20/630=3%
- Load pipe first. Load fitting after pipe side has fully seated.
- 63 mm outlet on 125 mm pipe
- 63/125=50%
- Load pipe and fitting simultaneously.

***NOTICE*** This is a guideline, not a rule. Conditions and results will vary.

Outlets are a craftsman-level skillset that take practice and an ability to gauge material mass and heat transfer.

When in doubt and dealing with a critical outlet weld, performing a practice weld of the same main/branch combo will yield positive results.

**Cooling**

With no written standard on cooling an outlet joint, POLOPLAST recommends employing the corresponding diametric socket fusion cooling times in regards to immobilization and pressurization.

For example: If you‘re setting a 63 mm/2" branch outlet, immobilize the joint for 1.5 minutes and don‘t pressurize for at least six minutes.

**SAFETY**

**CAUTION** **Outlet branch sizes 75 mm+**

It is not advised to attempt drilling or fusing large-diameter outlets by hand, as the degree of difficulty and danger increases significantly. Consult POLOPLAST America for information on appropriate machinery for such a task.

## 3.2.4 Optimize Efficiency

- Prefabricate! It's much easier than trying to set outlets in the air.
- Use machines! If you're going to fuse outlets in-line, get a machine. If you have a high volume of outlets, get multiple machines.

**Tools**

- Hand iron—a hand iron is a heating element with a handle that comes in multiple sizes and is a core utensil on any outlet-fusion job. It is used for both hand-held and jig-assisted fusion.
- Adapter—An adapter is made of machined aluminum, Teflon-coated bushings and will be necessary for each diameter of pipe to be socket fused. It is fastened to a heating iron and transmits heat from the iron to the PP-R.
- Ritmo Up 90 (20–90 mm branch, 40–630 mm main)
- McElroy Hornet & XL (20–160 mm branch, 40–630 mm)
- Hole saw - metric size specifically for PP-R outlets
- Consult manufacturer for operation

**Hand applied vs. tool assisted**

Tooling is available to mechanically assist with fusion outlets. The benefits of using such equipment is as follows:

- Safer drilling of hole
- Square as possible
- Repeatability and consistency

## 3.2.5 Quick Check (Circle the correct answers)

| | | |
|---|---|---|
| 1. To build a bead on the pipe, you must rock the heating iron back and forth. | | |
| True | False | Sometimes |
| 2. The 50% Guideline helps estimate how soon to begin heating the fitting after starting the: | | |
| Fusion | Weld | Pipe |
| 3. Where can you find the heat soak times for fusion outlets? | | |
| On the tools | In this booklet | They don‘t exist |
| 4. It is recommended to use an outlet machine once you reach this diameter branch line. | | |
| 63 mm | 75 mm | 90 mm |
| 5. A proper outlet joint will have two joining 360° beads and be squarely ____. | | |
| Aligned | Drawn | Cut |

# 3.3 Butt Fusion

## 3.3.1 When and Why

- 125 mm and larger
- Primary fusion process for medium and large diameters
- Most reliable process due to lack of potential leak paths or metals

## 3.3.2 Concepts

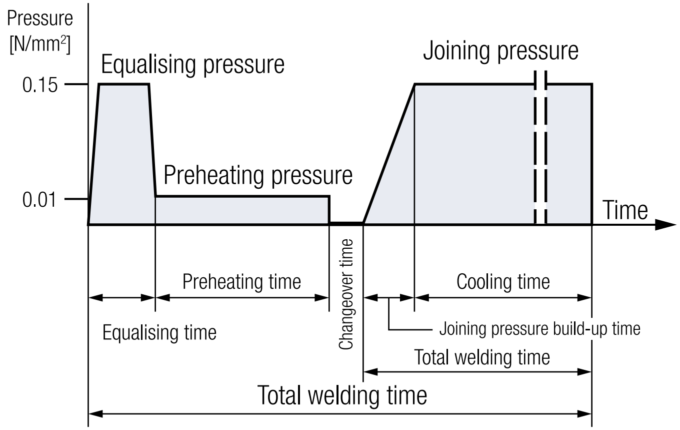
**Pressures:**

- Using gauge pressures to create interfacial pressure
  - Drag pressure—The minimum amount of force needed to overcome inertia and initiate movement of the dynamic jaw(s)
  - Weld pressure—The force required per machine, diameter, and SDR to achieve interfacial pressure of one bar or 14.5 pounds per square inch
  - Full pressure—Drag + weld

**Times:**

- Beading: not a prescribed time, but is complete when the bead reaches a certain height.
- Heating: often referred to as a heat soak, a prescribed amount of time for permeating heat into the plastic.
- Transition: the amount of time allowed to open the carriage, remove the heating plate, and close the carriage to the point that the pipe faces touch.
- Cooling: the prescribed amount of time post-transition for the joint to be ready to pressurize.

**Stages during the heated plate welding process:**



## 3.3.3 Process

**ELECTRICAL CHECK!**
How much are you going to need for this tool and how much do you have available at your location?

A traditional hydraulic butt fusion machine is comprised of four general components:

**Carriage**


**Control Box**

**Facer**

**Heater**

Machines will come in many configurations, but every machine will have jaw sets that move side to side (dynamic) as well as jaw sets that do not move at all (static).

The area found between the dynamic and static jaws is where our fusion will occur, and we call it the “work space”.

Plug in the machine and confirm that the heater plate is on and beginning to warm.

