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This manual is designed to accompany Aquatherm training and should be used in conjunction with the Aquatherm North America Design & Planning and Parts Guides. This document is not a substitute for taking Aquatherm training.

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aquatherm INSTALLER MANUAL 5 ed.

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AQUATHERM NORTH AMERICA

INSTALLER MANUAL

Owner

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Installer Number

Trainer Name

Trainer Contact Info.

Aquatherm Installer Manual

For the proper installation of PP-R and PP-RP (RCT) pipe and fittings manufactured exclusively by Aquatherm

Required for the Aquatherm Installer and Aquatherm Butt Fusing and Hot Tapping Courses

This manual was produced by Aquatherm, LP, and is intended strictly for the North American market. It combines information published by Aquatherm GmbH with accepted fusion practices in the USA and Canada. Aquatherm GmbH assumes no responsibility for the content of this manual beyond what they have specifically published. Aquatherm, LP does not warranty the completeness or accuracy of the information contained herein. In the event of a discrepancy between this manual and information published by Aquatherm GmbH, the information published by Aquatherm GmbH will be considered correct. Also, in the event of a discrepancy between this manual and the Aquatherm, LP catalog, the information published in the catalog will be considered correct. The information in this manual is superseded by any subsequent editions of this manual. Aquatherm, LP retains the right to modify the proper installation procedures at any time via technical bulletins.

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Chapter 3

Chapter 1: Welcome to Aquatherm

This manual has been compiled to help ensure safe and consistent installation of Aquatherm piping materials. Please read all instructions before beginning installation. Installers must take the Aquatherm Installer Course from an authorized Aquatherm trainer before beginning installation.

This training is designed to teach you the proper techniques for fast, reliable heat-fusion connections and help you take full advantage of Aquatherm's many benefits.

Read and understand all manufacturer's instructions before attempting any installation activities. Manufacturer instructions and warnings are available at www.aquatherm.com. Always wear the proper safety equipment and take the appropriate precautions. Failure to follow manufacturer's instructions and warnings could result in personal injury, property damage, product damage or death.

The most current version of the Aquatherm Installer Manual can be found at www.aquatherm.com/installer-manual. Please verify you are using the most current version of the Installer Manual before proceeding. See publication date on the back cover for edition date.

Getting started

Before you get started, you should know a little about the pipe you are installing. Aquatherm pipes and fittings are made from an engineered variation of polypropylene-random copolymer, PP-R or PP-RP (RCT).

Aquatherm PP-R and PP-RP (RCT) offer many benefits over metals and other plastics, such as reliability, longevity, and chemical purity.

Aquatherm PP-R and PP-RP (RCT) pipes and fittings are produced in Germany and have been used around the world for decades. The pipe and fittings are made to the highest international standards of quality, so you can trust the material every time you install it. If the pipe and fittings don't have Aquatherm labels, return them and don't install them. Only genuine Aquatherm products are protected by Aquatherm's comprehensive 10-year, multimillion-dollar warranty.

Working with PP-R

Polypropylene is a thermoplastic, similar to polyethylene pipe. It is made from a petroleum by-product, so it naturally repels water. This makes it ideal for a piping material as it does not affect, and is not affected by, the water it carries.

PP is made from chains of carbon and hydrogen, so Aquatherm pipes have no toxic chemicals that can affect drinking water.

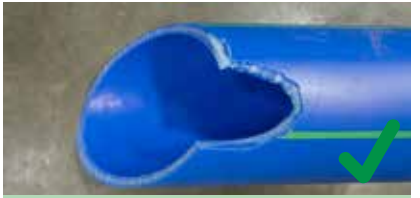
Aquatherm PP-R has a balance of polypropylene copolymerized (combined) with a small amount of ethylene. This combination, enhanced by Aquatherm's proprietary formula, gives the material a balance of durability, rigidity and flexibility. PP-R and PP-RP (RCT) are connected using heat fusion, which involves heating, pressure and cooling the pipe to join it to an identical material.

All of Aquatherm's pipes and fittings can be heat fused together without any strength loss; they have the same densities, durability and resistances.

Aquatherm PP-R and PP-RP (RCT) have been engineered for improved performance and should not be mixed with other types of PP-R/RCT. PP should never be fused to PVDF, PE, CPVC, or any other type of plastic. Never use solvent cements on Aquatherm, as they may damage the pipe and won't bind properly.

Jobsite material handling : Do

Inspect pipe upon receiving it. Aquatherm does not accept responsibility for damage that occurs after the pipe is shipped.



Don't fuse damaged pipe. Remove damaged sections and install the remaining pipe. Follow your distributor's policy for returns.

Keep the pipe on a flat surface or close supports to avoid bowing. Use at least three supports for 13' pipes and four for 19' pipes.

Keep the pipe in its protective wrap until you are ready for installation. The bag protects the pipe from dirt and scratches.

Handle the pipe carefully, especially in freezing temperatures.

Cover unwrapped pipe with a light-colored tarp if storing it outside. A dark tarp generates heat and can cause warping.

Material handling: Don't

Be careful where you store the pipe. Running over pipe with a vehicle is the most common cause of pipe damage.

Don't risk damaging the pipe by handling roughly.

Don't insert sharp or unpadded objects into the ends of the pipe. This can gouge the inside of the pipe and create weak spots.

Don't store pipe outside uncovered. The pipe should be stored in its factory packaging or under a light-colored tarp.

Don't remove fittings from their bags until you are ready to use them. Bagged fittings are easier to identify and protected from contaminants.

Don't use damaged pipe that is gouged deeper than 10% of the wall thickness on the outside or 5% on the inside.

Pipe sizes

Aquatherm pipe is made to metric sizes (millimeters). These charts provide matching metric and imperial sizes.

Aquatherm pipes use standard dimension ratios (SDR) instead of schedules. This means the wall thickness is proportional to the pipe diameter, making the pipe pressure rating consistent through each size.

1/2"— 4" pipes come in 13 ft (4 meter) lengths.

6"— 24" pipes come in 19 ft (5.8 meter) lengths.

Socket fusion

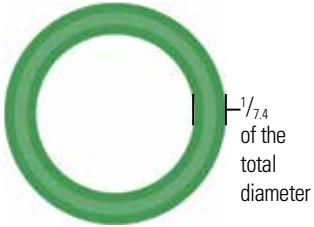
Factory metric OD	Nominal diameter
20 mm	½"
25 mm	¾"
32 mm	1"
40 mm	1 ¼"
50 mm	1 ½"
63 mm	2"
75 mm	2 ½"
90 mm	3"
110 mm	3 ½"
125 mm	4"

Butt Fusion

Factory metric OD	Nominal diameter
160 mm	6"
200 mm	8"
250 mm	10"
315 mm	12"
355 mm	14"
400 mm	16"
450 mm	18"
500 mm	20"
560 mm	22"
630 mm	24"

4" SDR 11, SDR 9, and SDR 17.6 may be butt fused.

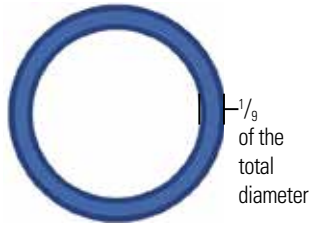
Wall thickness



SDR 7.4

A heavy wall provides increased pressure and temperature ratings for high-stress applications, such as domestic hot water recirculation (DWHR supply and return).

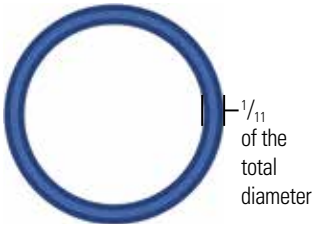
aquatherm green pipe MF



SDR 9

A medium wall thickness of (PP-RP (RCT)) provides increased temperature and pressure capabilites for high-stress applications, such as mechanical-heating hot-water systems.

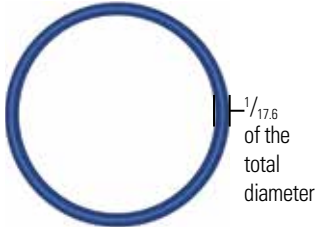
aquatherm blue pipe MF-RP



SDR 11

A balanced wall thickness provides higher flow rates while maintaining high pressures.
Suitable for most applications.
(all ½" and ¾" pipes are SDR 7.4 unless otherwise indicated).

aquatherm green pipe S
aquatherm blue pipe MF
aquatherm lilac pipe S



SDR 17.6

A thinner wall provides maximum flow rate while minimizing material weight, cost, and fusion times. Suitable for chilled, cooling, and condenser applications.

aquatherm blue pipe MF

MF: multi-layer, faser-composite pipe
S: single-layer pipe (non-faser)

Identification

Aquatherm has several lines of pipe that are specifically engineered for certain applications. Stripes and color indicate the type of pipe.

aquatherm green pipe® MF aquatherm blue pipe® MF aquatherm green pipe® S aquatherm lilac pipe® S

Pipe name
(only genuine Aquatherm pipe and fittings are backed by our warranty)

Expansion control (MF layer)
(not present on non-faser pipes)

Production size and nominal diameter

Material

Wall thickness
(based on pipe diameter)

Relevant code listings
(varies by pipe type)

Additional information
(including timestamp)

	aquatherm green pipe® aquatherm lilac pipe® SDR 11 (non-MF)	aquatherm green pipe® SDR 7.4 (MF)	aquatherm blue pipe® SDR 9 (PP-RP (RCT))	aquatherm blue pipe® SDR 11 (MF)	aquatherm blue pipe® SDR 17.6 (MF)
Temperature	Permissible working pressure (psi)				
50 °F	195	380	385	285	160
80 °F	170	320	305	220	125
100 °F	135	255	255	185	95
120 °F	110	215	215	155	80
140 °F	95	180	180	130	70
160 °F	-	120	150	100	45
180 °F	-	100	125	62	25
200 °F		45	100	30	15

Hot-water aquatherm green pipe® MF

Color: Green

Stripes: Dark green

Wall thickness: SDR 7.4

Size range: ½ - 10 in.

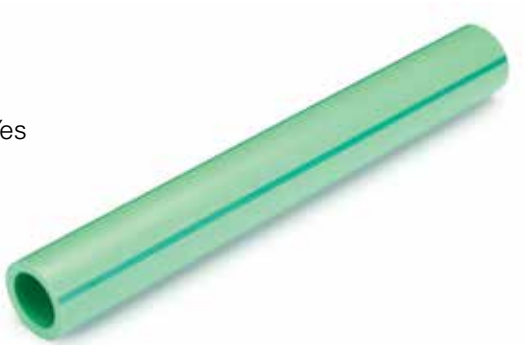
Multi-layer, faser-composite (MF) (expansion-controlled): Yes

Maximum operating pressure at 50°F: 380 psi

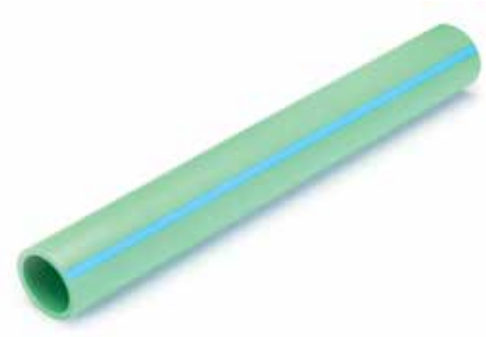
Maximum operating pressure at 180°F: 100 psi

Recommended applications: Domestic (potable) hot water, food processing, and light-hazard fire sprinklers (NFPA 13D multi-purpose systems)

Acceptable applications: Domestic (potable) cold water, heating, cooling, compressed air, chemical transport, and any other application suitable for PP-R



Cold-water aquatherm green pipe® S



Color: Green

Stripes: Light blue

Wall thickness: SDR 11, 7.4 (¾ in. or smaller only)

Size range: ½ - 18 in.

Multi-layer, faser-composite (MF) (expansion-controlled): No

Maximum operating pressure at 50°F: 195 psi

Maximum operating pressure at 140°F: 95 psi

Recommended applications: Domestic (potable) cold water and food processing

Acceptable applications: Cooling, chemical transport, and any other lower-temperature application suitable for PP-R

Heavy-wall aquatherm blue pipe® MF

Color: Blue

Stripes: Green

Wall thickness: SDR 9

Size range: 1 - 14 in.

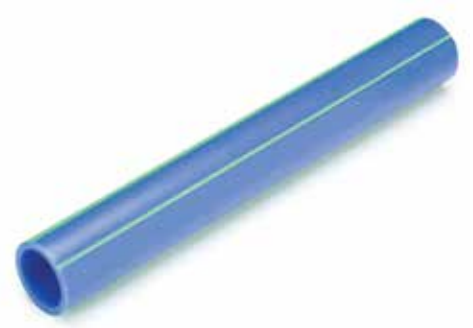
Multi-layer, faser-composite (MF) (expansion-controlled): Yes

Maximum operating pressure at 50°F: 385 psi

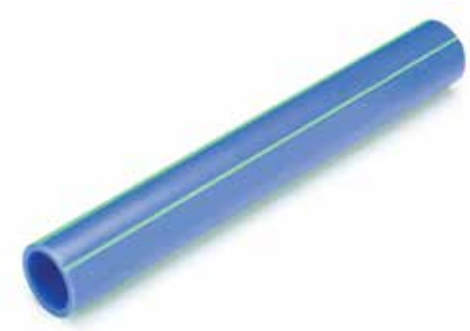
Maximum operating pressure at 180°F: 125 psi

Recommended applications: Heating and cooling distribution, chemical transport, swimming pools (verify treatment levels), and in-floor heating

Acceptable applications: Irrigation and any other non-potable piping



Medium-wall aquatherm blue pipe® MF



Color: Blue

Stripes: Green

Wall thickness: SDR 11, 7.4 (¾ in. or smaller only)

Size range: ½ - 18 in.

Multi-layer, faser-composite (MF) (expansion-controlled): Yes

Maximum operating pressure at 50°F: 285 psi

Maximum operating pressure at 180°F: 62 psi

Recommended applications: Heating and cooling distribution, compressed air, chemical transport, swimming pools (verify treatment levels), and in-floor heating

Acceptable applications: Irrigation and any other non-potable piping

Thin-wall aquatherm blue pipe® MF

Color: Blue

Stripes: Green

Wall thickness: SDR 17.6

Size range: 4 - 24 in.

Multi-layer, faser-composite (MF) (expansion-controlled): Yes

Maximum operating pressure at 50°F: 160 psi

Maximum operating pressure at 140°F: 70 psi

Recommended applications: Geothermal, district cooling, low-pressure cooling distribution, and condenser water piping to cooling towers

Acceptable applications: Any non-potable, low pressure, and low temperature applications suitable for PP-R

Color: Purple

Stripes: None

Wall thickness: SDR 11

Size range: ½ - 6 in.

Multi-layer, faser-composite (MF) (expansion-controlled): No

Maximum operating pressure at 50°F: 195 psi

Maximum operating pressure at 100°F: 135 psi

Recommended applications: Rainwater, gray water, reclaimed water, and irrigation

Molded fittings

- Single piece
- ½" - 4" fittings socket fuse over the pipe wall
- 6"- 24" fittings butt weld in-line with the pipe
- All pipes use the same PP-R fittings
- Minimal markings on the fittings
- Full labeling on the bag
- Keep fittings in their bags until ready for use
- Pressure rating meets or exceeds the pressure rating of the pipe

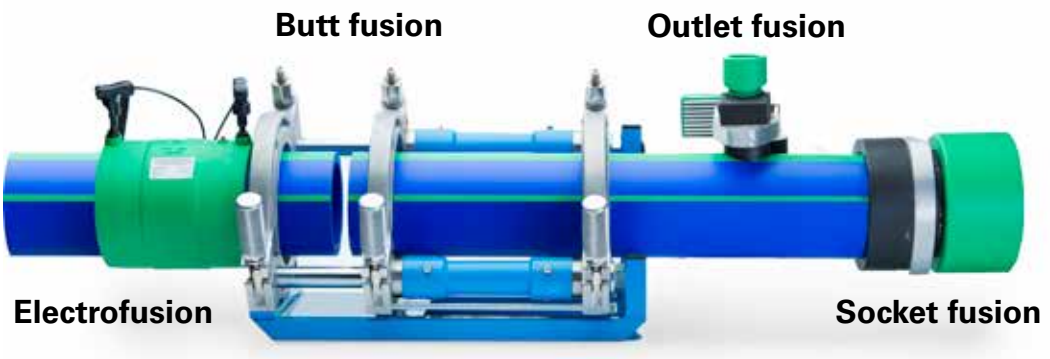
Segmented fittings

- Usually 2 - 3 fused pieces
- Butt weld in-line with the pipe
- 6″ - 24″ (elbows & tees)
- Made from **aquatherm green pipe®** or **aquatherm blue pipe®** to match piping system
- Size marked on label
- Stamped on the side to indicate origin
- **aquatherm green pipe®** fittings may be used with **aquatherm blue pipe** installations -- do not use **aquatherm blue pipe** fittings in **aquatherm green pipe** installations

Chapter 2 : Heat fusion

Aquatherm is a rigid piping system, similar to copper and steel. Proper training helps ensure proper connections. Your own care and attention to detail will yield impressive results, whereas sloppy workmanship will yield poor results. This chapter will cover the basic techniques for heat fusing pipe.