Configure the rest of your machine in preparation to load. Watch for cords and hoses as you set up.

Cutting large pipe:

- Pipe wrap and a marker
- Reciprocating saws with blade recommendations (Milwaukee ax)
- Dry bar chain saws
    - o Cut squarely! It will reduce the amount of prep time once in the machine.

Load the pipe into the machine, leaving 1"–1 ½" of pipe protruding into the work space. If your cut is sloppy, measure from the short side.

For proper aesthetics, position the pipe so striping aligns.

Close jaw sets onto pipe, creating snug and even pressure in each jaw.

Alignment pre-check

- Generally lined up
- Nothing obviously misaligned

Ensure facer is clean. Sterilize with isopropyl alcohol, 90% or better.

Insert facer into work space, making sure it is locked into position.

Establish your drag pressure by slowly increasing the hydraulic pressure in the machine until movement is achieved. Drag pressure is the lowest amount of force needed to create movement. Reestablish drag pressure on every joint.

With drag pressure established, now is a good time to look up the rest of your data. Reference the POLOPLAST butt fusion table on the following pages for everything except the weld pressure. Consult the machine manufacturer for weld pressure based on the machine type, pipe diameter, and pipe SDR.

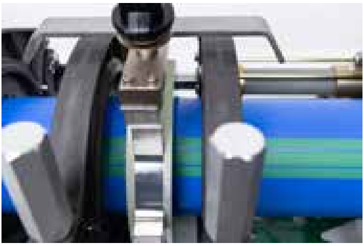
Start the facer and close the carriage starting with drag pressure, increasing pressure as necessary to produce ribbons of plastic from all 360° of both pipe faces.

Finish the face according to machine manufacturers instructions. Evaluate pipe faces for clean, smooth, parallel ends.

Alignment post-check

- High-low
- 10% of wall thickness allowed

Verify heater plate temperature is 410°+/-18°F and place in carriage between pipes.

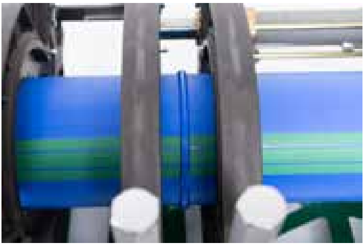


Close carriage, forcing the pipes into contact with the heater plate at full pressure.

Observe pipe faces. Leave in contact with heater plate until specified bead height has been reached all the way around both pipe faces.

Reduce machine pressure to drag pressure and start heating time countdown.

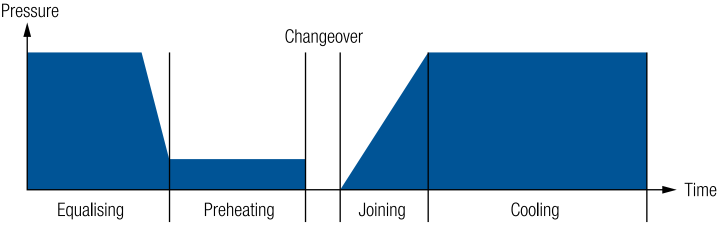
Upon completion of heating time, open the carriage just enough to successfully remove the heater plate and immediately close the carriage until the pipe faces touch and the machine is again at full pressure.



Begin cooling time countdown.

The joint must cool under pressure and can not be torqued or stressed during its cool down period. If the machine can be removed without stressing the joint, it may be done after 50% of the total cooling period has passed. It is advised that this be done in a variable-controlled environment, and if there is any doubt, leave the joint in the machine under pressure for the total cooling period.

## Schematic Representation of the Welding Process




| POLOPLAST Butt Fusion Table | | | | | | | |
|---|---|---|---|---|---|---|---|
| Developed around DVS 2207-11 (2017) PP<br>Temperature heating element: 410° F +/- 18° F | | | | | | | |
| **Dimension** | | | **Heating** | | **Fusing** | | **Cooling** |
| **Diameter** | | **SDR** | **Bead Up** | **Heating** | **Change-over** | **Joining** | **Cooling** |
| **mm** | **inch** | | **Bead inch** | **Time min:sec** | **Time seconds** | **Time seconds** | **Time minutes** |
| 125 | 4" | 11 | 1/32 | 2:13 | 7 | 11 | 13 |
| | | 17.6 | 1/32 | 1:23 | 6 | 7 | 8 |
| 160 | 6" | 11 | 1/32 | 2:41 | 9 | 13 | 14 |
| | | 17.6 | 1/32 | 1:44 | 7 | 9 | 9 |
| 200 | 8" | 11 | 1/32 | 3:18 | 9 | 17 | 17 |
| | | 17.6 | 1/32 | 2:08 | 7 | 11 | 11 |
| 250 | 10" | 11 | 1/16 | 4:01 | 10 | 18 | 21 |
| | | 17.6 | 1/32 | 2:37 | 9 | 15 | 14 |
| 315 | 12" | 11 | 3/32 | 4:52 | 12 | 24 | 27 |
| | | 17.6 | 1/32 | 3:15 | 9 | 15 | 17 |
| 355 | 14" | 11 | 3/32 | 5:22 | 13 | 28 | 29 |
| | | 17.6 | 1/16 | 3:36 | 9 | 18 | 19 |

**NOTICE** *Reference values for fusion of PP-R/RCT pipes and fittings at an ambient temperature of 68°F with moderate air flow. Fusion can be impacted by air temperature, sunlight, wind, and relative humidity. Adjustment of heating or cooling times may be necessary to accommodate these variable combinations. POLOPLAST recommends controlling these variables as much as possible and to begin work with a test fusion joint, as well as retesting when changing worksite conditions warrant it. The respective cooling times can be reduced by 50% if 1) the joint is made in controlled, workshop-like conditions and 2) no torque, load, or stress is placed the joint while removing it from the machine.*

## 3.2.4 Optimize Efficiency

Butt fusion has longer cooling times than socket fusion—get more than one machine on site! One technician can be operating multiple machines at one time, producing new joints as old ones cool, and job productivity can reach unbelievable levels—but only if there are enough machines to prevent being held hostage by cooling cycles.

On the ground vs in the air

- Big pipe and the big machines required for fusion are much easier to manage on the ground. Machine manufacturers continue to advance the technology of the equipment, making it lighter and more adaptable to tight spaces, but the impact of prefabricated spools intensifies as the diameters get larger. Other piping system fabrication abilities are limited due to glued joints or sheer weight. With PPR, consider flying a multi-story riser into place after fusing it on the ground. Or maybe those supply and return lines can be built ditch-side and placed sub-grade.

## 3.3.5 Quick Check (Circle the correct answers)

| | | |
|---|---|---|
| 1. Butt fusion becomes the primary joining process at which diameter? | | |
| 90 mm | 125 mm | 160 mm |
| 2. Reduce the amount of facing time by ensuring that: | | |
| The pipe is cut square | The blades are sharp | Maintaining the facer |
| 3. What is the total cooling time for 200 mm SDR 17.6? | | |
| 2:08 minutes | 13 minutes | 11 minutes |
| 4. Every joint must cool under pressure for what minimum percentage of the total cooling time? | | |
| 50% | 25% | 100% |
| 5. We use hydraulic pressure of a machine to generate ______ pressure between pipes to create fusion. | | |
| Intracranial | Intercontinental | Interfacial |

# 3.4 Electrofusion

## 3.4.1 When and Why

- Repairs, replacements, rework, tight space
- 20 mm – 250 mm (1/2"-10" N.D.)
- Recommended to be used only when traditional methods absolutely cannot be performed.
- It requires favorable conditions, an experienced technician, and specialty tooling beyond traditional methods.

## 3.4.2 Concepts

- Electrical: The power source for electrofusion must be extremely clean, powerful, and near to the installation point.
- Pipe in fitting

## 3.4.3 Process

Each pipe end must be cut squarely, with a smooth face and completely deburred.

**ELECTRICAL CHECK!**
How much are you going to need for this tool, how much do you have available at your location, and how far can the source be from the processor (max extension cord gauge and length)?

Mark the pipe at least a half fitting length from the cut end.

Each pipe end must then be evenly peeled to remove oxidized plastic as well as reduce the O.D. for coupling fitment. An uneven peel can lead to uneven interfacial pressure in the joint.

- After each pass, test fit the coupling without contaminating it.
- Contact between the pipe and fitting should be present, but not severe.
- Continue making peeling passes until this fitment is achieved.
- If the coupling slides loosely up the pipe or rattles around when at proper insertion depth, the pipe is too small in diameter. Restart with fresh material.
- Never use striking tools to set the fitting.

Once peeling is complete, ensure that your insertion mark is visible. If it is not, remark the peeled pipe at exactly a half fitting length from the cut end.

Ensure the pipe O.D. and fitting I.D. are completely sterile. Use isopropyl alcohol (90%  purity or higher) to decontaminate.

Insert both peeled pipe ends into the coupling until they meet, and are flush and level in the middle of the coupling.

Immobilize the material in proper alignment with designated equipment.

- Bracing must be evenly distributed and maintained to achieve proper interfacial pressure during the fuse.

Attach the processor leads to the coupling pins.

Refer to fitting label for fusion data.

**SAFETY**

**⚠WARNING**

Stand back from coupling while heating! Heated liquid plastic under uneven pressure can escape and cause burning.

Follow the processor manufacturer's instructions on how to input fusion data and heat the coupling.

Do not stress or torque the joint in any manner until the full cool down time has been observed.

## Tools

**Processor.** This device runs an electrical current at precise voltage and amperage for a prescribed amount of time through electrofusion fittings. Processors require copious amounts of electricity, the amount increasing parallel the diameter. Ritmo Elektra Series: Light, 500, & 1000;  Widos ESI 2000.

**Peeler/Scraper.** Self-explanatory by name, this device removes an ultra-thin layer of polymer from the O.D. of a pipe to prepare it for fitting insertion. Ritmo Turbo series & RTC series; Widos W, S, & F series.

**Immobilization Brace.** Used to lock the pipe and fitting in proper alignment and angle through the entirety of the thermocycle. Ritmo Aligner series; Widos Quadruple series.

## 3.4.4 Optimize Efficiency

Being a last choice for bonding thermoplastics, electrofusion is more a precision process than anything else. If multiple joints need to be performed, consider the following advisements:

- Multiple braces help avoid waiting on cool down times.
- Multiple peelers help reduce prep times.
- Check and then recheck the power requirements of the processor against what is available at the installation point. Investigate plug types as well.
- Having a backup processor could be useful if the primary overheats or malfunctions.