Once you learn how to heat fuse, it will be up to you to provide the quality labor that makes each installation a work of art.



Certain procedures should be followed to work safely with Aquatherm pipe, including:

Take proper precautions around electrical equipment and follow all instructions.

Wear OSHA-approved steel-toe shoes.

Wear a properly rated hard hat at all times.

Wear safety glasses.

Wear heat-resistant gloves while handling fusion irons.

Be careful when handling hot irons.

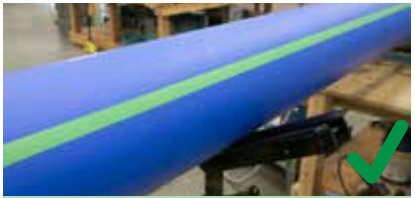
Follow Aquatherm-specific guidelines for proper material installation. Take proper precautions when conducting pressure test.

Cutting the pipe: manual

These are recommended cutting methods, but you may use any method that doesn't damage the pipe. Cuts should be as square as possible (never more than 5° off) and without jagged edges. **Check for cracks on the interior and exterior pipe wall after each cut.**

Use ratchet cutters with a sharp, pointed blade for smaller sizes. The pointed blade prevents the pipe from ovaling during the cut.

Don't use ratchet cutters with a dull or flat blade. Dull or flat blades can oval the pipe and cause it to crack.



Support the pipe while cutting to yield square ends and prevent bouncing or snapping.

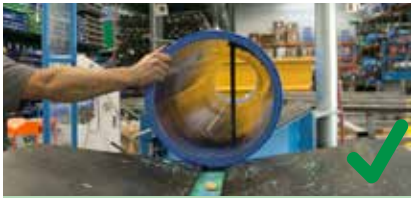
Use tube cutters with a wheel taller than the pipe wall. Smaller wheels might not reach through the entire pipe wall.

Hand saws are a safe alternative, even in cold weather.

Cutting the pipe: power

With powered saws, blades that are intended for hardwood will yield the best results. Avoid jagged or angled cuts, as these require additional prep to fuse.

Use a circular hardwood blade (60-100T) with carbide teeth. This will produce a cut that needs little to no cleanup.



Band and reciprocating saws are safe to use. The thinner blades leave a smooth cut, but you will also have some shavings to clean up.

A wide-toothed blade (24-40T) will produce a jagged cut that is rough and not desirable for socket fusion.

A fine-toothed blade (180T) will overheat the pipe, as will cutting too slowly. Make your cut as quickly and squarely as possible.

Don't use power cutters if the pipe is 40°F or colder. Cold pipe can crack and split. Warm the pipe before cutting it.

Inspecting and cleaning the cut

After cutting the pipe, inspect the ends for cracks or damage on both the interior and exterior of the pipe. Mark and remove damaged sections, cutting a few inches past the damage.

Remove any debris left from cutting the pipe. Often, you can simply pull them out by hand. You may need to carefully cut them away with a blade, de-burring, or reaming tool.

Remove standing dirt and oil using an isopropyl alcohol-based cleaner (91% by volume or greater).

A good cut is smooth, square and has no cracks or stress marks inside or outside the pipe.

White stress marks and cracks indicate damage. Reassess any cutting tools that leave cracks. You may need to squeeze the end of the pipe to see small cracks.

During socket fusion, a fitting is fused over the outside of the pipe, leaving the inside open and unrestricted.

The fittings are sized to be too small to fit over the pipe unheated. This makes dry-fitting impossible, so connections cannot be accidentally left unfused. Also, the difference in diameter between the fitting and pipe creates the required pressure for fusion.

During socket fusion, the inside layer of the fitting is removed, as is the outside layer of the pipe.

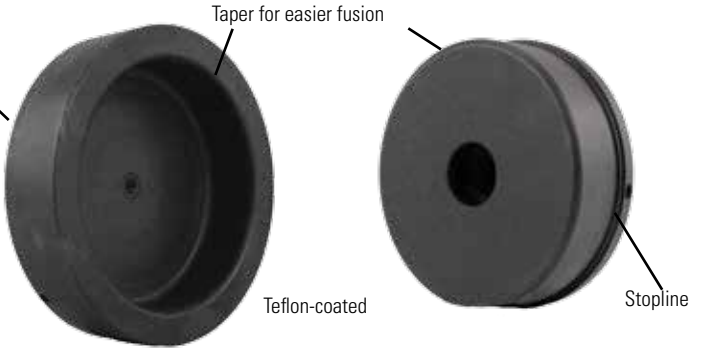
The heating process allows the pipe to be inserted into the fitting. The inner wall of the fitting fuses to the outer wall of the pipe, forming a bond that is as strong as the pipe itself. The connection forms on the entire fused surface.

Fusion heads

Socket fusions are made using fusion heads. Fusion heads are specifically sized to match the pipe and fittings. Different fusion-head sets are required for each size of pipe. Only use heads from an approved tool manufacturer.

Threaded bolt

Heads store inside each other to avoid scratches.

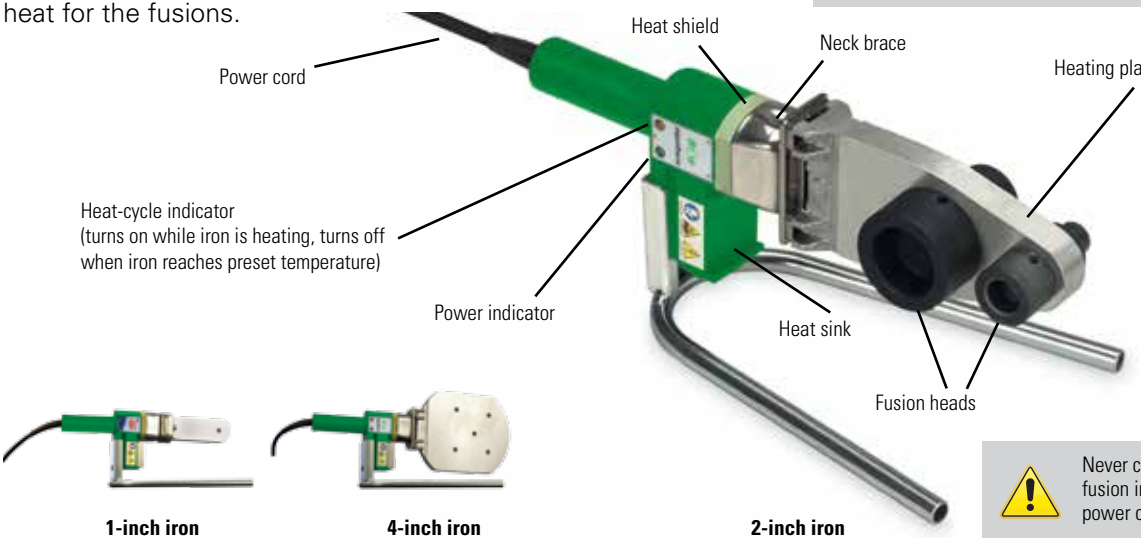


Before setting up a fusion iron, clean the fusion heads with rubbing alcohol or a similar non-corrosive agent.

Fusion irons

The fusion heads can be interchangeably attached to a fusion iron, which provides heat for the fusions.

Note: Heat fusion requires a steady electrical supply, so please consult with your Aquatherm rep to ensure you have the proper power supply.



1-inch iron

4-inch iron

2-inch iron

Never carry a fusion iron by its power cord!

Fusion-iron safety: Do

Compared with open flames or noxious glues, a fusion iron is fairly safe to use. However, the iron is hot enough to burn on contact and can remain hot for up to 30 minutes after it is unplugged. Never use water to cool an iron or head.

Wear heat-resistant gloves while handling the iron. Few gloves are heat-proof, so know the limitations of your gloves.

After use, return the iron to its case for storage.

Post a sign near irons to warn that they are hot. Irons can remain hot for up to 30 minutes after being turned off.

Be aware of where other people are at all times while fusing. Make sure they are clear before you move the hot iron around.

Keep the cord away from hot surfaces. Some cords are heat-resistant, but it's best to keep everything away from the heating surface.

Fusion-iron safety: Don't

Don't leave the iron unattended. Passers-by may not know if the iron is hot and could accidentally burn themselves.

Don't hold the iron by its cord. The cord is not intended to hold weight.

Don't touch the iron with bare hands unless you are certain the iron has cooled. Assume irons and heads are hot until tested.

Don't store multiple irons in a single box. Irons can damage each other easily and should be stored separately.

Don't let the iron touch flammable or meltable surfaces. This is a fire hazard and can damage the plate or heads.

Don't use the fusion iron if the plate or heads are dirty. Clean the plate with a soft wire wheel and the heads with a cloth.

Tool assembly

An iron will take 5-10 minutes to heat up. Low-gauge extension cords can be used to deliver power over long distances if needed. Be aware of other devices drawing power if you are using a limited power source, as this can cause fluctuations in temperature. A surge protector will protect the iron from on-site power surges.

Set fusion heads loosely in place while the iron heats up. The plate will expand as it heats and leave indentations if the heads are too tight.

When the iron is hot, tighten the fusion heads for full contact, which will ensure uniform heat.

Check the temperature on the inside of the fusion heads using a digital thermometer—at close range if using an infrared thermometer. The temperature for socket fusion should always be around 500°F (+/- 18°F). If the iron constantly cycles on and off, or if the heating phase takes a long time, there may be a power-supply issue. If the iron does not reach 500°F or exceeds it, the thermometer may be faulty. Use a contact thermometer if you are unsure.

Marking the pipe

The marking guides help ensure proper insertion depth. The green marking guide is ideal for smaller pipes (½ - 4 in.) and the blue marking guide is designed for larger pipes (2 - 4 in.). Marking on several sides can help you line up the connection.

If the cut is slightly angled (but not enough to prohibit fusion), make only one mark on the long side. Use this mark to prevent over-insertion. Inserting to a mark on the shorter side will leave a partial bead in the pipe. Inserting to the long side will leave a slight internal gap, but this will not affect the connection strength.

When using the blue marking guide, insert the fitting to the beginning of the mark, not the middle. The bead may roll over the initial mark during fusion, so the tail shows that the pipe was marked properly upon inspection.

Under-inserting will weaken the connection by reducing the amount of fusing surface.

Over-inserting will form a bead inside the fitting, causing a restriction in the pipe.

Socket fusion heating and cooling times

Column A: Nominal diameter in inches
Column A represents the size of standard pipe that the Aquatherm pipe normally replaces. In some cases, it may be possible to use a smaller-diameter Aquatherm pipe based on flow rate.

Column B: Metric OD in mm
Column B represents the manufactured size of the pipe.

Column C: Actual OD in inches
Column C represents the actual size of Aquatherm pipe in inches. Use this for sizing clamps and penetrations.

Column D: Fusion depth in inches
Column D represents the depth the pipe should be inserted into the socket fitting. Use this for planning the length of a cut and if no marker is available.

Column E: Heating time for normal weather
Usually 40-100°F. Reduce heating time slightly if working in extreme heat (100 °F+). Never use less than 80% of the heat time in these circumstances. Additionally, when using SDR 11 non-faser pipe in small sizes (½ in. & ¾ in.), reduce the observed time by 1 sec. to avoid overheating and collapsing the pipe wall. Insert the pipe into the fitting as quickly as possible.

Column F: Heating time for cold weather
Use the times in Column F when the temperature is 40°F or colder. You may also use these times if you are having difficulty inserting the pipe all the way into the fitting within the fusion time (G), but be careful not to overheat the pipe.

Column G: Fusion time
Column G represents the window of time between removing the PP-R from the fusion iron and inserting the pipe completely into the fitting before it cools. If you exceed this time, you risk having the connection cool off, which could cause an incomplete insertion. If you cannot fully insert the pipe into the fitting within this time limit, get another installer or a fusion machine to help you.

Column H: Cooling time
Pipe should not be pressurized or stressed during cooling time. You will need to fully immobilize the pipe for up to a quarter of this time while the connection sets.

Socket fusion heating and cooling times

Pipe diameter			Fusion depth	Heating time in sec.		Fusion time	Cooling time
ND	OD	Actual OD	inch	above 40 °F	below 40 °F	sec.	min.
A	B	C	D	E	F	G	H
½″	20 mm	0.79″	9/16″ (14.5 mm)	5	8	4	2
¾″	25 mm	0.98″	5/8″ (16 mm)	7	11	4	2
1″	32 mm	1.26″	11/16″ (18 mm)	8	12	6	4
1¼″	40 mm	1.57″	13/16″ (20.5 mm)	12	18	6	4
1½″	50 mm	1.97″	15/16″ (23.5 mm)	18	27	6	4
2″	63 mm	2.48″	1 1/16″ (27.5 mm)	24	36	8	6
2½″	75 mm	2.95″	1 3/16″ (30 mm)	30	45	8	8
3″	90 mm	3.54″	1 5/16″ (33 mm)	40	60	8	8
3½″	110 mm	4.33″	1 7/16″ (37 mm)	50	75	10	8
4″	125 mm	4.92″	1 9/16″ (40 mm)	60	90	10	8

Socket fusion instructions

(page 1 of 2)

Socket fusion heats the outside of the pipe and fuses it to the inside of the fitting. This creates a large joining surface with no leak path.

The fusion area on the pipe and socket must be kept clean and free of contaminants and moisture during the fusion process. You must use the properly sized fusion heads for a proper fusion. These heads are available through Aquatherm and approved tool manufacturers.

The heating times (column E or F) begin when the pipe and fitting are fully inserted onto the fusion head.

Clean the pipe and insert the pipe and fitting fitting onto the fusion head. Pushing both sides at the same time helps hold the iron steady.

Stop pushing the pipe when you hit the mark (column D). Over-insertion will cause a restriction in the pipe and lower performance.

Stop pushing the fitting when you reach the stopline. Tapered heads will offer little resistance until just before the stop. (see page 2.7)

Observe the heating time (column E or F). A bead will form and become shiny as the fusion nears readiness.

Socket fusion instructions

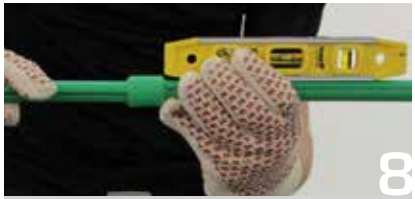
(page 2 of 2)

Remove fitting and pipe from the fusion heads. Use a clamped stand or an extra hand to hold the iron in place.

Immediately* insert the pipe into the fitting. Push the pipe until the bead rings meet within the fusion time (column G).

Do not touch the face of the pipe to the edge of the fitting. This flattens the beads and can cause an improper connection.

Once the bead rings meet, you will have 5-10 sec. to make adjustments to the alignment, depending on pipe size. Do not twist during adjustment, alignment, or insertion.

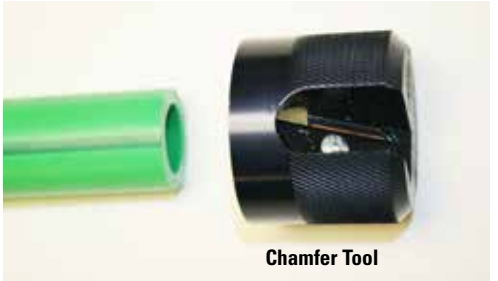


Align the pipe and observe the cooling time (column H). You will need to provide full support for at least a quarter of the cooling time.

*You normally will have 5-10 sec. to begin joining the connection after you remove it from the iron. The time will vary with pipe size and conditions. Waiting too long will let the pipe surface cool and make fusion impossible.