## 3.4.5 Quick Check (Circle the correct answers)

| 1. Electrofusion must be immobilized for what percentage of the total cooling time? | | |
|---|---|---|
| 80% | 90% | 100% |
| 2. Electrofusion is designed to be used for: | | |
| Repairs | Rework | Tight spaces |
| 3. Heating and cooling information for the fitting comes from: | | |
| The catalog | The website | The fitting label |

## 4.1 Chemical Resistance

**NOTICE** Polypropylene is naturally very resistant to many chemicals and medias. It has a multitude of uses in the piping world including mechanical applications and beyond. If you wish to run a particular chemical through POLOPLAST pipe, please submit a Chemical Inquiry, which can be found in our Mechanical Applications Catalog or www.POLOPLAST.us

### 4.1.1 Hanger Spacing

Tables for the determination of the distance between clamps, depending on temperature and outside diameter. The values specified are POLOPLAST recommendations and are valid for horizontal and vertical installations.

**POLOPLAST Mechanical pipes SDR 7.4, SDR 11, SDR 17.6**

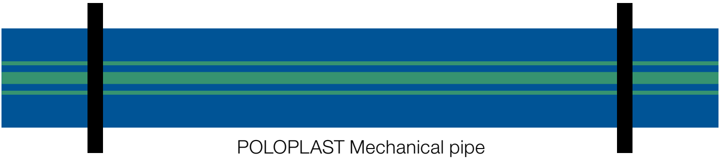
| POLOPLAST Mechanical with ML5 fiber technology | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SDR 7.4 and SD R11 | | | | | | | | |
| Dimension | | Media temperature [°F] | | | | | | |
| mm | in | 50° | 68° | 86° | 104° | 122° | 140° | 158° |
| | | Hanging distance in ft | | | | | | |
| **20** | **1/2”** | 3.6 | 3.1 | 3.0 | 2.8 | 2.8 | 2.6 | 2.3 |
| **25** | **3/4”** | 3.9 | 3.4 | 3.4 | 3.1 | 3.1 | 3.0 | 2.6 |
| **32** | **1”** | 4.6 | 3.9 | 3.9 | 3.6 | 3.6 | 3.4 | 3.1 |
| **40** | **1 1/4”** | 5.2 | 4.6 | 4.4 | 4.1 | 4.1 | 3.9 | 3.6 |
| **50** | **1 1/2”** | 6.1 | 5.1 | 5.1 | 4.8 | 4.8 | 4.4 | 4.3 |
| **63** | **2”** | 6.6 | 5.7 | 5.7 | 5.4 | 5.4 | 5.1 | 4.8 |
| **75** | **2 1/2”** | 7.1 | 6.2 | 6.2 | 5.7 | 5.7 | 5.4 | 5.1 |
| **90** | **3”** | 7.5 | 6.9 | 6.9 | 6.4 | 6.4 | 5.9 | 5.9 |
| **125** | **4”** | 8.2 | 7.9 | 7.4 | 7.1 | 6.4 | 6.1 | 5.6 |
| **160** | **6”** | 9.2 | 8.9 | 8.0 | 7.7 | 6.7 | 6.4 | 5.9 |
| **200** | **8”** | 9.4 | 9.0 | 8.2 | 7.9 | 6.9 | 6.7 | 6.1 |
| **250** | **10”** | 9.5 | 9.2 | 8.4 | 8.0 | 7.1 | 6.6 | 6.2 |
| **315** | **12”** | 10.0 | 9.8 | 8.9 | 8.5 | 7.5 | 7.2 | 6.6 |
| **355** | **14”** | 11.0 | 10.8 | 9.8 | 9.2 | 8.2 | 7.9 | 7.2 |

| POLOPLAST Mechanical with ML5 fiber technology | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SDR 17.6 | | | | | | | | |
| Dimension | | Media temperature [°F] | | | | | | |
| mm | in | 50° | 68° | 86° | 104° | 122° | 140° | 158° |
| | | Hanging distance in ft | | | | | | |
| **125** | **4”** | 7.4 | 7.1 | 6.6 | 6.3 | 5.8 | 5.5 | 5.0 |
| **160** | **6”** | 8.3 | 8.0 | 7.2 | 6.9 | 6.1 | 5.8 | 5.3 |
| **200** | **8”** | 8.4 | 8.1 | 7.4 | 7.1 | 6.2 | 6.1 | 5.5 |
| **250** | **10”** | 8.6 | 8.3 | 7.5 | 7.2 | 6.3 | 5.9 | 5.6 |
| **315** | **12”** | 9.0 | 8.9 | 8.0 | 7.7 | 6.8 | 6.5 | 5.9 |
| **355** | **14”** | 9.9 | 9.7 | 8.9 | 8.3 | 7.4 | 7.1 | 6.5 |

With POLOPLAST Mechanical pipes, you need around 30% fewer clamps compared to an installation with standard plastics without fiber reinforcement.

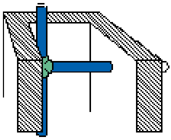
**Example:**

POLOPLAST Mechanical pipe 1½ in., medium temperature 104° F
mounting distance = 4.8 in.



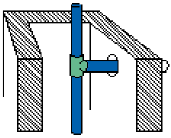
POLOPLAST Mechanical pipe

## Placing the pipes



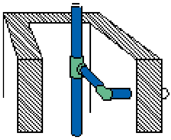
Installing pipe in ceiling and wall supports

- Use of fixed and sliding clamps is mandatory to control expansion.
- If the linear length of a run exceeds 130 feet, an expansion control of some form must be employed.
- Inline supports increase linear fortitude of the pipe, especially in small diameters.



Installing pipe in a vertical shaft

- All hangers/clamps must be fixed.
- The distance between fixed points must not be greater than 10 feet.
- It is recommended to position clamps at each lateral branch run.
- With the amount of fixed points on a vertical riser, expansion controls are not required.



Installing pipe embedded in cement, concrete, or subterranean

- The friction forces that occur prevent expansion of the pipe.
- Resulting tensions are absorbed by the pipe material.
- Due to low expansion forces, the embedment material will not be damaged.

## 4.1.2 Linear Expansion, Calculation

### Length variation

Like all materials, changes in the length of pipes are dependent on the increasing temperature of the pipe material. This temperature change can be caused by different installation and operating temperatures, as well as varying media temperatures. The potential variation in length must be taken into account at the time of installation.

If the operating temperature is higher than the installation temperature, the pipe will elongate. If the media temperature (e.g. cold water) is lower than the installation temperature, the calculation will result in a reduction in length.

The following factors must be considered in the calculation of the variation in length:

- Installation temperature
- Operating temperatures (media temperatures)
- Temperature difference between installation and operating temperatures
- Coefficient of linear expansion
- Pipe length

The coefficient of linear expansion $\alpha$ are:

- PP-R monolayer
- POLOPLAST fiber pipe

The formula for the calculation of the variation in length is:

$$\alpha = 1.0 \times 10^{-3} \frac{in}{ft \times \Delta °F}$$

$$\alpha = 2.533 \times 10^{-4} \frac{in}{ft \times \Delta °F}$$

| $\Delta L = \alpha \times l_0 \times \Delta T$ | | |
|---|---|---|
| $\Delta L$ | variation in length | inch |
| $l_0$ | pipe length prior to temperature change | feet |
| $\alpha$ | length variation coefficient | $\frac{\text{inch}}{\text{feet x } \Delta \text{ °F}}$ |
| $\Delta T$ | maximum occurring temperature difference between installation and operating temperature | °F |

**Example:**

POLOPLAST Mechanical pipe
Length = 33 ft
Assembly temperature: 70° F
Working temperature: 104° F

Calculation:

$$\Delta L = 2.533 \times 10^{-4} \frac{\text{in}}{\text{ft} \times \Delta \text{°F}} \text{ x 33 ft x (104°F – 70°F)}$$

$\Delta L$ = 0,284 in.

| POLOPLAST Mechanical with ML5 fiber technology | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Pipe length (ft) | Temperature difference [°F] | | | | | | | |
| | 10° | 20° | 30° | 40° | 50° | 60° | 80° | 100° |
| | Linear expansion (in) | | | | | | | |
| **10** | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 |
| **20** | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.5 |
| **30** | 0.1 | 0.2 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.8 |
| **40** | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.8 | 1.0 |
| **50** | 0.1 | 0.3 | 0.4 | 0.5 | 0.6 | 0.8 | 1.0 | 1.3 |
| **60** | 0.2 | 0.3 | 0.5 | 0.6 | 0.8 | 0.9 | 1.2 | 1.5 |
| **70** | 0.2 | 0.4 | 0.5 | 0.7 | 0.9 | 1.1 | 1.4 | 1.8 |
| **80** | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 | 1.2 | 1.6 | 2.0 |
| **90** | 0.2 | 0.5 | 0.7 | 0.9 | 1.1 | 1.4 | 1.8 | 2.3 |
| **100** | 0.3 | 0.5 | 0.8 | 1.0 | 1.3 | 1.5 | 2.0 | 2.5 |
| **150** | 0.4 | 0.8 | 1.1 | 1.5 | 1.9 | 2.3 | 3.0 | 3.8 |
| **200** | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 4.1 | 5.1 |

## Expansion Compensation

**NOTICE** Variations in length caused by temperature differences must be taken into account during the planning stage to prevent subsequent damage to pipelines, fastening elements, and the building structure. In order to keep the occurring stress impacts within acceptable ranges, the variation in length must be compensated appropriately. There are two options available to achieve this compensation:

- Expansion compensation using bending legs and U-pipe bends (natural expansion compensation)
- Expansion compensation using compensators (artificial expansion compensation)

In most cases, directional changes in the pipe routing can be utilized to absorb the variation in length. Should the directional changes not be sufficient, a U-pipe bend must be used.

It is important to bear in mind that the outlets distributed throughout the line system can also influence the variation in length, or may be negatively affected themselves by the variation in length.

Please refer to the manufacturers of the compensators for more information on the expansion compensation provided by compensators.

## Bending legs

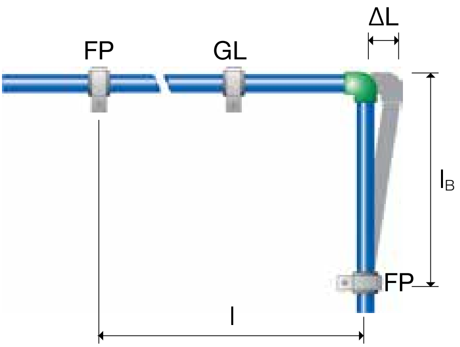
In order to determine the specific direction in which the expansion compensation is steered, the directional change is installed between two fixed points. Generally, the pipes are arranged in right angles at the points where the direction changes. A variation in the length of one leg produces bending in the other leg. Provided that all legs are of a sufficient length to prevent the resulting flexural strain from becoming too great, the system can flexibly absorb the variation in length.