Cold ring and chamfer tools

Cold ring and chamfer tools may be used when socket fusing Aquatherm pipe and fittings. Tools are generally available for 20-50mm (½-1½ inch) sizes. Note that the tools must be sized correctly for metric OD PP piping. The chamfer tools must also be sized correctly for the PP fitting socket depths to properly locate the cold ring tool for the correct insertion depth when doing the socket fusion. Refer to Aquatherm Technical Bulletin 201603B-AQTTB and the tool manufacturer's instructions for proper use of the chamfer and cold ring tools.



Chamfer Tool

Chamfer Tool in Action

Cold Ring applied to the pipe at the base of the chamfer tool.

Fusing pipe larger than 2 in. is difficult without help. There are several tips for assisted (two-man) fusions:

- Increase the heating time by up to 50% if needed. It can take longer to fuse the pipe and fitting by hand, additional heat time makes the connection easier and prevents it from sticking mid-fusion. The ideal amount of overheating depends on the ambient temperature, pipe size, and installer strength. Use your best judgment to prevent the pipe from becoming too soft.
- Don't waste time. Once the pipe and fitting are removed from the iron, push them together immediately.
- PP-R doesn't burn while heating, so you can put the pipe and fitting back on the fusion heads and start again if the connection is underheated. After the initial heating, pipes and fittings may be reheated safely only once.
- Ensure the pipe end is cut square and mark the pipe on several sides; this will help you line up the fitting.

- If you can't push the pipe or fitting all the way onto the iron, allow the heat to melt the PP-R and then continue.
- Remember that the fitting fusion heads are tapered; they will not offer much resistance until the fitting is almost entirely on.

Mechanically assisted fusions

For larger fittings, it is generally faster and more accurate to use a fusion machine. Fusion machines act as an additional set of hands during the fusion, aligning the pipe and fitting while providing a mechanical advantage.

There are many different types of fusion machines. Some lighter machines are easier to operate overhead, but may not offer additional support or have a fixed heating iron. Heavier bench-style machines offer increased stability and accuracy, but are less mobile.

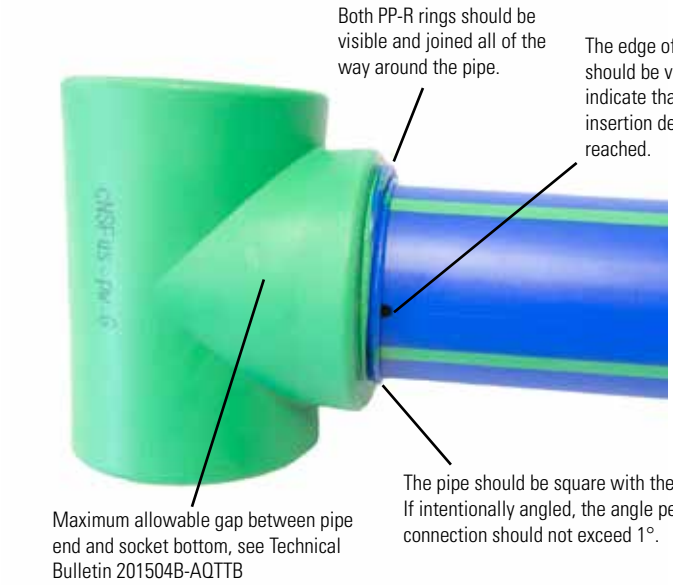
Other fusion processes, such as butt fusion and electrofusion, require special tools.

These, as well as the tools for socket fusion, are available from Aquatherm's approved tool manufacturers. These manufacturers supply properly sized tools for Aquatherm's piping systems and have an established history of providing excellent support to Aquatherm installers.

A complete list of these manufacturers can be found starting on page page 2.35. Do not use fusion tools from an unapproved manufacturer.

Specific indicators confirm your connections have been performed properly. However, you still will need to perform a pressure test to confirm the joint's integrity. (Information on the pressure test can be found on page 3.34.)

Certain fusion-assistance machines have integrated depth controls. These controls should be used for their accuracy, but it is best to mark the pipe for inspection. Some machines will not bring rings completely together, but this is acceptable as long as the gap is consistent and the pipe reaches the bottom of the fitting socket.



Avoiding improper fusions

Don't twist

Never twist a fusion connection. Twisting prevents proper fusion of the material and will lead to a weakened connection. You may make some minor adjustments early in the cooling process, but avoid turning the fitting or pipe more than 2°.

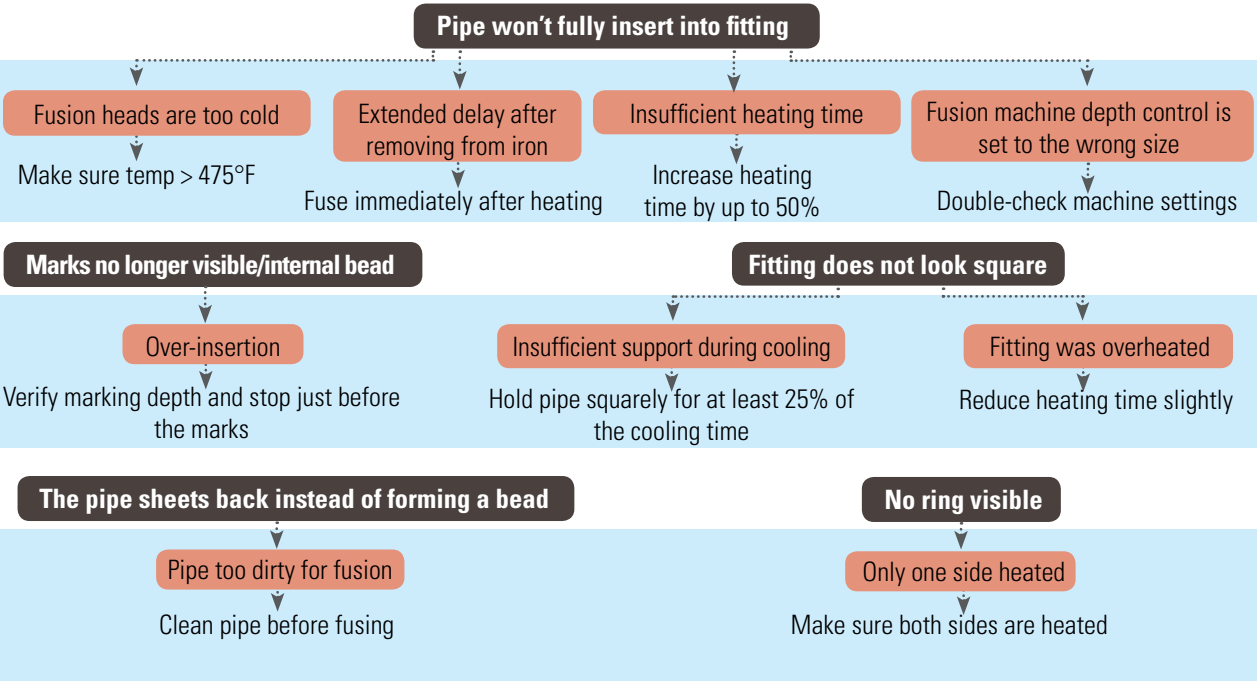
Prevent water contact

Like oil, PP-R is hydrophobic and repels water. Any water contact on the fusion area will interfere with proper fusion and create a potential leak path. Make sure the pipe is dry before beginning the fusion.

Use enough heat

If the iron is too cold, the fitting or pipe experience an extended delay after they're removed from the iron, or the heat time is insufficent, you will not have enough heat to create a full connection. Insufficient heat will also result in potential leak paths in the joint.

Troubleshooting bad connections



Ovaling in machine-assisted fusions

Fusion heads are designed to operate under very specific tolerances, and compressing the end of a fitting can prevent proper contact and, thus, proper fusion. This is referred to as ovaling.

Ovaling occurs when a fusion machine's clamps exert too much force on the socket entrance and bend it out of round. To prevent the problem, avoid over-tightening the clamp that holds the front of the fitting. The clamps should be snug, but not so tight that they distort the fitting.

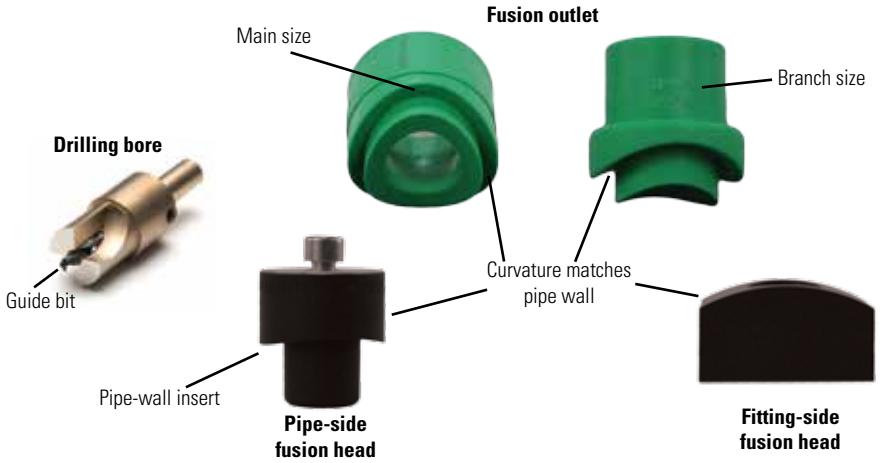
To prevent the fitting from slipping, use a backstop or support the fitting with your hand during insertion. Giving the iron time to heat the pipe and fitting also can reduce the chances of slippage.

To determine if your machine or technique are causing ovaling, look for two complete beads all of the way around the finished connection. If beads are present on two sides but absent on the other two sides, the fitting most likely was ovaled during fusion. Ovaled fittings are not fully functional and may leak.

Fusion outlets

Using a technique similar to socket fusion, branches and outlets can be added to pipe walls easily. This technique helps save time and money while providing flexibility for expansion following installation.

Alignment tools are available to aid in drilling the hole perpendicular to the pipe wall, and aligning the outlet fitting squarely with the pipe. Aquatherm does not require the use of these tools, but they can be very helpful in applying even pressure while heating, and properly aligning the fitting.



Fusion-outlet instructions

(page 1 of 3)

When drilling out a fusion-outlet hole, remember two important things:

1. Make sure to remove the material from the hole so it will not clog the main line.
2. The hole needs to be 1/24 in. - 1/8 in. (1-3 mm) smaller than the OD of the branch line.

Aquatherm's boring tools are sized properly and designed to remove any shavings. The boring tools use a hand-held drill with a 1/2 in. chuck. You also may use hole saws or bores provided by other manufacturers as long as they can cut a smooth, even, and properly-sized hole.

Getting a properly sized hole is critical. An oversized hole will result in an incomplete fusion and cause leaks. An undersized hole will make it difficult to insert the fusion head and can create a larger internal bead, reducing flow performance.

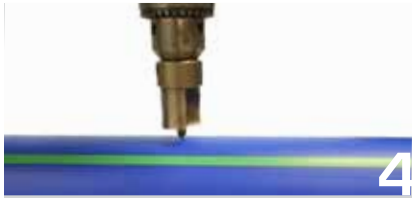
Set up the fusion iron following normal socket procedures, found on page 2.14.

Don't forget to tighten the fusion heads after the plate is hot and check the temperature before starting.

The fusion head should not stick out past the iron. This will lead to uneven heat transfer and can prevent proper fusion.

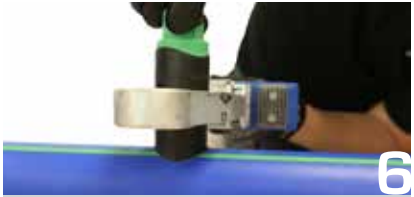
Fusion-outlet instructions

Mark the pipe where you want the outlet. Once you begin drilling you cannot move the hole, so be sure of your placement.

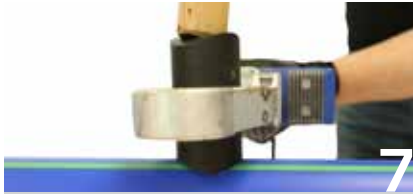


Use the guide bit to start the hole and ensure accurate positioning. Drill at a right angle to the pipe. Quickly drill out the hole.

The bore should pull the shavings out so they don't fall into the pipe. Clear away any excess debris. Flush any leftover shavings.



Insert the fusion head into the hole and fitting into the head. Push down gently to keep the iron in contact with the PP-R.



Rather than putting excessive force on the iron's neck, you can use a dowel or a board to help push the iron into the pipe.

Pro tip:

For branches smaller than 2 in., don't use the fitting to push the iron into the pipe. This overheats the fitting. Instead, push the fusion head into the pipe, then set the fitting on the iron. For larger sizes, you may use the fitting to push the fusion head into the pipe.

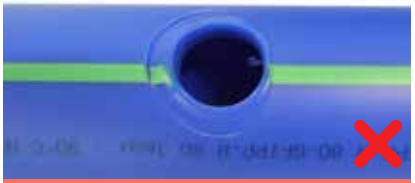
Fusion-outlet instructions

(page 3 of 3)

Pro tip:
Make sure the fusion head you are using matches the pipe and fitting. In an emergency, it is possible to use a head with the wrong curvature, but you must have the right branch size. Tilting the fusion head slightly from side to side can help ensure contact at all points.

Look for a bead to form around the fitting. This does not take much pressure. Too much pressure will cause internal restriction.

Ensure the fusion head makes a full impression on the pipe. Check and adjust the head until the ring is complete.



If the fusion head has not made a full impression, do not set the fusion outlet into the hole. It will not form a proper fusion.

Set the fitting in the hole and hold in place. Use only enough pressure to maintain contact between the heated surfaces.

Level and square the fitting as it cools. Like the socket fittings, you only have a few seconds before the fitting sets.

Electrofusion

Electrofusion is another technique for fusing a socket onto a pipe. Rather than using contact heat, electrofusion uses electrical resistance heat from a copper coil inside the fitting. The fitting is attached to an electrofusion machine using a pair of leads, and a set voltage is applied to the coil for a set time. The time and voltage can be found on the fitting label. Electrofusion is particularly useful for situations in which there is not enough space or mobility to perform a traditional socket fusion. However, electrofusion has more steps and is more difficult to inspect visually. Therefore, the choice to use electrofusion over traditional socket fusion depends on the installation's physical restrictions and the installer's preferences. Electrofusions may be integrated with traditional socket fusion and butt fusion if necessary.

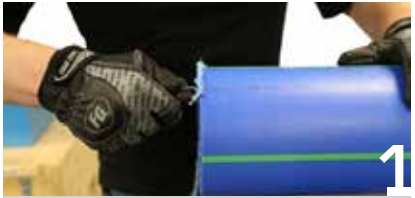
Electrofusion machines are available from approved tool manufacturers.

Electrofusion Coupling Dwell Times

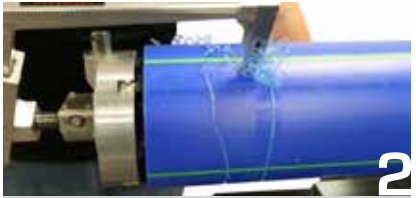
Coupling P/N	Dimension (ND - OD)	Heat Time (seconds)	Cooling Time (minutes) Secured Position
0117208	½" - 20 mm	27 s	10 min
0117210	¾" - 25 mm	35 s	10 min
0117212	1" - 32 mm	50 s	10 min
0117214	1 ¼" - 40 mm	60 s	10 min
0117216	1 ½" - 50 mm	95 s	10 min
0117218	2" - 63 mm	105 s	10 min
0117220	2 ½" - 75 mm	105 s	10 min
0117222	3" - 90 mm	150 s	15 min
0117224	3 ½" - 110 mm	200 s	15 min
0117226	4" - 125 mm	260 s	15 min
0117230	6" - 160 mm	280 s	15 min
0117234	8" - 200 mm	470 s	30 min
0117238	10" - 250 mm	800 s	30 min

Electrofusion instructions

(page 1 of 3)



Make sure the pipe is cut exactly square to ensure proper contact. Chamfer or ream the pipe to remove any rough edges.



Use a peeling tool or paint scraper to remove the outside of the pipe. Peel back at least half the length of the coupling being fused.

Pro tip:

Multiple passes may be necessary. Peeling tools are available from approved manufacturers. Make sure that you use metric or metric-compatible peelers. Avoid over-peeling the pipe. You can always make one more pass, but you cannot "unpeel" the pipe.

Repeat with the other pipe. If you are using the fitting as a slip coupling, peel one side back the entire length of the coupling.

Clean the outside of the pipes with an isopropyl alcohol (91% or higher). Avoid touching those surfaces after cleaning them.