| $l_B = K \times \sqrt{d \times \Delta L}$ | | |
|---|---|---|
| $l_B$ | length of the bending leg | inch |
| K | material-dependent constant (2.98* for PP) | |
| d | outside pipe diameter | mm |
| ΔL | variation in length | inch |

*includes metric to imperial conversion factor

Sample calculation:
Pipe outside diameter 75 mm
Variation in length 3.3 in.

$$l_B = 2.98 \times \sqrt{75 \text{ mm} \times 3.3 \text{ in}}$$
$$l_B = 46.9 \text{ in.}$$




FP = Fix Point
GL = Gliding Point

## Expansion Loop

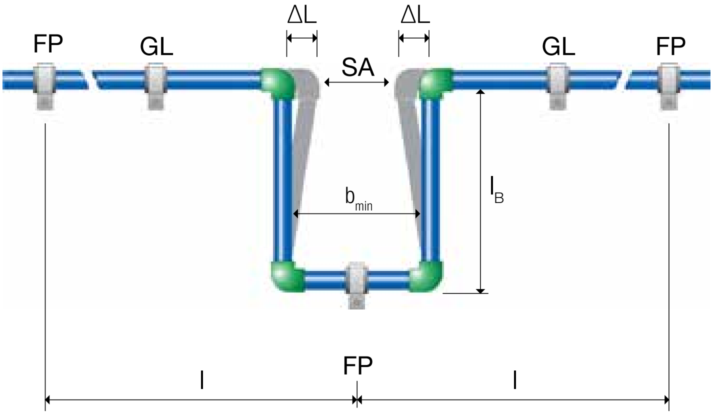
If it is not possible to compensate for the variation in length by introducing directional changes into the pipe routing, an expansion loop must be used instead.

For the implementation of the expansion bend, the length $l_B$ of the bending leg and the width $b_{min}$ of the expansion bend must be considered. It is advisable to position the expansion bend in such a way that the lengths $l_1$ and $l_2$ are equal.

| $b_{min} = 2 \times \Delta L + SA$ | | |
|---|---|---|
| $b_{min}$ | minimum width of the expansion | in. |
| $\Delta L$ | variation in length | in. |
| SA | safety clearance = 6 | in. |

Sample calculation:
Variation in length $\Delta L$ = 3.3 in.

$b_{min} = 2 \times 3.3$ in + 6 in.
$b_{min} = 12.6$ in.



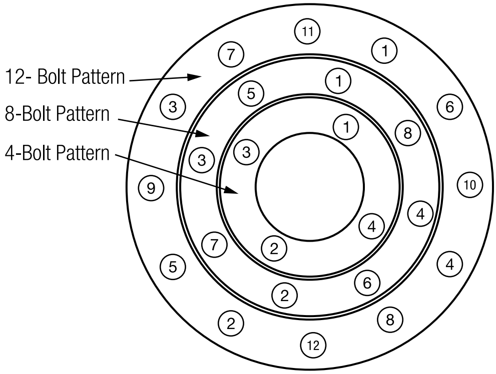

FP = Fix Point
GL = Gliding Point

## 4.1.3 Flanging and Torque Specs

When joining flange faces of any material type, a robust and effective seal can only be achieved if sufficient compressive forces are transmitted to the flange stub end via the carbon steel backing flange ring. These compressive forces must be of sufficient magnitude to overcome fluctuating hydrostatic and temperature generated forces encountered during the lifetime of the joint. In assembling the flange adapters, gasket and backing flange rings it is extremely important to ensure cleanliness and true alignment of all mating surfaces. The correct bolt tightening procedure must also be followed, and allowance made for the stress relaxation characteristics of the plastic stub ends.

### Tightening the bolts

- Plastic flanges require gradual, even bolt tightening.
- To ensure even distribution of stresses in the fully installed flange, tighten the bolts in a star pattern as described in ANSI B16.5:




- To ensure even distribution of stresses and a uniform seal, tighten the bolts to a third of the torque rating using a star pattern, then repeat the star pattern, and so on up to the maximum torque value.

**PRO TIP**
A final tightening after 24 hours is recommended, when practical, to ensure that any bolts that have loosened due to relaxation of the polymer are fully engaged.

| Recommended Flange Bolt Torque | | | |
|---|---|---|---|
| Flange size (inch) | OD (mm) | ANSI 150 bolt pattern | Flat gasket, unlubed (ft-lb) |
| 2” | 63 | 4 | 35 |
| 2 1/2” | 75 | 4 | 50 |
| 3” | 90 | 4 | 60 |
| 4” | 125 | 8 | 40 |
| 6” | 160 | 8 | 60 |
| 8” | 200 | 8 | 70 |
| 10” | 250 | 12 | 75 |
| 12” | 315 | 12 | 90 |
| 14” | 355 | 12 | 90 |

- POLOPLAST recommends using a full-face flat gasket (black EPDM) for most applications. For special chemical applications please check the resistance of the gaskets. The gasket should have an inside diameter consistent with the ID of the flange adapter.

## 4.1.4 Direct Bury and Pull Force

Trenchless applications are a growing field. POLOPLAST Mechanical pipe systems can be used underground.

### Direct Bury

- In applications where the pipe needs to be buried in soil, sand, or concrete, PP-R is safe, non-leaching, and resistant to crushing or damage. POLOPLAST Mechanical pipe can be used for directional boring, if a properly sized pulling head is used.