Don't open the fitting bag until you are ready to fuse the connection. This helps keep dirt off of the fusion surface.

Electrofusion instructions

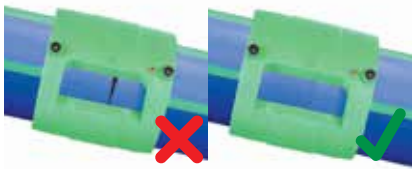
Mark the pipe at half the depth of the fitting. The two pipe sections will meet in the middle.

Do not touch the peeled pipe or inside the fitting. Any oils, dirt, dust, or other contaminants may ruin the connection.

Insert the pipes into the fitting. The pipes should fit snugly, but without any force. You should be able to pull them apart.

Pro tip:

If the fitting cannot be pushed into the coupling without a significant amount of force, make another pass with the peeling tool. Remember to wipe the fusion surface with isopropyl alcohol (91% or higher), as the peeler may be dirty.



Make sure there is no gap in the middle. You won't be able to see the gap, so use your depth marks.

Use an alignment tool to ensure both sides of the pipe and fitting are fully supported for the entire fusion process including cool-down.

Electrofusion instructions

(page 3 of 3)

Attach the leads to the fitting. Most leads slide in with little resistance, so don't force them. Be careful not to bend them.

Scan the tag on the fitting. Rescan if needed. On smaller couplings, the tag can be removed and laid flat for better reading.

Verify that the display matches the sticker. If the label and the machine don't match, rescan the fitting label or input manually.

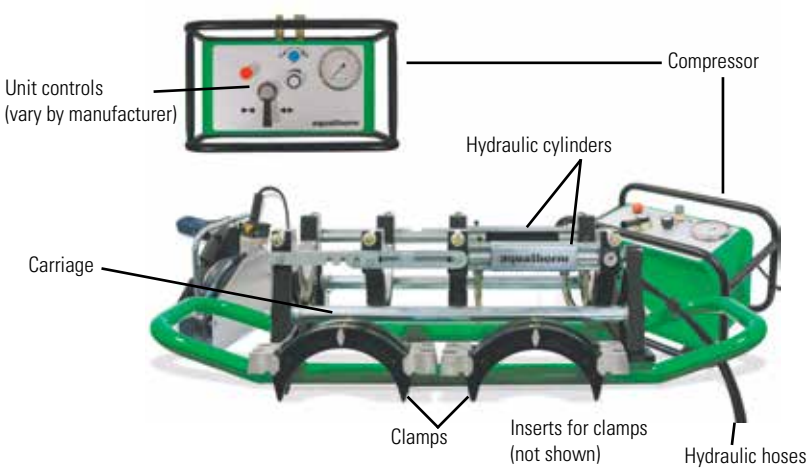
Follow the directions on the machine. Verify your prep work and then begin heating upon confirmation.

Remove leads when heating is finished. The pipe and fitting will get hotter before cooling down again.

The black indicator on the top of the fitting will drop in after the connection is done heating, as long as the electrical leads are pointing up. You will only be able to verify the fusion during the pressure test. All electrofusion sockets are rated to 300 psi.

Butt fusion

Butt fusion is the process of using heat and pressure to join the faces of two pieces of pipe together. This eliminates the need for a socket-type fitting while maintaining the full strength of the connection. As with any fusion, the primary elements are heat and pressure. Therefore, a butt fusion machine is designed to provide both as well as support the pipe and prepare the pipe face for fusion.



Aquatherm supports butt fusion on sizes 6 in. and larger on all SDRs as well as 4 in. on SDR 9, 11, and 17.6. Installers may decide to butt fuse smaller sizes at their own risk.

Explanation of butt fusion

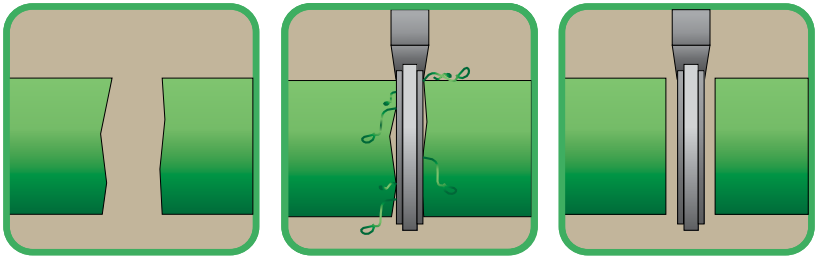
The basic steps to successful butt fusion.

Clean: Clean the pipe ends to remove any dirt, dust, residue or other contaminants, and then wipe with a clean cloth and isopropyl alcohol (91% or higher).

Clamp: Secure the pipe in the clamps and tighten.

Align: Using the butt fusion machine, bring the pipe ends together and ensure proper alignment. Adjust the pipe position and re-tighten clamps as needed.

Face: Facing is performed to square the ends of the pipe. It also produces a contaminant-free surface on which the fusion will occur.

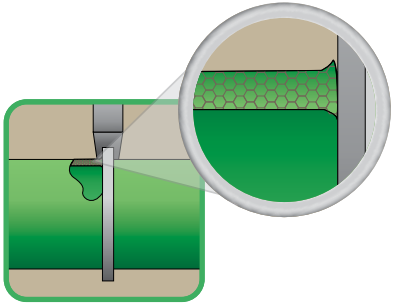


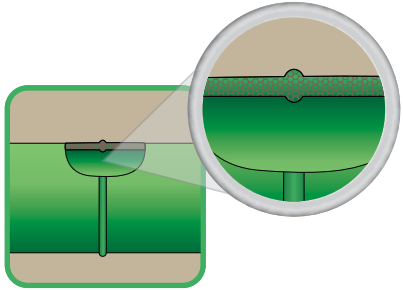
Explanation of butt fusion

Adjust/beadup : Bring the pipe ends in contact with the heating iron and maintain full fusion pressure until the correct bead height is achieved (see p. 2.41). Full fusion pressure is the combination of drag + machine pressures.

Heat: Reduce the pressure to the point where the pipe ends maintain contact with the heating iron but are not under machine pressure. Allow the pipe to heat for the heating time (see p. 2.42).

Fuse/inspect/cool: After removing the heating iron, bring the pipe ends together under full fusion pressure (drag + machine) and maintain full fusion pressure for the cooling time (see p. 2.42), inspecting the bead and alignment as the butt fusion progresses.





Note: When butt fusing molded fittings, not all machines will work with all fittings due to the short length of some fitting configurations such as reducers and reducing tees. Verify that the machine you are using will work with the fittings and configurations you will be using.

McElroy machine pressure

McELROY

918-836-8611
fusion@mcelroy.com
www.mcelroy.com

Installers should always use the operator's manual included with the butt fusion machine or the manufacturer's online information to calculate the machine pressure. This table is based on the information available to Aquatherm at the time of this manual's printing and may not be complete, accurate, or current. If there is a discrepancy between this table and any information provided by the tool manufacturer, the tool manufacturer's information shall be considered correct.

Full fusion pressure = machine pressure + drag pressure

Dimension ND (OD mm)	SDR	28 Low Force	Acrobat™ 160	Acrobat 250	Acrobat 315	Polygon™	DM 250	412 & 618 Low Force	824 & 1236 Low Force
		Machine pressure, pounds per square inch (psi)							
4" (125 x 7.1)	17.6	36	66	66	40	59	36	19	6
4" (125 x 11.4)	11	55	101	101	62	91	55	29	10
4" (125 x 14.0)	9	66	121	121	74	109	66	35	12
6" (160 x 9.1)	17.6	58	108	108	66	97	58	31	10
6" (160 x 14.6)	11	90	166	166	102	149	90	48	16
6" (160 x 17.9)	9	108	198	198	121	179	108	57	19
6" (160 x 21.9)	7.4	127	235	235	144	211	127	67	22
8" (200 x 11.4)	17.6	91	168	168	103	151	91	48	16
8" (200 x 18.2)	11	141	259	259	159	233	141	74	25
8" (200 x 22.4)	9	168	310	310	190	279	168	89	30
8" (200 x 27.4)	7.4	199	367	367	225	330	199	105	35
10" (250 x 14.2)	17.6	142	263	263	161	236	142	75	25
10" (250 x 22.7)	11	220	405	405	248	365	220	116	39
10" (250 x 27.9)	9	263	484	484	296	436	263	139	46
10" (250 x 34.2)	7.4	311	573	573	351	516	311	164	55
12" (315 x 17.9)	17.6	226	417	417	255	375	226	120	40
12" (315 x 28.6)	11	349	643	643	394	579	349	184	61
12" (315 x 35.2)	9	417	769	769	471	692	417	220	73
12" (315 x 43.1)	7.4	493	910	910	557	819	493	261	87

McElroy machine pressure

Dimension ND (OD mm)	SDR	412 & 618 Low Force	824 & 1236 Low Force	QuikFit™
		Machine pressure, psi		
14" (355 x 20.1)	17.6	152	50	255
14" (355 x 32.2)	11	234	78	393
14" (355 x 39.7)	9	280	93	470
14" (355 x 48.0)	7.4	331	110	556
16" (400 x 22.7)	17.6	193	64	324
16" (400 x 36.3)	11	297	99	499
18" (450 x 25.5)	17.6	249	83	410
18" (450 x 40.9)	11	385	128	632
20" (500 x 28.4)	17.6	301	100	506
22" (560 x 31.7)	17.6	378	126	635
24" (630 x 35.7)	17.6	478	159	803

Full fusion pressure = machine pressure + drag pressure

Ritmo machine pressure

863-679-8655
info@ritmoamerica.com
www.ritmoamerica.com

Installers should always use the operator's manual included with the butt fusion machine or the manufacturer's online information to calculate the machine pressure. This table is based on the information available to Aquatherm at the time of this manual's printing and may not be complete, accurate, or current. If there is a discrepancy between this table and any information provided by the tool manufacturer, the tool manufacturer's information shall be considered correct.

Full fusion pressure = machine pressure + drag pressure

Dimension ND (OD mm)	SDR	Gamma 160	Basic/Delta Dragon 160	Basic/Delta Dragon 200	Basic/Delta Dragon 250B	Basic/Delta Dragon 315B	Basic/Delta Dragon 355B
		[N]	Machine pressure, psi				
4" (125 x 7.1)	17.6	263	196	121	65	-	-
4" (125 x 11.4)	11	407	303	187	100	-	-
4" (125 x 14.0)	9	732	361	223	119	-	50
6" (160 x 9.1)	17.6	431	247	198	116	102	44
6" (160 x 14.6)	11	667	392	306	189	160	73
6" (160 x 17.9)	9	1199	591	365	195	172	81
6" (160 x 21.9)	7.4	950	551	436	276	232	102
8" (200 x 11.4)	17.6	-	-	310	189	160	73
8" (200 x 18.2)	11	-	-	477	290	261	102
8" (200 x 22.4)	9			570	305	269	127
8" (200 x 27.4)	7.4	-	-	682	421	363	160
10" (250 x 14.2)	17.6	-	-	-	305	261	102
10" (250 x 22.7)	11	-	-	-	464	406	160
10" (250 x 27.9)	9			-	477	421	199
10" (250 x 34.2)	7.4	-	-	-	653	566	232
12" (315 x 17.9)	17.6	-	-	-	-	406	174
12" (315 x 28.6)	11	-	-	-	-	638	261
12" (315 x 35.2)	9			-		668	316
12" (315 x 43.1)	7.4	-	-	-	-	914	377

Ritmo machine pressure

Dimension ND (OD mm)	SDR	Basic/Delta Dragon 355B	Basic/Delta Dragon 500	Basic/Delta Dragon 630
		Machine pressure, psi		
14" (355 x 20.1)	17.6	218	-	150
14" (355 x 32.2)	11	334	-	232
14" (355 x 39.7)	9	401	253	278
14" (355 x 48.0)	7.4	479	-	-
16" (400 x 22.7)	17.6	-	174	191
16" (400 x 36.3)	11	-	269	294
18" (450 x 25.5)	17.6	-	220	241
18" (450 x 40.9)	11	-	340	373
20" (500 x 28.4)	17.6	-	272	298
22" (560 x 31.7)	17.6	-	-	374
24" (630 x 35.7)	17.6	-	-	473

Full fusion pressure = machine pressure + drag pressure

Widos machine pressure

678-766-1250
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Installers should always use the operator's manual included with the butt fusion machine or the manufacturer's online information to calculate the machine pressure. This table is based on the information available to Aquatherm at the time of this manual's printing and may not be complete, accurate, or current. If there is a discrepancy between this table and any information provided by the tool manufacturer, the tool manufacturer's information shall be considered correct.

Full fusion pressure = machine pressure + drag pressure

Dimension ND (OD mm)	SDR	Maxiplast	W4400	W4600	W4900	W4911	W5100 & 5500	W6100
		lb	Machine pressure, bar					
4" (125 x 7.1)	17.6	60	11	6	-	-	-	-
4" (125 x 11.4)	11	90	17	8	-	-	-	-
4" (125 x 14.0)	9	108	20	10	9	-	-	-
6" (160 x 9.1)	17.6	97	18	9	8	8	-	-
6" (160 x 14.6)	11	148	27	13	12	12	-	-
6" (160 x 17.9)	9	176	32	16	14	14	-	-
6" (160 x 21.9)	7.4	212	39	19	17	17	-	-
8" (200 x 11.4)	17.6	-	-	13	12	12	5	-
8" (200 x 18.2)	11	-	-	20	18	18	8	-
8" (200 x 22.4)	9	-	-	25	22	22	9	-
8" (200 x 27.4)	7.4	-	-	29	26	26	11	-
10" (250 x 14.2)	17.6	-	-	21	18	18	8	-
10" (250 x 22.7)	11	-	-	32	28	28	12	-
10" (250 x 27.9)	9	-	-	38	33	33	14	-
10" (250 x 34.2)	7.4	-	-	45	40	40	17	-
12" (315 x 17.9)	17.6	-	-	-	29	29	12	10
12" (315 x 28.6)	11	-	-	-	44	44	19	15
12" (315 x 35.2)	9	-	-	-	53	53	22	18

Widos machine pressure

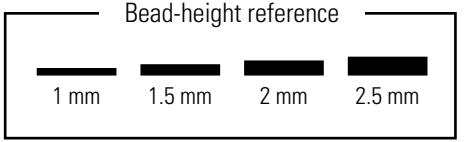
Dimension ND (OD mm)	SDR	W4911	W5100 & 5500	W6100
		Machine pressure, bar		
14" (355 x 20.1)	17.6	36	15	13
14" (355 x 32.2)	11	56	24	19
14" (355 x 39.7)	9	67	28	23
16" (400 x 22.7)	17.6		20	16
16" (400 x 36.3)	11		30	24
18" (450 x 25.5)	17.6		25	20
18" (450 x 40.9)	11		38	31
20" (500 x 28.4)	17.6		30	25
22" (560 x 31.7)	17.6		-	31
24" (630 x 35.7)	17.6		-	39

Full fusion pressure = machine pressure + drag pressure

Adjustment bead height

(4"- 24")

Size	SDR 7.4	SDR 11	SDR 17.6
4" (125 mm)	-	0.04" (1.0 mm)	0.04" (1.0 mm)
6" (160 mm)	0.06" (1.5 mm)	0.04" (1.0 mm)	0.04" (1.0 mm)
8" (200 mm)	0.08" (2.0 mm)	0.04" (1.0 mm)	0.04" (1.0 mm)
10" (250 mm)	0.08" (2.0 mm)	0.06" (1.5 mm)	0.04" (1.0 mm)
12" (315 mm)	0.1" (2.5 mm)	0.08" (2.0 mm)	0.04" (1.0 mm)
14" (355 mm)	0.1" (2.5 mm)	0.08" (2.0 mm)	0.06" (1.5 mm)
16" (400 mm)	-	0.08" (2.0 mm)	0.06" (1.5 mm)
18" (450 mm)	-	0.1" (2.5 mm)	0.06" (1.5 mm)
20" (500 mm)	-	-	0.08" (2.0 mm)
22" (560 mm)	-	-	0.08" (2.0 mm)
24" (630 mm)	-	-	0.08" (2.0 mm)



The height of the bead is important during the fusion, as too small of a bead may lead to an improper connection, whereas too large of a bead can create a flow restriction and also may indicate a problem with fusion pressure. You will need to carefully watch the bead during the adjustment phase and reduce the pressure once the bead reaches its required height.

Remember that 1 mm is only 1/25th of an inch and is difficult to measure. Generally, a bead is at its 1 mm height when you first see it. If your final bead (when the connection is all finished) looks too large, try reducing the size of your adjustment bead slightly.

Butt fusion heating and cooling times (4”- 12”)

Dimension		Heating	Fusion		Fuse/inspect/cool
ND (OD x Wall thickness in mm)	SDR	Heating time	Maximum transition time	Time of pressure buildup	Fuse/inspect/cool time
4” (125 x 7.1)	17.6	2 min., 56 sec.	6 sec.	7 sec.	12 min.
4” (125 x 11.4)	11	3 min., 57 sec.	7 sec.	11 sec.	19 min.
4” (125 x 14.0)	9	4 min., 48 sec.	8 sec.	14 sec.	25 min.
6” (160 x 9.1)	17.6	3 min., 24 sec.	6 sec.	9 sec.	15 min.
6” (160 x 14.5)	11	4 min., 37 sec.	8 sec.	13 sec.	24 min.
6” (160 x 17.9)	9	4 min., 48 sec.	8 sec.	14 sec.	25 min.
6” (160 x 21.9)	7.4	6 min., 1 sec.	10 sec.	19 sec.	34 min.
8” (200 x 11.4)	17.6	3 min., 57 sec.	7 sec.	11 sec.	19 min.
8” (200 x 18.2)	11	5 min., 20 sec.	9 sec.	16 sec.	29 min.
8” (200 x 22.4)	9	6 min., 5 sec.	10 sec.	20 sec.	35 min.
8” (200 x 27.4)	7.4	6 min., 52 sec.	11 sec.	23 sec.	42 min.
10” (250 x 14.2)	17.6	4 min., 32 sec.	8 sec.	13 sec.	23 min.
10” (250 x 22.7)	11	6 min., 8 sec.	10 sec.	20 sec.	35 min.
10” (250 x 27.9)	9	7 min., 23 sec.	13 sec.	27 sec.	28 min.
10” (250 x 34.2)	7.4	7 min., 46 sec.	13 sec.	30 sec.	52 min.
12” (315 x 17.9)	17.6	5 min., 17 sec.	9 sec.	16 sec.	28 min.
12” (315 x 28.6)	11	7 min.	12 sec.	24 sec.	44 min.
12” (315 x 35.2)	9	7 min., 23 sec.	13 sec.	27 sec.	28 min.
12” (315 x 43.1)	7.4	8 min., 40 sec.	15 sec.	37 sec.	62 min.

Butt fusion heating and cooling times

(14”- 24”)

Dimension		Heating	Fusion		Fuse/inspect/cool
ND (OD x Wall thickness in mm)	SDR	Heating time	Maximum transition time	Time of pressure buildup	Fuse/inspect/cool time
14” (355 x 20.2)	17.6	5 min., 41 sec.	9 sec.	18 sec.	32 min.
14” (355 x 32.3)	11	7 min., 28 sec.	13 sec.	28 sec.	48 min.
14” (355 x 39.7)	9	8 min., 43 sec.	16 sec.	38 sec.	63 min.
14” (355 x 48.0)	7.4	9 min., 25 sec.	17 sec.	42 sec.	70 min.
16” (400 x 22.8)	17.6	6 min., 7 sec.	10 sec.	20 sec.	35 min.
16” (400 x 36.3)	11	8 min.	14 sec.	31 sec.	54 min.
18” (450 x 25.6)	17.6	6 min., 35 sec.	11 sec.	22 sec.	39 min.
18” (450 x 40.9)	11	8 min., 28 sec.	15 sec.	36 sec.	59 min.
20” (500 x 28.4)	17.6	6 min., 59 sec.	12 sec	24 sec	43 min.
22” (560 x 31.8)	17.6	7 min., 24 sec.	12 sec.	27 sec.	48 min.
24” (630 x 35.8)	17.6	7 min., 55 sec.	14 sec.	31 sec.	53 min.

Butt fusion instructions: 1. Setup

Set up and inspect the machine. Follow all of the manufacturer's directions. Perform any maintenance as needed.

Maintenance should be performed only by trained people, the manufacturer, or authorized dealer. Only refill the hydraulic oil according to the manufacturer's specifications. Make sure that your power supply is fully compatible with the machine you are using.

Check and tighten seals as needed. Release any air bubbles by bringing the machine to full pressure and slowly releasing it.

Inspect and turn on fusion iron. Make sure the iron is clean and set to 410°F (210°C) +/- 18°F.

Set in the correct metric inserts, if needed. The manufacturer will know which clamps and inserts are compatible.

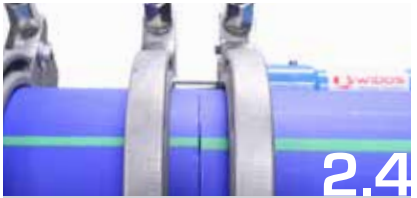
Cut the pipe at least ½ in. longer than your intended final length or longer if your cut is not square.

Butt fusion instructions: 2. Alignment

Set pipe and/or fitting into the clamps. If possible, use at least two clamps for each pipe length. Adjust configuration as needed.

Leave a lip of ½ -1 in. (more if cut is uneven). A thumb's width is normally a good measurement. Leave enough room for the facer.

Reposition clamps to accommodate fittings as needed. Some clamps slide, and others can be removed entirely.



Tighten clamps and bring the pipe ends together. Make sure all hands are clear of the carriage while it is in motion.

Check the pipes' alignment by running your finger or the end of a pen across the gap. If one side is higher than the other, tighten it down.

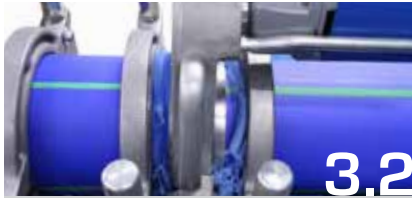
Drag pressure: Find the drag pressure by increasing the pressure control until the carriage begins to move. Drag pressure varies by machine design and orientation as well as pipe size.

Machine pressure: Look up the machine pressure in the operating manual (note the pages of the previous tool manufacturer charts if no manual is available). Machine pressure varies by pipe size and SDR for each type of machine.

Full fusion pressure: Add the drag and machine pressures to get the full pressure.

Butt fusion instructions: 3. Facing

Open the carriage set and lock in the facing tool. Turn on the facer, and let it reach full speed. Never turn on the facer if it is pinched between pipes.

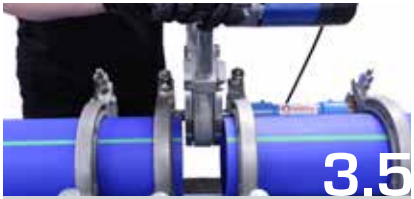


Close the pipes on facer. Increase the pressure until the facer begins shaving off ribbons of PP-R. Don't use excessive pressure.

Drive the carriage forward whenever the pressure drops or the facer stops facing. Replace the blades if they are too dull.

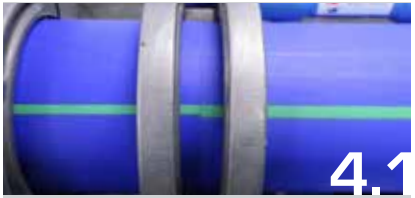
Pro tip:
If one side begins facing before the other, try opening and closing the clamps again to give the facer a "bump." You also can try inserting wood blocks between the clamps and the planing tool to force the facer to shave the opposite side. Facing to a pre-marked point can ensure proper length of the finished connection.

Proper facing will produce 360°, full-width strips on both sides. At this point, open the carriage to separate the pipes while the facer is still moving. Adjust the facer if one side is ready before the other.



Switch off and remove the facer. Don't turn off the facer while the carriage is still closed, as this can leave nicks on the pipe face.

Butt fusion instructions: 4. Adjustment/Beadup

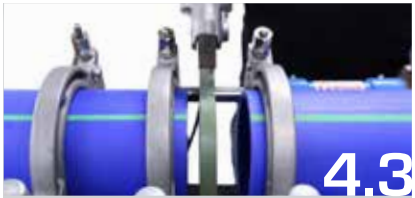


Close the carriage and check for gaps. Reface or realign as needed. Wipe down the pipe face with 91% isopropyl alcohol.

Pro tip:

Make sure the two pieces being connected are still approximately ¼" longer than your desired final length. You will lose roughly ⅛" off each side of the connection during the adjustment and fusion phases. Measure and track your average loss to increase accuracy.

Set your max pressure level (machine + drag). Controls vary by manufacturer. Don't change this pressure after setting it.



Open the carriage and insert the heating iron. Make sure your heating iron is at 410±18°F (210±10°C).

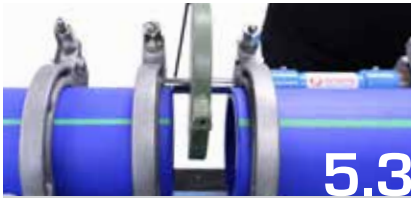
Close the pipes onto the heating iron under full pressure to begin formation of the adjustment bead.

Build your adjustment bead to the specified height. The guide is on page 2.41. Do not let your bead get larger than required.

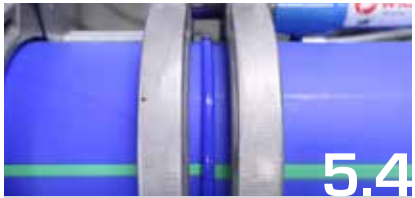
Adjustment bead complete, drop the system to drag pressure. If necessary to maintain contact, add up to 10% of machine pressure.

The heating phase requires as little pressure as possible. Some machines lock in place only requiring the drag pressure. Others require a slight positive pressure to keep them in place, but never more than drag plus 10% machine pressure. Excessive pressure during the heating phase can create a restriction in the pipe.

Use a timer and observe the entire heating time. Too little or too much heating time will create an improper connection.



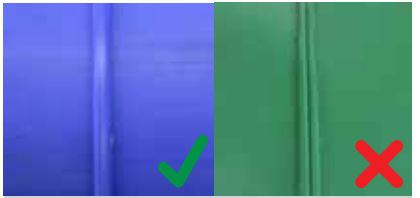
Open the carriage and remove the iron. Make sure you have a safe place to set the iron down immediately if you can't hold it in one hand.



Bring the pipes together within the transition time and ensure the machine achieves full fusion pressure within the pressure buildup time.

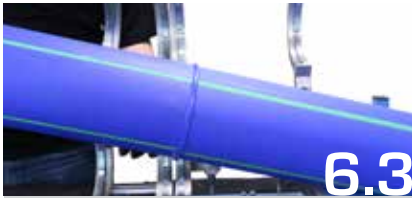
Butt fusion instructions: 6. Cooling

Wait for the connection to cool. Do not try to shorten the cooling time by pouring water on the connection.



The final bead should look like one solid piece. A bad PP-R fusion will have a split bead with two distinct sides.

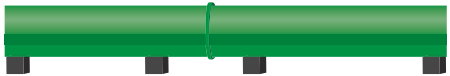
Release the pressure, and undo clamps. Don't loosen the clamps until the pressure has been released completely.



Remove the connection from the machine. Remember to keep the pipe supported if you want to reduce the cooling time.

Cooling times can vary with pipe size and support. With proper support, short and long piping sections can cool for shorter time periods. Long piping sections without support must cool for the full amount of time. Check out the visual guide on the following page for more information.

Butt fusion needs to cool under pressure to ensure proper connections. Cooling times for butt-welded connections can be reduced by up to 50% if the joint is supported properly for the remainder of the cooling time. For example, the cooling time for 6 in., SDR 11 pipe can be reduced from 24 min. to 12 min. if the joint is not subjected to any undue stress for the remaining 12 minutes. The following images show proper and improper pipe support.



Correct

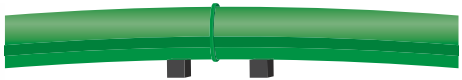
Whether on hangers or blocks, the pipe should be supported on either side of the connection as well as further down the line to prevent deflection.

Correct

The pipe also can lay flat on the ground or a similar level surface.

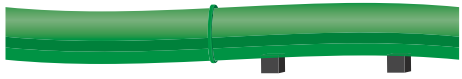
Incorrect

Failure to support the pipe near the connection can result in undue stress on the bottom of the joint.



Incorrect

Failure to support the pipe further away from the connection can result in undue stress at the top of the joint.



Incorrect

Failure to support the pipe on both sides of the connection can cause undue stress across the joint.

Fusing different SDRs

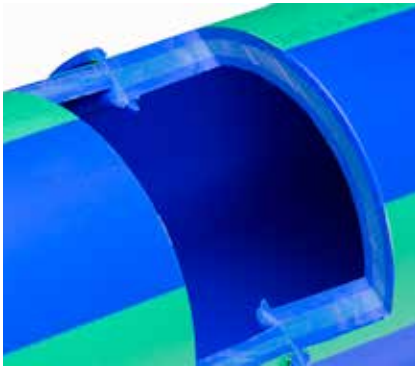
To fuse pipes with different SDRs, you will need to make the following modifications:

1. Use the heat time from the lower SDR (thicker wall) pipe or fitting.
2. Use the pressure from the higher SDR (thinner wall) pipe or fitting.
3. Use the average bead height of the two pipes.

The external bead should appear normal. The internal bead will appear lopsided, but this is not an issue.

The system will have the pressure rating of the highest SDR (thinnest wall) material that is fused into the section.

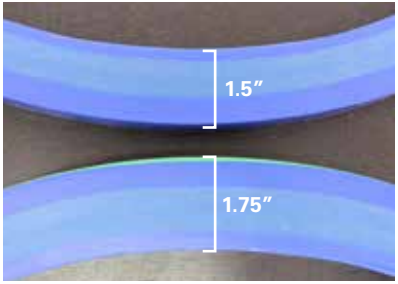
As a general rule, you should avoid butt-fusing different SDRs unless it is unavoidable. You should never attempt to butt fuse pipes with different ODs.

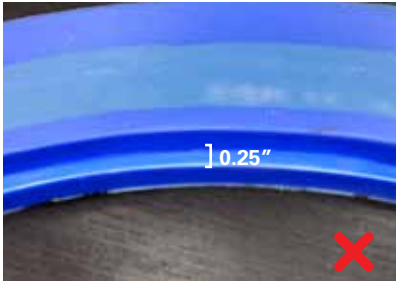


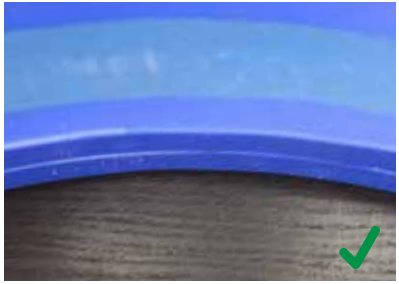
Internal alignment

Because of gravity and the physics of extrusion, larger pipes tend to be slightly thicker on the bottom than they are on the top. However, the top always will be at least as thick as the production SDR, so there is no concern over pressure and temperature ratings.

The difference is not enough to cause problems with flow calculations or require a change in fusion pressures. The only concern is simple aesthetics: the internal bead will be misshapen if a thinner top is fused to a thicker bottom. To avoid the problem, line up the tops and bottoms of the pipe before fusing them. The easiest way to align the pipes is using the printed label on the side, as the label is always in the same position relative to the top of the pipe. Aligning the labels will help eliminate internal misalignment. If aligning the labels does not fix the issue, use your best judgment when aligning the pipe. The issue does not affect the outer wall of the pipe, which always will be consistent.







Repairs

For small holes in the pipe, such as holes from nails or screws, you can use the repair pin shown here. For larger holes, install and cap a fusion outlet fitting or remove the pipe and fuse in a new section.

Attach the repair head to a fusion iron. Heads are available in 5/16" and 7/16" sizes. Use a size that is larger than the hole.

If the hole is too small, carefully drill it out. Use a ¼" bit for the 5/16" head, and a 3/8" bit for the 7/16" head.

Insert the repair head into the iron, and insert the repair pin into the repair head. Heat for 5 sec.

Remove the pin from the head and the fusion head from the pipe. Insert the pin into the pipe wall. Do not overinsert the pin.

Once the pin has set, you may use cutters to remove the rest of the pin. Pressure test the system to ensure a proper repair.

Chapter 3: Planning

Beyond heat fusion, there are a number of differences between installing Aquatherm pipe and installing other systems. This chapter will discuss important installation details, such as pipe sizing, hanger spacing, expansion controls, insulation, and pressure testing.

Technical bulletins

Aquatherm works hard to deliver the best training and most accurate product information available to you, the installer.