### Pull Force

**NOTICE**

- The proceeding table provides maximum pull forces allowed on POLOPLAST Mechanical PP-R pipes, assuming a material temperature of 70° F and short term tensile load time of no more than one hour. A load cell should be used to control the pulling force.
- Exceeding the calculated safe pull force may result in pipe damage.
- To avoid excess drag and snag, removing the butt fusion bead is allowed and encouraged.
- Contact POLOPLAST America for bead removal tooling options.

| Maximum Safe Pull Force for PP-R Mechanical pipe (70° F:1h) | | | |
|---|---|---|---|
| Dimension | | Max. pull force (lb) | |
| inch | mm | SDR 11 | SDR 17.6 |
| 4” | 125 | 7,622 | 4,927 |
| 6” | 160 | 12,494 | 8,082 |
| 8” | 200 | 19,474 | 12,654 |
| 10” | 250 | 30,367 | 19,707 |
| 12” | 315 | 44,352 | 28,796 |
| 14” | 355 | 56,281 | 36,449 |

**NOTES**

1. Pulling pipe at elevated temperature—multiply the value in the table by 0.87 at 85° F, by 0.74 at 105° F, by 0.61 at 120° F.
2. Pipe is under tension for over 1 h - multiply by 0.95 for pull tension duration up to 12 h, by 0.91 for pull tension duration up to 24 hours.

## 4.1.5 Bend Radius

POLOPLAST does not recommend bending POLOPLAST PP-R pipes as a means of making a change in direction, as fittings are designed for this purpose.

In the instance the decision is made to bend the pipe, the pipe may be bent or bowed a maximum bending radius of 100 times the fiber pipe outside diameter.

| | | Installation Temperature |
|---|---|---|
| | | ≈20° C / 70° F |
| Minimum bending radius | PP-R single layer pipes | 50 x $d_a$ |
| | PP-R fiber pipes | 100 x $d_a$ |

**NOTICE** Observe appropriate safety precautions during field bending.

Please contact our sales and/or technical team to assist you in cases of these specific application.

## 4.1.6 Additional Information

Because PP-R/RCT is a nonbrittle thermoplastic, the natural characteristics of the material and the process through which it is joined allows the installer fewer concerns than some traditional systems.

### 4.1.6.1 Thrust Blocking

POLOPLAST Mechanical pipes and heat fused fittings do not require thrust blocks to restrain the longitudinal loads resulting from pipe pressurization. Because fittings are part of the monolithic structure, no thrust blocks are needed to keep the fittings from separating from the PP-R pipe.

### 4.1.6.2 Water Hammer

Combining the natural PP-R/RCT noise attenuation, the ability to absorb forces of surge pressure, and the fact that the flow velocity in mechanical applications are low (often between 1 and 4 ft/s, based on size) water hammer and noise generation is not normally an issue with POLOPLAST Mechanical pipes.

### 4.1.6.3 Vibration

Due to the natural ability of PP-R to absorb vibration, isolators/supports are not required if the pipe is not anchored off the pump.

### 4.1.6.4 UV

**NOTICE** All plastics are subject to eventual effect from ultraviolet radiation. This is the case for POLOPLAST as well. Pipes and fittings must not be exposed to UV radiation for more than 4 months as this could reduce their durability and capabilities. Generally, mechanical heating/cooling pipes installed in UV exposed conditions will already require insulation for code approval, so extra measures may not be required.

In an installation requiring exposed pipe, POLOPLAST UV pipe is the only 100% PP-R pipe designated for UV. Contact POLOPLAST America for further information.

### 4.1.6.5 Flushing

As with any other piping system, PP-R/CT systems require complete and thorough flushing prior to start up.

### 4.1.6.6 Freezing

**NOTICE** POLOPLAST pipes and fittings are not designed to have frozen material inside them. All measures should be taken to avoid freezing. However, the natural flexion and absorptive properties of PP-R/CT pipe walls makes it resistant to the axial forces of temporary freezing.

## 4.2 Quick Check (Circle the correct answers)

| | | |
|---|---|---|
| 1. Before using chemicals in a PP-R system, it is recommended to submit a: | | |
| Sacrifice | $100 bill | Inquiry form |
| 2. Compared to steel pipe, hanging POLOPLAST Mechanical PP-R pipe will require: | | |
| More support | Less support | The same support |
| 3. If the linear length of one run exceeds 130 ft, some form of expansion control must be: | | |
| Considered | Employed | Drawn |
| 4. When installing vertically, a fixed point must be installed every: | | |
| 10 yards | 10 feet | 10 furlongs |
| 5. POLOPLAST PP-R pipe is suitable for direct bury and concrete embedment: | | |
| Never | Sometimes | Always |
| 6. Torqueing a flange connection is important and must be done in this order: | | |
| Habitual | Rotational | Sequential |
| 7. Flushing a PP-R system before start up is required only: | | |
| When the moon is full | During a North wind | On days that end in "y" |

## 5.1 Testing Procedure, Protocol, and Reporting/Submission

**NOTICE** **Pressure tests**

Completed installations must be tested for leaks before they are covered or painted. They should be tested with a pressure test. The pressure test can be performed with water or air. The test medium depends on the installed and planned commissioning. If the pipe system is to be left empty after the pressure test, a pressure test with air or inert gas should be performed.

The test medium and results should be documented in a test report. The entire system must undergo a visual check prior to the pressure test. During this check, care should be taken to ensure that the pipelines have been installed professionally.