However, because of the wide variety of applications in which Aquatherm PP-R and PP-RP (RCT) pipe are used, as well as the ongoing development of third-party tools, clamps, insulations, and other solutions, staying up on the best practices requires a bit of effort.

To keep you informed of new techniques and requirements, Aquatherm frequently releases technical bulletins to fill in the gaps between editions of the Installer Manual. Technical bulletins also give more detailed explanations of some additional installation techniques and safety precautions.

As a result, in the event of a discrepancy between this Installer Manual and the current technical bulletins on the Aquatherm website, the bulletins should be considered correct.

Aquatherm recommends reading the technical bulletins in addition to this manual.

These technical bulletins can be found at:
aquatherm.com/technical-bulletins

If you are installing metal clamps, use only rubber- or felt-lined clamps, as shown here. Metal clamps should never be directly tightened down on hot water piping. The pipe must be able to expand outward slightly when heated to avoid excessive localized stresses. Plastic clamps are safe without additional padding.

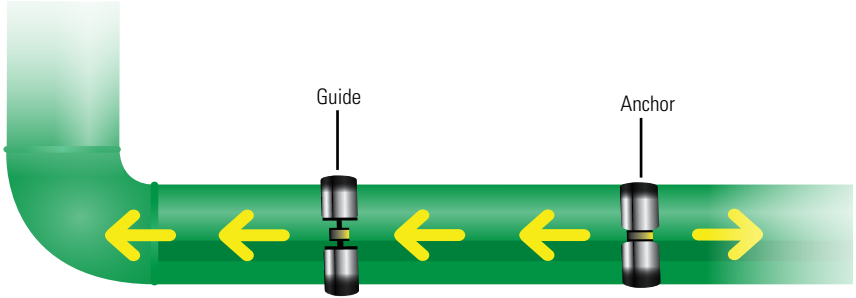
Metal clamps–even plastic-safe clamps–can damage hot-water pipes and can condense when used on cold-water pipe. When installing chilled water lines in high-humidity areas, use a non-crushable pipe shield (pictured above). Metal that is in direct contact with Aquatherm PP-R pipe may sweat in certain chilled applications, even if the pipe itself shows no signs of condensation. Do not tighten metal clamps directly onto pipe at locations where the support is being used as a fixed-point/anchor.

See also Technical Bulletin 201203B-AQTTB.

Anchors and guides

For the purposes of dealing with linear expansion, there are two types of supports: anchors and guides. Anchors are tight against the pipe and prevent movement through that point. Guides support the pipe, but are loose and allow movement through the joint.

There are many available options for metric-size supports. However, IPS or CTS size supports may also be used when sized correctly. The table on page 3.30 provides the best match of CTS and IPS sizes.



Joining spools: Socket and butt fusion




When pre-fabricating spool pieces, you will need to have a plan for installing spools once they are built. Time saved utilizing fabrication can be lost trying to rework sections that aren't easy to join together. Traditional fusion methods (socket and butt fusion) require space for a few inches of lateral movement. If that space for lateral movement is available, then socket and butt fusion will be the most cost-effective and secure means of joining the spools. For straight lengths, leave moving spools unclamped until the fusion is complete. Places where the pipe changes direction, such as at elbows, allow an installer to take advantage of the PP-R pipe's flexibility. (See the Aquatherm North America Design & Planning Guide for safe bending lengths.) Using a fusion machine, the installer can force the pipe to bend, perform the fusion, and bring the pipe and fitting together for a square connection (see photo series above).

Joining spools: Flanges

Flange adaptors can join the pipe to itself or another material. Aquatherm flange connections consist of two parts: an adaptor and a ring (see the Aquatherm North America Design & Planning Guide). Flange adaptors are commonly used to connect to equipment or metal piping. Flange transitions are available up to 24 in.

Planning for flanged spools will include considerations for the thickness of a gasket and any equipment being installed between the spools, such as valves. This affects both the spools' build lengths as well as the bolts' length.

In areas where lateral movement is not possible, electrofusion couplings can join pipe sizes up to 10 in. without lateral movement.

One side of the pipe is peeled back far enough for the electrofusion socket to be used as a slip coupling (right). Once the spool is in place, the coupling is slid back to center (below).

Support intervals and hanger spacing (SDR 11 non-MF)

With PP-R and PP-RP (RCT), the support spacing depends on the temperature differential between the operating temperature and ambient conditions. The table below for SDR 11 non-MF pipe assumes that the pipe is being used for cold water only, so the pipe is either colder than room temperature, or at room temperature. For hot or chilled water applications, the MF pipe charts on the following pages should be used for the appropriate pipe SDR.

The temperature difference is based on an ambient temperature of 68°F. For example, a 100°F system in a 100°F room should have support spacing based on **(100°F - 68°F = 32°F)** temperature differential, not zero differential. In systems with a 0 or negative ΔT, use the maximum spacing.

Note: These support intervals are based on the pipes carrying water. If the pipes are carrying a material that is denser than water, additional support may be required. Alternative spacing should be confirmed in the chemical compatibility report.

Pipe diameter															
½" 20 mm	¾" 25 mm	1" 32 mm	1 ¼" 40 mm	1 ½" 50 mm	2" 63 mm	2½" 75 mm	3" 90 mm	3½" 110 mm	4" 125 mm	6" 160 mm	8" 200 mm	10" 250 mm	12" 315 mm	14" 355 mm	16" 400 mm	18" 450 mm
Support intervals																
4'	4'	4'	4'	4'	4.6'	4.9'	5.2'	5.9'	6.6'	7.2'	7.5'	7.9'	8.4'	9.5'	10.5'	11.2'

Support intervals (SDR 7.4 MF)

ΔT Difference in temperature	Pipe diameter																
	½″ 20 mm	¾″ 25 mm	1″ 32 mm	1¼″ 40 mm	1½″ 50 mm	2″ 63 mm	2½″ 75 mm	3″ 90 mm	3½″ 110 mm	4″ 125 mm	6″ 160 mm	8″ 200 mm	10″ 250 mm	12″ 315 mm	14″ 355 mm	16″ 400 mm	18″ 450 mm
	Support intervals																
0°F (0°C)	4′	4.6′	5.2′	5.9′	6.7′	7.5′	8′	8.5′	9.5′	10.5′	11.2′	11.3′	11.5′	12.5′	13.5′	15′	16′
36°F (20°C)	4′	4′	4′	4.4′	5.1′	5.7′	6.1′	6.4′	7.1′	7.9′	8.9′	9′	9.2′	10.1′	11′	14′	15′
54°F (30°C)	4′	4′	4′	4.4′	5.1′	5.7′	6.1′	6.4′	6.9′	7.4′	8′	8.2′	8.4′	9.2′	10′	12′	13′
72°F (40°C)	4′	4′	4′	4.1′	4.8′	5.4′	5.7′	6.1′	6.6′	7.1′	7.7′	7.9′	8′	8.7′	9.5′	11′	12′
90°F (50°C)	4′	4′	4′	4.1′	4.8′	5.4′	5.7′	6.1′	6.2′	6.4′	6.7′	6.9′	7.1′	7.8′	8.5′	10′	11′
108°F (60°C)	4′	4′	4′	4′	4.4′	5.1′	5.4′	5.7′	5.9′	6.1′	6.4′	6.6′	6.7′	7.1′	7.5′	9′	10′
126°F (70°C)	4′	4′	4′	4′	4.3′	4.8′	5.1′	5.4′	5.6′	5.7′	6.1′	6.2′	6.4′	6.7′	7′	8′	8′

Support intervals (SDR 9 MF)

ΔT Difference in temperature	Pipe diameter												
	1″ 32 mm	1¼″ 40 mm	1½″ 50 mm	2″ 63 mm	2 ½″ 75 mm	3″ 90 mm	3½″ 110 mm	4″ 125 mm	6″ 160 mm	8″ 200 mm	10″ 250 mm	12″ 315 mm	14″ 355 mm
	Support intervals												
0°F (0°C)	5.2′	5.9′	6.7′	7.5′	8.0′	8.5′	9.5′	9.9′	10.2′	10.3′	10.7′	11.0′	11.2′
36°F (20°C)	4.0′	4.4′	5.1′	5.7′	6.1′	6.4′	7.1′	7.4′	7.4′	7.9′	8.0′	8.2′	8.4′
54°F (30°C)	4.0′	4.4′	5.1′	5.7′	6.1′	6.4′	6.9′	6.9′	7.1′	7.4′	7.6′	7.9′	8.0′
72°F (40°C)	4.0′	4.1′	4.8′	5.4′	5.7′	6.1′	6.6′	6.6′	6.7′	7.1′	7.4′	7.4′	7.6′
90°F (50°C)	4.0′	4.1′	4.8′	5.4′	5.7′	6.1′	6.2′	6.1′	6.4′	6.7′	7.1′	7.2′	7.2′
108°F (60°C)	4.0′	4.0′	4.4′	5.1′	5.4′	5.7′	5.9′	5.7′	6.1′	6.4′	6.6′	6.7′	6.9′
126°F (70°C)	4.0′	4.0′	4.3′	4.8′	5.1′	5.4′	5.6′	5.4′	5.7′	6.1′	6.2′	6.6′	6.7′

Support intervals (SDR 11 MF)

ΔT Difference in temperature	Pipe diameter																
	½″ 20 mm	¾″ 25 mm	1″ 32 mm	1¼″ 40 mm	1½″ 50 mm	2″ 63 mm	2½″ 75 mm	3″ 90 mm	3 ½″ 110 mm	4″ 125 mm	6″ 160 mm	8″ 200 mm	10″ 250 mm	12″ 315 mm	14″ 355 mm	16″ 400 mm	18″ 450 mm
	Support intervals																
0°F (0°C)	4′	4.6′	5.2′	5.9′	6.7′	7.5′	8′	8.5′	9.5′	10.5′	11.2′	11.3′	11.5′	12.5′	13.5′	15′	16′
36°F (20°C)	4′	4′	4′	4.4′	5.1′	5.7′	6.1′	6.4′	7.1′	7.9′	8.9′	9′	9.2′	10.1′	11′	14′	15′
54°F (30°C)	4′	4′	4′	4.4′	5.1′	5.7′	6.1′	6.4′	6.9′	7.4′	8′	8.2′	8.4′	9.2′	10′	12′	13′
72°F (40°C)	4′	4′	4′	4.1′	4.8′	5.4′	5.7′	6.1′	6.6′	7.1′	7.7′	7.9′	8′	8.7′	9.5′	11′	12′
90°F (50°C)	4′	4′	4′	4.1′	4.8′	5.4′	5.7′	6.1′	6.2′	6.4′	6.7′	6.9′	7.1′	7.8′	8.5′	10′	11′
108°F (60°C)	4′	4′	4′	4′	4.4′	5.1′	5.4′	5.7′	5.9′	6.1′	6.4′	6.6′	6.7′	7.1′	7.5′	9′	10′
126°F (70°C)	4′	4′	4′	4′	4.3′	4.8′	5.1′	5.4′	5.6′	5.7′	6.1′	6.2′	6.4′	6.7′	7′	8′	8′

Support intervals (SDR 17.6 MF)

ΔT Difference in temperature	Pipe diameter										
	4″ 125 mm	6″ 160 mm	8″ 200 mm	10″ 250 mm	12″ 315 mm	14″ 355 mm	16″ 400 mm	18″ 450 mm	20″ 500 mm	22″ 560 mm	24″ 630 mm
	Support intervals										
0°F (0°C)	8.4′	8.5′	8.7′	9.0′	9.2′	9.4′	9.7′	10.0′	10.3′	10.7′	10.8′
36°F (20°C)	6.1′	6.2′	6.6′	6.7′	6.9′	7.1′	7.5′	7.9′	8.4′	8.9′	9.2′
54°F (30°C)	5.7′	5.9′	6.2′	6.4′	6.6′	6.7′	7.2′	7.5′	8.0′	8.5′	9.0′
72°F (40°C)	5.6′	5.7′	5.9′	6.2′	6.2′	6.4′	6.9′	7.4′	7.7′	8.2′	8.7′
90°F (50°C)	5.2′	5.4′	5.7′	5.9′	6.1′	6.1′	6.6′	7.1′	7.5′	7.9′	8.4′
108°F (60°C)	4.9′	5.1′	5.4′	5.6′	5.7′	5.7′	6.1′	6.6′	7.1′	7.5′	7.9′
126°F (70°C)	4.6′	4.8′	5.1′	5.2′	5.6′	5.7′	5.7′	6.2′	6.7′	7.2′	7.5′

In some applications, the positioning of hangers is determined by outside factors, such as a retrofit with hangers from previous metal pipes. In order to accommodate for these variations, installers may use an in-line support, like the one shown here.

The supported distance can be added to the hanger spacing. For example, a pipe with a 6-ft spacing requirement can be hung on 8-ft spacers if 2 ft of the pipe is supported in-line.

The supports must be rigid enough to support the filled pipe, and have a smooth surface to avoid damage to the pipe. Metal supports should not apply any compressive stress (pressure) on the outside of the pipe.

Linear expansion

Linear expansion occurs when pipe is heated. The amount of expansion is determined by the change in temperature. It is important to know how much expansion will occur during system operation and plan for it. Aquatherm's MF pipes use a combination of glass fibers and PP-R or PP-RP (RCT) to reduce linear expansion and contraction by 75%.

MF pipes can be fused without any additional tools, treatment, or prep work. Fuse MF pipes using the same techniques as non-MF pipe.

For hot water, heating, and chilled applications, use a MF pipe, such as **aquatherm green pipe®** SDR 7.4 or **aquatherm blue pipe®** SDR 17.6, 11 or 9.

For ambient-temperature applications, such as gray water or DCW, use a non-MF pipe, such as **aquatherm green pipe** SDR 11 or **aquatherm lilac pipe®**.

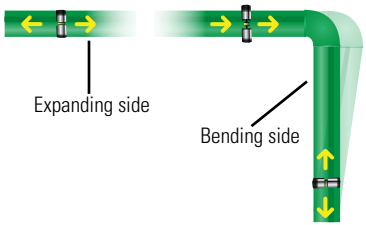
To determine the sizes for various types of expansion controls, consult the Aquatherm North America Design & Planning Guide.

The MF extrusion process produces a middle layer with expansion-inhibiting properties. The percentage of PP-R is high enough to ensure proper bonding between the layers, so the middle layer cannot be separated from the inner and outer layers.

Expansion controls

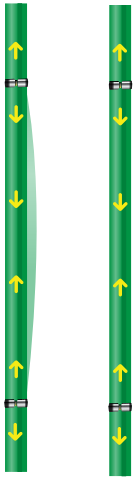
To control linear expansion, you will need to isolate and direct the expansion in a safe way. Expansion will move away from anchors and through guides until it reaches your expansion control or another anchor. On long runs, you should use an expansion control every 120 ft. Remember that branches and other fittings cannot expand through an anchor or guide. Common expansion controls include:

Bending leg: Expansion is directed to where the pipe changes direction. The force of the expansion is absorbed by the flexibility of the bending side.



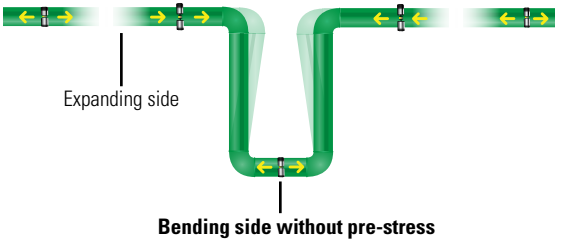
Linear isolation: For vertical installations, expansion can be contained to each floor, leaving each 10-ft space with a fraction of an inch of expansion. This will cause a slight bowing of the pipe, which can be minimized using a midfloor guide.

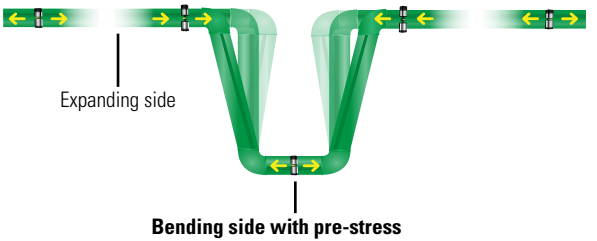
Note: Non-MF pipes in heated applications must have other expansion controls installed every 30 ft. Expansion should be handled by the engineer in the design documents, and those documents must be followed. The information here is for reference and verification only.



Expansion controls

Expansion loop: Used on long, straight runs. Two distant anchors direct expansion to a central loop. An expansion loop can be used on long straight runs. The loop can even be pre-stressed to accommodate additional expansion or to give a square appearance during operation.





Sliding end: Used for short distances where the pipe ends with a cap. The distance between the end of the pipe and the wall (or other obstruction) must be less than the expansion. The pipe should be supported as closely to the end as possible.

Integration of other systems or components with Aquatherm piping

When integrating Aquatherm piping systems with other systems or components not made of PP-R (e.g. non-PP-R valves, pumps, other piping, check valves, strainers, etc.), care must be taken to ensure the operating parameters for PP-R won't damage the other materials or vice versa.

Aquatherm recommends following the Copper Development Agency's guidelines for sizing, temperature and flow speed in copper pipe. This will also help ensure that the copper levels in the water do not approach the regulatory action levels recommended by independent institutions. Sustained high levels of copper in domestic hot water recirculation (DHWR) piping can damage components within the system, even PP-R. Damage caused by copper in the water resulting from erosion/corrosion or other degradation of copper components in the DHWR system will void the Aquatherm warranty.

When adding PP-R to an existing copper system in a DHWR-application, the level of copper in the water should be tested. These levels should not exceed 0.1 mg/L (ppm). Higher levels of total copper indicate that the copper pipe is corroding/eroding due to system operation and/or water conditions.

For additional information, see the Aquatherm Technical Bulletin 201207C - AQTTB and the Aquatherm North America Design & Planning Guide.

PP-R to copper transition fittings

To facilitate transitions to fixture units, Aquatherm offers a PP-R to copper stub out, intended for use with angle stops, flush valves, and other terminations. It is compatible with both compression and solder-type connections.

The fittings are a combination of a custom Aquatherm PP-R socket with a gasket and copper stub added by Sioux Chief Manufacturing. The fused PP-R portion is covered under Aquatherm's warranty. The copper portion and gasket are covered under a warranty from Sioux Chief. PP-R to copper transitions are available in ½-, ¾-, and 1-in sizes sizes.

Do not expose the copper area of a PP-R-to-copper transition fitting to heat in excess of 160°F. Excessive heat will damage both the PP-R insert and the internal o-ring seal.

Perform all solder joints on PP-R-to-copper transition fittings at a minimum distance along the copper tube of 10" from a 1/2" or 3/4" PP-R socket; 18" from a 1".

A plug must be in the PP-R socket when soldering to prevent heated air from rising through the fitting, which can damage the PP-R socket and O-ring. Use a soaked cloth or commercial heat-blocking agent between solder joint and PP-R joint. Always keep the PP-R insert cool and dry during soldering and immediately after it's complete.

Aquatherm pipe is required to pass a system malfunction test of 8,760 hours (~1 year) at 230°F. This does not mean the pipe is intended to be operated at this condition, but rather that it can withstand temperatures above 180°F for a limited time in the event of a boiler malfunction. Therefore, Aquatherm pipe can be connected directly to a boiler in many cases.

Some codes may require a minimum of 18 in. of metal pipe from the boiler to the Aquatherm PP-R. Stainless steel pipe should be used if this is a domestic hot water recirculation (DHWR) system.

It is safest to complete all heat-producing connections, such as fusion, before making the Aquatherm piping connections to the metal pipe. When this is not possible, one solution is installing a union that can be uncoupled until the metal piping installation is complete. In any case, do not expose any PP-R or PP-RP (RCT) piping and transition fittings to temperatures in excess of 170°F during the metal piping installation process. Excessive heat may distort and deform any O-ring seals and fitting connections, resulting in a leak during testing or after system startup.

Where copper is used in a mechanical system or domestic cold water, perform all solder joints on copper pipe at the following minimum distances from the PP-R pipe along the copper tube:

10" from a ½" or ¾" PP-R fitting or pipe;
18" from a 1" or 1¼" PP-R fitting or pipe;
20" from a 1½" PP-R fitting or pipe;
22" from a 2" (or larger) PP-R fitting or pipe.

For additional safety, use a water-soaked cloth or commercial heat-blocking agent between the solder joint and the PP-R or PP-RP (RCT) pipe; immediately cool the copper tube and the transition fitting after the soldering is completed.

Copper tubing is not recommended for use with Aquatherm piping in a domestic hot water recirculating system (DHWR).

Bushings, reducers, and reducing couplings

To help limit the number of reducing fittings that a wholesaler must stock, Aquatherm uses bushings which are designed to be inserted into another fitting, such as a coupling, tee, or elbow. The larger spigot side acts like a piece of pipe and is the side from where the pipe is reduced. The smaller socket side is fused to the smaller diameter pipe.

The spigot side has a bevel on its face and a thicker wall than a normal socket connection. The socket side is labeled with the fitting dimension and has a stop on the inside, just like a regular socket fitting. Bushings are available in sizes from 4 in. to ½ in.

Reducers are used with larger pipes and are butt-fused on both sides. They may go directly onto a pipe or fitting.

Aquatherm also provides reducing couplings to reduce pipe during a straight run. Sizes smaller than 4 in. are socket fused on both ends. Sizes that reduce from larger than 4 in. to 4 in. or smaller will butt fuse on the larger size and socket fuse on the smaller size.

Bushing

The benefits of an all-polypropylene system can be realized up to 6 in., and Aquatherm has available large-diameter PP-R ball valves.

True union ball valves, ½-2 in.

The true union ball valves are designed to allow removal of internal components. The components are held in place by a seat retainer that can be tightened using a spanner wrench. When the valve is in the open position, the handle is directed away from the end with the retainer. The valve should be installed with the handle pointing downstream when the valve is open. This ensures the retainer is upstream and cannot be inadvertently removed while the system is pressurized. See Technical Bulletin 201609A-AQTTB for further information.

ISO flange ball valve, 2 ½ -6 in.

The valves flange in-line and can be installed quickly and easily as long as the following items are addressed:

- The bolt-hole pattern is built to the ISO/ European standard. Therefore, flange rings and full face gaskets will need to match the pattern. Aquatherm rings match; the dimensions are available in the Parts Guide.
- The nuts inset in the valve are a coarse metric thread, and require metric bolting.
- Valves are provided with gasket and bolt kits, or these can be ordered separately as needed.

Threaded connections

Aquatherm offers a wide range of threaded transitions to connect with non-fusible system components. These transitions have a machined brass or stainless-steel thread mold-injected into a PP-R base for maximum strength.

The brass transition components are lead-free (<0.25% Pb) in accordance with the Safe Drinking Water Act (SDWA).

When installing these threaded connections, there are a few important things to remember:

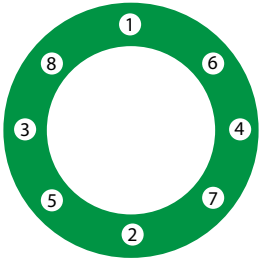
- Only continue one or two turns past hand-tight, and do not bottom out. Use tape only; do not use pipe dope unless absolutely necessary. **Do NOT bottom out in the threaded fitting**.
- Your sealant needs to be compatible with brass or stainless steel as you are not threading to PP-R.
- Always apply counter pressure on the fitting when tightening the connection. If the fitting has a hex head, place your wrench on it; a crescent wrench may give you a more secure fit. For fittings without a hex head, use a strap or pipe wrench on the PP-R body of the fitting. Excessive torque on the brass may cause the brass to turn in the PP-R body, which will result in a leaking fitting. Never tighten the mating components to the point where the brass insert moves.

FPT Hex Brass

MPT Round SS

MPT Hex Brass

To transition to other piping systems and mechanical equipment, Aquatherm provides a full range of flange adapters. Aquatherm's flange rings are uniquely designed to have a metric center and an ANSI bolt pattern. For a flange transition, you will need both the adapter (fusible fitting) and the ring.



Aquatherm recommends using a full-face rubber gasket (black EPDM or red SBR) with a minimum 1/8 in. thickness with its flanges. Viton® gaskets may also be used if needed for chemical resistance. The gasket should have an inside diameter consistent with the ID of the flange adapter.

Bolt tightening should follow the "star" pattern regardless of flange size and number of bolts (see example at left). Tighten all bolts to a third of the torque rating and repeat until fully tightened. Bolt length will depend on the thickness of gasket and flange ring being used.

Refer to Technical Bulletin 201405B-AQTTB for detailed flange connection instructions.

Aquatherm flange bolt torque and size

Nominal pipe size	Torque		Bolts		
	N-m	ft-lb	Number	Diameter	Washers
½"	9	7	4	½	Yes
¾"	14	10	4	½	Yes
1" (32 mm)	15	11	4	½	Yes
1¼" (40 mm)	20	15	4	½	Yes
1½" (50 mm)	30	22	4	½	Yes
2" (63 mm)	35	26	4	⅝	Yes
2½" (75 mm)	40	30	4	⅝	Yes
3" (90 mm)	40	30	8	⅝	Yes
3½" (110 mm)	50	37	8	⅝	Yes
4" (125 mm)	50	37	8	⅝	Yes
6" (160 mm)	60	44	8	¾	Yes
8" (200 mm)	75	55	8	¾	Yes

Nominal pipe size	Torque		Bolts		
	N-m	ft-lb	Number	Diameter	Washers
10" (250 mm)	95	70	12	⅞	Yes
12" (315 mm)	142	105	12	⅞	Yes
14" (355 mm)	203	150	12	1	Yes
16" (400 mm)	244-366	180-270	16	1	Yes
18" (450 mm)	271-407	200-300	16	1⅛	Yes
20" (500 mm)	271-407	200-300	20	1⅛	Yes
24" (630 mm)	393-590	290-435	20	1⅛	Yes

Note: These are typical values for rubber gaskets with lubricated or plated bolts. Values may be increased for harder gaskets or plain/un-plated bolts.

Aquatherm produces modified flange adapters for use with ANSI butterfly valves. Note that these are available only for sizes 6 in. and larger, excluding 22-in. size as the ANSI and DIN dimensions overlap in smaller sizes.

Tolerances with some butterfly valves may be very tight. Opening the valve before bolting it in place can help center the valve and ensure proper actuation.

Refer to Technical Bulletin 201405B-AQTTB for detailed butterfly valve connection instructions.

Modified flange adapter

Branch lines

Pipe size	Thread size		
	½"	¾"	1"
1¼"	M/F	M/F	
1½"	M/F	M/F	
2"	M/F	M/F	
2½"	M/F	M/F	F
3"	M/F	M/F	F
3½"	M/F	M/F	F
4"	M/F	M/F	F
6"	M/F	M/F	F
8"	F	F	F
10"	F	F	F

M = MPT thread available
F = FPT thread available

Pipe size	Outlets available
1¼"	½" - ¾"
1½"	½" - ¾"
2"	½" - 1"
2½"	½" - 1 ¼"
3"	½" - 1 ¼"
3½"	½" - 1 ½"
4"	½" - 2"
6"	½" - 3"
8"	½" - 4"
10"	½" - 4"
12"	2" - 6"
14"	2" - 8"
16"	2" - 10"
18" - 24"	2" - 12"

There are two ways to install branch lines on Aquatherm pipe: tees and outlets. Tees are full-sized fittings that either socket fuse or butt fuse in-line. They usually are used for branches that are within two sizes of the main line.

Outlets are smaller fittings that use outlet fusion to attach to the side of the pipe, see outlet fusion installation in Chapter 2. The table immediately to the left gives the available branches for each pipe size.

The table on the far left shows the available outlets with metal threads.

Unlike many other piping materials, PP-R is able to absorb the stress caused by expansion within certain limits. The MF construction helps keep the pipe within these limits for most applications.

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

Buried installations generally do not require additional consideration for the expansion of MF pipes. Resistance to movement from the concrete or backfill will restrict the natural expansion or contraction of the pipe. The expansive force of PP-R is much lower than metal pipes.

Aquatherm pipe is safe to use with insulating backfills. When penetrating through concrete on an application where the pipe may expand or contract, or otherwise be subjected to movement or lateral forces, a shield or protective layer must be used and should be installed per local codes. It is best to anchor the pipe at that location.

Thrust blocking: Because of the inherent strength and integrity of fused connections, thrust blocking is not required in buried applications.

Maximum pull force

The following table gives the maximum pull force for directional boring or similar applications. Make sure that the pull heads you are using are compatible with metric PP-R pipe. Pull forces include a 2.5 safety factor.

Pipe diameter	Maximum pull force, lb			
	SDR 7.4	SDR 9	SDR 11	SDR 17.6
6" - 160 mm	16,060	13,570	11,350	7360
8" - 200 mm	25,090	21,200	17,740	11,500
10" - 250 mm	39,200	33,120	27,720	17,970
12" - 315 mm	62,230	52,590	44,010	28,530
14" - 355 mm	79,040	66,790	55,890	36,240
16" - 400 mm	-	-	70,960	46,010
18" - 450 mm	-	-	89,810	58,230
20" - 500 mm	-	-	-	71,890
22" - 560 mm	-	-	-	90,180
24" - 630 mm	-	-	-	114,140

Bending Aquatherm pipe

In general, Aquatherm does not recommend bending Aquatherm pipe as a means of making a change in direction or going around obstacles. However, there are instances when the pipe is required to bend, such as buried and trenchless applications.

The pipe may be bent or bowed a maximum of 5° off straight in a 20-ft section or to a bending radius of 100 x the pipe OD. For an 8" SDR 11 pipe with an OD of 200 mm (or 7.87 in.), the bending radius is 787 in. or 66 ft.

This applies for all SDRs and pipe diameters for the **aquatherm green pipe** and **aquatherm blue pipe**, with and without multi-layer, faser-composite. The only exceptions to this are Aquatherm's coiled tubing products.

When using coiled Aquatherm products for radiant floor, snow melt, field/turf warming, or similar applications, the bending radius should be no less than 8 x OD of the tubing being used. For example, ½-in. tubing with an OD of 20 mm, 8 x 20 = 160 mm bending radius; 160 mm = 6.3 in. bending radius or 12 in. on center.

Always bend the tubing in the coil direction and use a bending guide to prevent the tube from kinking.

Please note that considerable force may be required to field bend the pipe, and the pipe may spring back forcibly if the restraints slip or are released inadvertently while bending or after installation. Observe appropriate safety precautions during field bending.

Insulation sizing

Insulation sizing: Aquatherm pipe is made using a metric OD, so standard insulations do not always fit over the pipe. The table on the right gives the closest fit between IPS and CTS sizes and the best fit using only the more common IPS size. These sizes also work for clamps and hangers for the bare pipe. Owens Corning provides insulation specifically sized for Aquatherm pipe, with a metric ID and standard OD.

Pre-formed insulation		
Aquatherm ND	Best fit	Best IPS fit
½″	½″ IPS	½″
¾″	¾″ IPS	¾″
1″	1″ IPS	1″
1¼″	1½″ CTS	1¼″
1½″	1½″ IPS	1½″
2″	2″ IPS	2″
2 ½″	3″ CTS	2½″
3″	3″ IPS	3″
3½″	4″ IPS	4″
4″	5″ CTS	5″
6″	6″ IPS	6″
8″	8″ CTS	8″
10″	10″ CTS	10″
12″	12″ IPS	12″

UV radiation can damage and weaken PP-R and PP-RP (RCT) over time. Avoid exposing Aquatherm pipe and fittings to UV radiation.

Transport and storage: Aquatherm pipes come in UV-resistant bags or wrap for storage and transport. Leave the pipes in these bags or wrap until you are ready for installation.

Installation: Aquatherm offers its pipes with a UV protective layer. This upgrade is ideal for UV protection because it does not require maintenance. However, extra preparation is needed for installation (see 3.32). Another option is to paint the pipe. Painted pipe may need to be recoated or maintained. Aquatherm recommends using an elastomeric paint, which will expand and contract with the pipes. Visit aquatherm.com/ancillary-products for paint options.

You also may paint the pipe for non-UV reasons. Standard acrylic, enamel, epoxy, and latex paints do not harm the pipe. Painting the pipe is considered an aftermarket modification and Aquatherm does not assume any responsibility for the performance of the paint.

Fusing UV pipe

To fuse the Aquatherm UV-protected pipe, you will need to remove the outer layer. The outer layer is a black polyethylene, and it is factory extruded over the top of normal **aquatherm green pipe**® and **aquatherm blue pipe**®. You may still need to protect or paint the fittings depending on amount of UV exposure expected.

Mark the pipe one size up from its actual size. This will protect the black layer from the heat-fusion process.

Cut around the outside of the pipe, just through the black layer. A rolling cutter works well. Do not cut into the pipe wall.