The pressure test consists of two steps:

- Preliminary test
- Load test

The preliminary test involves checking the system for major errors or leaks. The system will expand and stretch. Once test pressure has been reached and is stable, proceed with the load testing. The load test focuses on checking the system's strength. If only one section of the system is to undergo a pressure test, care must be taken to ensure that any open pipe ends associated with the section concerned have been sealed by means of caps, plugs, or blind flanges. It is also important to ensure that the section has been isolated from the rest of the system using suitable shut-off devices.

If the system or section contains valves and appliances that have not been designed to withstand the test pressures associated with the preliminary/load test, these components will need to be disassembled and fitting pieces used in their place.

The components should not be reinstalled in the system until the pressure test is complete. If the test medium is supplied via a connection with a higher pressure level than the test pressure, then a water-pressure-reducing valve (plus a relief valve, if necessary) must be used to prevent the test pressure being exceeded.

As a basic principle, POLOPLAST recommends carrying out the pressure test in sections and performing separate tests if there are different types of piping systems.

The choice of test medium depends on the piping system, the application, and the time when the system is due to be commissioned. As a general guideline, POLOPLAST recommends carrying out the pressure test for non-potable systems like mechanical applications with water.

The pressure-test form on the next page must be understood as a recommendation from POLOPLAST.

## 5.1.1 Pressure Test Form: Water

Project: ______________________________________________________

Project Owner: _________________________________________________

City, State: ____________________________________________________

Contractor Name: _______________________________________________

Type of POLOPLAST product installed: ____________________________

Maximum system operating pressure: _________ psi

Water temperature ______ °F Ambient temperature _______ °F

Pressure test carried out as ☐ complete system ☐ in ________ sections

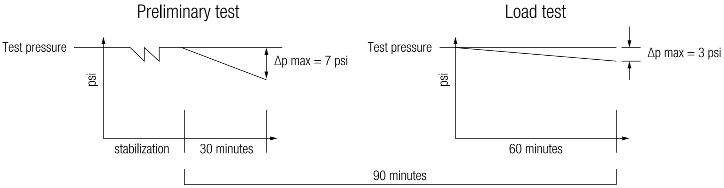
Preliminary arrangements:

- ☐ All pipes have been sealed by metal plugs, caps, blind plates, or blind flanges.
- ☐ All components within the system that do not meet the required test pressure have been separated from the pipe system.
- ☐ The system has been filled, flushed, and bled.
- ☐ Installation is done by POLOPLAST trained personnel

What manufacturer of fusion equipment was used:

☐ McElroy ☐ Ritmo ☐ Widos ☐ Other

| Pressure Test Procedure | | | |
|---|---|---|---|
| *Test pressure = 150% of operating pressure or 150 psi whichever is greater (2) | | | |
| **Preliminary Test** | Test pressure* ______ psi | | |
| | After bringing up the test pressure the system will expand slightly, so additional pressure may be required to help it stabilize. | | |
| **Load Test** | Test duration: | 30 minutes | Pressure drop ______ psi |
| | | | Maximum pressure drop of 7 psi is allowed during 30 minutes |
| | Test duration: | 60 minutes | Pressure drop ______ psi |
| | | | Maximum pressure drop of 3 psi is allowed during 60 minutes |




- ☐ Visual inspection of pipe system has been carried out
- ☐ No leaks were determined during the testing period
- ☐ The pipe system is leak-proof

Place ____________________________________ Date ____________________

Client ____________________________________________________________

Contractor ________________________________________________________

1. The pressure gauges used must allow a precise reading of a 0.5 psi change in pressure.
2. Maximum test pressure allowed at 68° F

| | | |
|---|---|---|
| PP-R SDR7.4 | PP-R SDR11 | PP-R SDR17.6 |
| 360 psi | 260 psi | 150 psi |

## 5.2 Quick Check (Circle the correct answers)

| | | |
|---|---|---|
| 1. The pressure test as described in Chapter 5 is the testing procedure recommended by POLOPLAST. | | |
| True | False | Maybe |
| 2. Pressure testing a system before commissioning is commonly accepted proper practice on any material including PPR. | | |
| True | False | Maybe |
| 3. The maximum allowable test pressure for SDR 11 at 70° F is: | | |
| 216° | 206° | 260° |
| 4. The recommended test pressure is 150% of operating pressure of 150 psi, whichever is: | | |
| Less | Convenient | Greater |
| 5. Before attempting to repair an identified leak in the system, the system should be completely: | | |
| Depressurized | Depreciated | Decapitated |

## 5.3 Customer Support Information

Without customers, we wouldn't have a business. The POLOPLAST America team operates with this understanding in mind regarding everything we do. We have staff dedicated to answering your questions because providing you a solution is the core of our business.

Whether it involves design, application, fabrication, build strategy, equipment, training, or fusion practices, we're here to help. Please reach out.

coreservices@poloplast.us

15415 International Plaza Drive, Suite 200
Houston, TX 77032
WWW.POLOPLAST.US

1. **Safety is top priority.**
2. **More electricity required.**
3. **Plug in first.**
4. **New techniques take practice.**
5. **Have more machines than welders.**
6. **Prefabricate.**
7. **Test welds eliminate doubt.**
8. **Drill square outlet holes.**
9. **Fusion = Heat + Pressure.**
10. **Ask questions.**
    POLOPLAST CORE Services is here to help.

# NOTES

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PURE PROGRESS / poloplast

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