Cut from the mark to the edge of the pipe. Wear protective gloves, and mind your fingers.

Use a knife to pry up the edge of the black layer. Re-score the cuts if they are not deep enough.

Peel back and remove the black layer. Fuse the pipe following normal guidelines.

Flushing: Before beginning operation, flush the system to remove dust, pipe shavings, and other particles that may have fallen into the pipe. Make sure the system is flushed in a safe manner that doesn't damage or clog any components. Unless otherwise required, water is sufficient for flushing the system.

The following concerns should be addressed before the installed piping is put into service:

1. Protection of the water quality
2. Avoidance of corrosion damage to metallic components in the system
3. Avoidance of malfunctions of pumps and equipment such as strainers and valves
4. Cleanliness of the inner surface of the pipe for optimal flow

These requirements can be met by:

1. Flushing the system with clean, clear water
2. Flushing the system with a mixture of air and water
3. Flushing the system with a medium as may be determined by local codes, engineering specifications, or the needs of the mechanical equipment used

Where no requirements are established, potable water is sufficient for flushing Aquatherm piping systems.

Flushing of the entire system should be continued until the water coming out of the piping system runs clear of any debris, particulates, oils, or other contaminants.

If disinfection is required, please refer to the Technical Bulletin 201301A – AQTTB – Disinfecting Aquatherm Piping Systems.

Pressure testing (page 1 of 13)

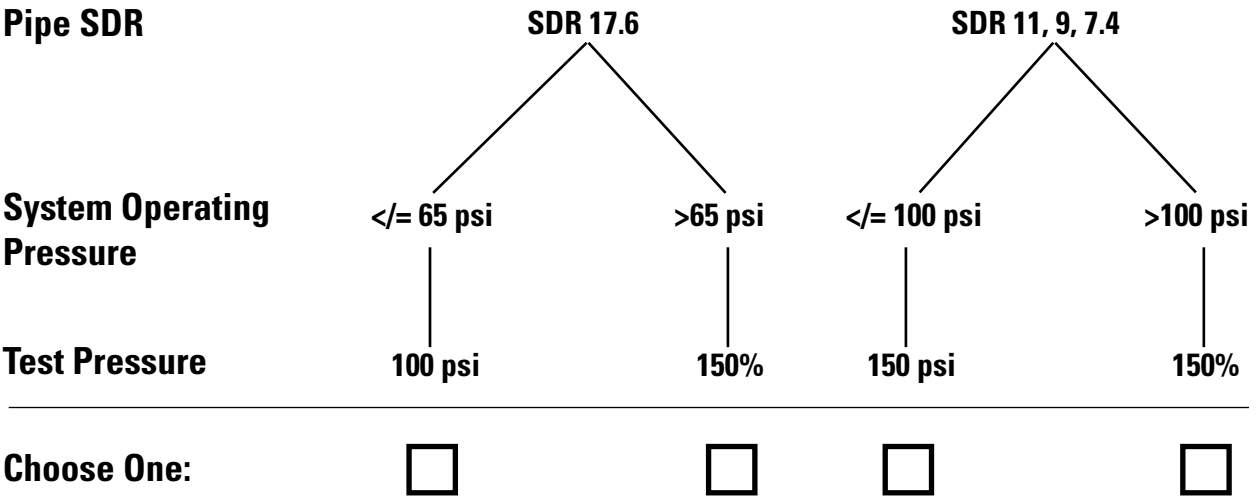
Aquatherm offers an extensive warranty to protect against damages caused by failure from manufacturer's defect. Aquatherm requires that all installations be pressure tested in accordance with the following instructions and that proof of the pressure test be submitted to Aquatherm before the coverage can go into effect. Warranty coverage begins only after the pressure test is properly completed and submitted. Aquatherm's warranty does not cover failures caused by improper installation, operation outside of the recommended parameters, freeze damage or damage from mishandling after the pipe has left the manufacturer. The Aquatherm warranty also does not cover elastomeric components (seals, gaskets, O-rings), components made by other manufacturers, or connections made to other non-Aquatherm systems or components.

REFER TO AQUATHERM TECHNICAL BULLETIN 201802A-AQTTB FOR ADDITIONAL INFORMATION AND SAFETY PRECAUTIONS

Step 1: Determine your testing pressure. To help ensure the integrity of the heat fusion connections, a pressure test must be performed on the completed system. The amount of pressure used depends on the type of pipe and intended pressure of the application.

- If the piping system has a mixture of SDR pipe, you should test to the higher SDR's (thinner walled pipe's) testing requirements. For example, if the piping system contains SDR 17.6 pipe and SDR 11 piping, you should test to the requirements of the SDR 17.6 piping.
- If the piping system contains SDR 17.6 pipe and has an intended operating pressure of 65 psi or lower, the system must be tested at 100 psi.
- If the piping system contains SDR 17.6 pipe and has an intended operating pressure higher than 65 psi, the system must be tested at 150% of the intended operating pressure or a maximum of 160 psi. **Do not use compressed air to test SDR 17.6.**
- If the system contains only SDR 11 or heavier-walled pipe (lower SDR) and has an intended operating pressure of 100 psi or less, the system must be tested at 150 psi.
- If the system contains only SDR 11 or heavier-walled pipe (lower SDR) and has an intended operating pressure higher than 100 psi, the system must be tested at 150% of the intended operating pressure.
- If you have concerns regarding your testing pressure, please contact Aquatherm. Exceptions to the required pressure test must be given via written confirmation from Aquatherm.

Pressure testing



Step 2: Determine your testing medium. Water is the preferred medium for testing purposes, due to its incompressibility. However, low pressure (15 psi or less) air testing may be used to find leaks and open-end pipes. Do not use compressed air alone on any piping system unless it is a compressed air system.

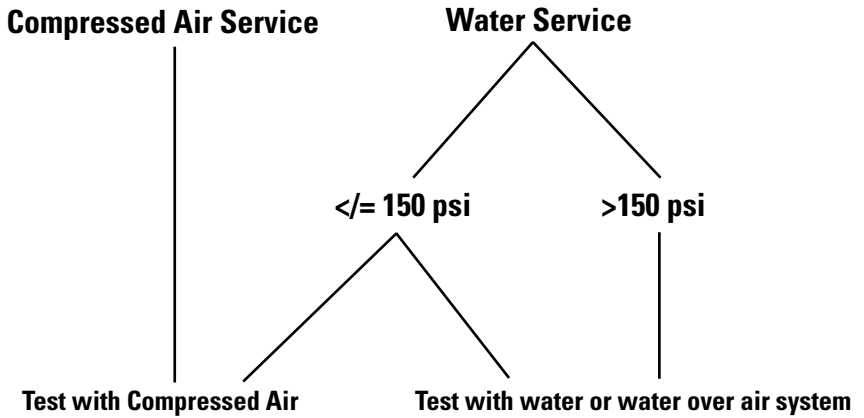
- If the system is intended for compressed air service, only compressed air may be used for the pressure test, regardless of the following restrictions.
- If the testing pressure is equal to or less than 150 psi, you may test with water only, or with an air-over-water combination system (water-filled piping, with air as pressure source).
- If the testing pressure exceeds 150 psi, the test must be performed using water only. Compressed air alone is not approved for systems with a testing pressure higher than a 15 psi leak test, unless those systems are intended for compressed air service.

Pressure testing

System Operating Medium:

Test Pressure:

Test Medium:



Choose One: ☐ ☐

Do not use compressed air to test SDR 17.6.

Step 3: Observe safety protocols. The full Aquatherm warranty does not take effect until the pressure test is completed and submitted and the system is in operation. Therefore, it is important for the tester to observe all safety recommendations from Aquatherm until the testing is complete.

For all systems:

- Visually inspect the connections for signs of proper fusion, following the guidelines given in the Aquatherm Installer Manual. Socket connections should have two even rings of melted plastic, and a visible depth mark. Butt fused connections should have a single bead with a rounded top. This inspection is most easily done during the fusion process. The absence of these signs may be indicative of an improper fusion.
- Remove all fusion equipment from the system before starting the pressure test.
- Set your pressure gauge near the bottom of the system, where the pressure will be highest. This reduces the risk of over-pressurizing the system.
- Observe the system during the test for any indications of leaks. If a leak is found, relieve all test pressure and repair the leak before continuing.

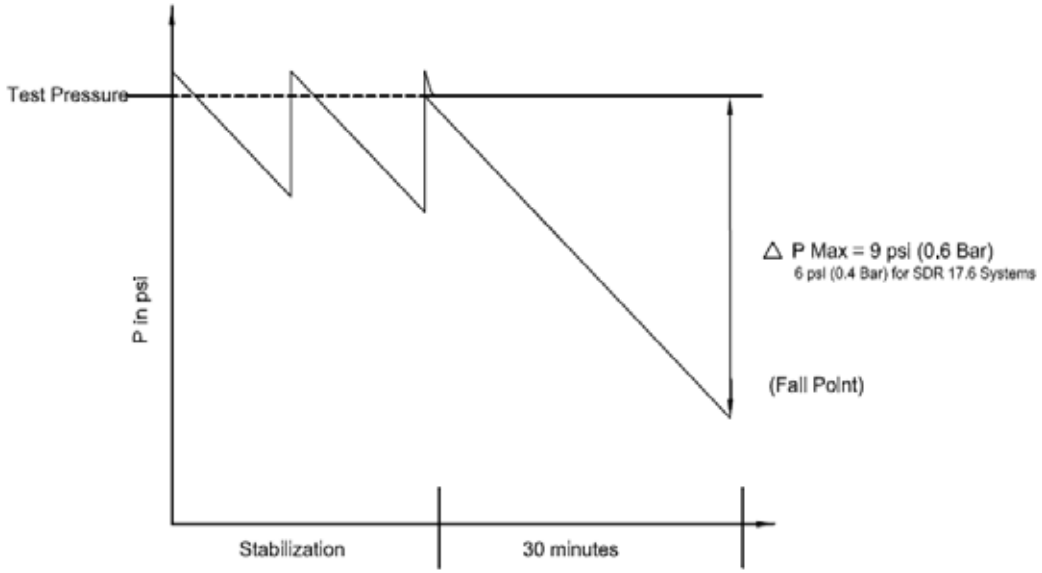
(continued on next page)

Pressure testing (page 7 of 13)

Step 3 (continued from previous page):

Additionally, when using compressed air:

- Stand clear of the pipe during testing and warn others nearby to do the same. Take measures to secure loose sections of the pipe in case a rupture does occur.
- Do not perform the test if the ambient temperature is higher than 100°F. Use water instead.
- Should any transition joints leak during testing, check the joints for proper assembly and repeat the test using water before replacing any of the fittings.


Test Pressure
P in psi
△ P Max = 9 psi (0.6 Bar)
6 psi (0.4 Bar) for SDR 17.6 Systems
(Fall Point)
Stabilization
30 minutes

Pressure testing

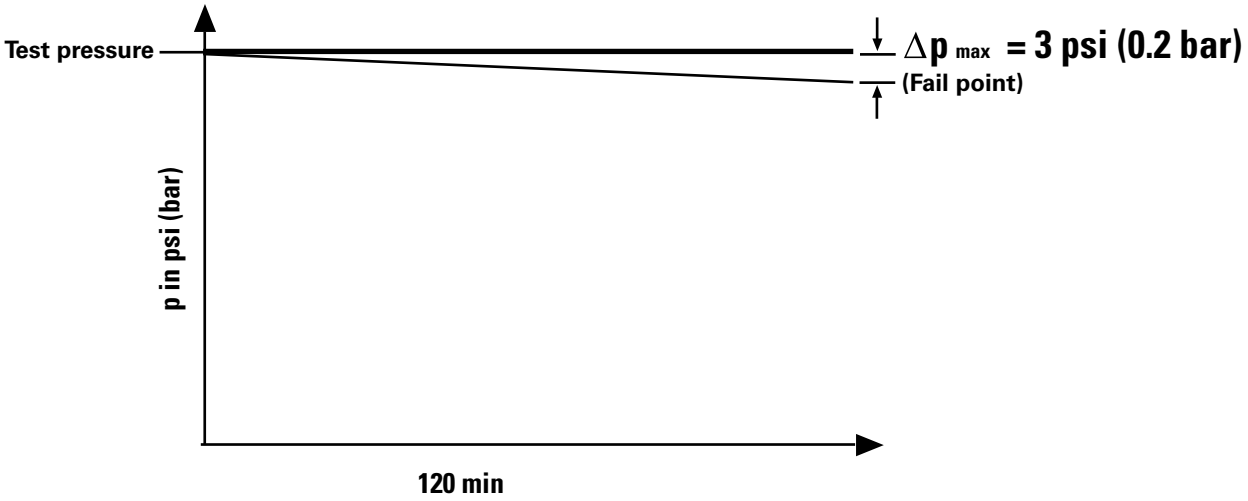
REFER TO AQUATHERM TECHNICAL BULLETIN 201802A-AQTTB FOR ADDITIONAL INFORMATION AND SAFETY PRECAUTIONS

Principal test:

- If the system has lost any pressure during the preliminary test, bring the system back up to the test pressure.
- Observe the system for 120 minutes. The system should be able to hold the full test pressure during that time.
- The loss of more than 3 psi or steadily decreasing pressure during this test is indicative of a leak. Identify the leak and repair the system before repeating this test. The test pressure must have less than 3 psi loss, and have stabilized at a value of less than 3 psi loss during the test.
- A successful version of this test must be completed before proceeding.

(continued on next page)

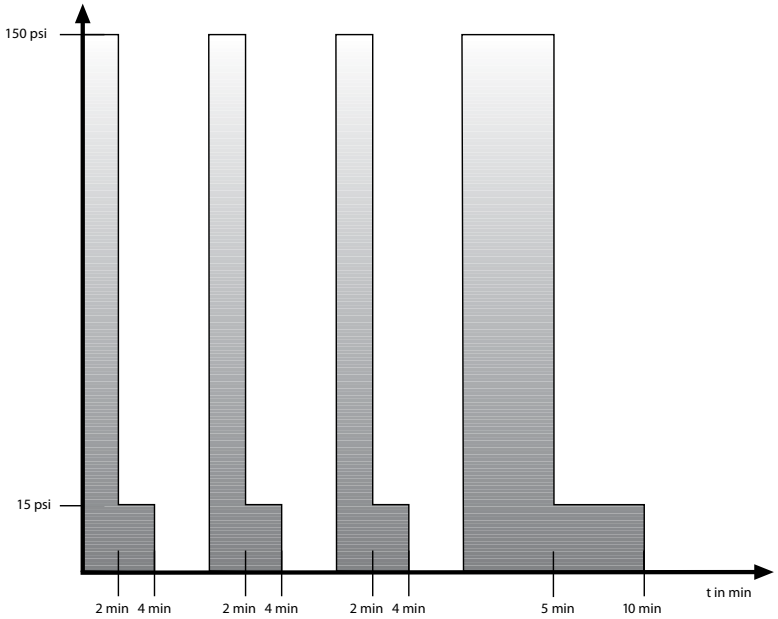
Principal test



Pressure testing

Final test:

- Release the pressure from the system.
- Bring the system up to test pressure for two minutes. Reduce the system pressure to 15 psi for two minutes.
- Release the pressure from the system.
- Bring the system up to test pressure for two minutes. Reduce the system pressure to 15 psi for two minutes.
- Release the pressure from the system.
- Bring the system up to test pressure for two minutes. Reduce the system pressure to 15 psi for two minutes.
- Release the pressure from the system.
- Bring the system up to test pressure for five minutes. Reduce the system pressure to 15 psi for five minutes.
- Release the pressure from the system.


150 psi
15 psi
2 min
4 min
2 min
4 min
2 min
4 min
5 min
10 min
t in min

Pressure testing

Step 5: Complete and submit the pressure test record.

- Submit the forms to Aquatherm within 30 days of completing the pressure test.
- If you are testing a system in sections, save all the pressure test records and submit them together.
- Include the installer numbers of all the installers who fused connections on the system.

The Aquatherm standard pressure test submission form can be found online at www.aquatherm.com/pressure-test-submission. Additional installer numbers may be added after the primary installer information.

The following are maximum testing pressures for high-rise buildings or high-pressure systems. The maximum testing pressures should not exceed the following:

Pipe	Maximum Test Pressure Allowed
PP-RP (RCT) SDR 9	400 psi
PP-R SDR 7.4	400 psi
PP-R SDR 11	270 psi
PP-R SDR 17.6	160 psi

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