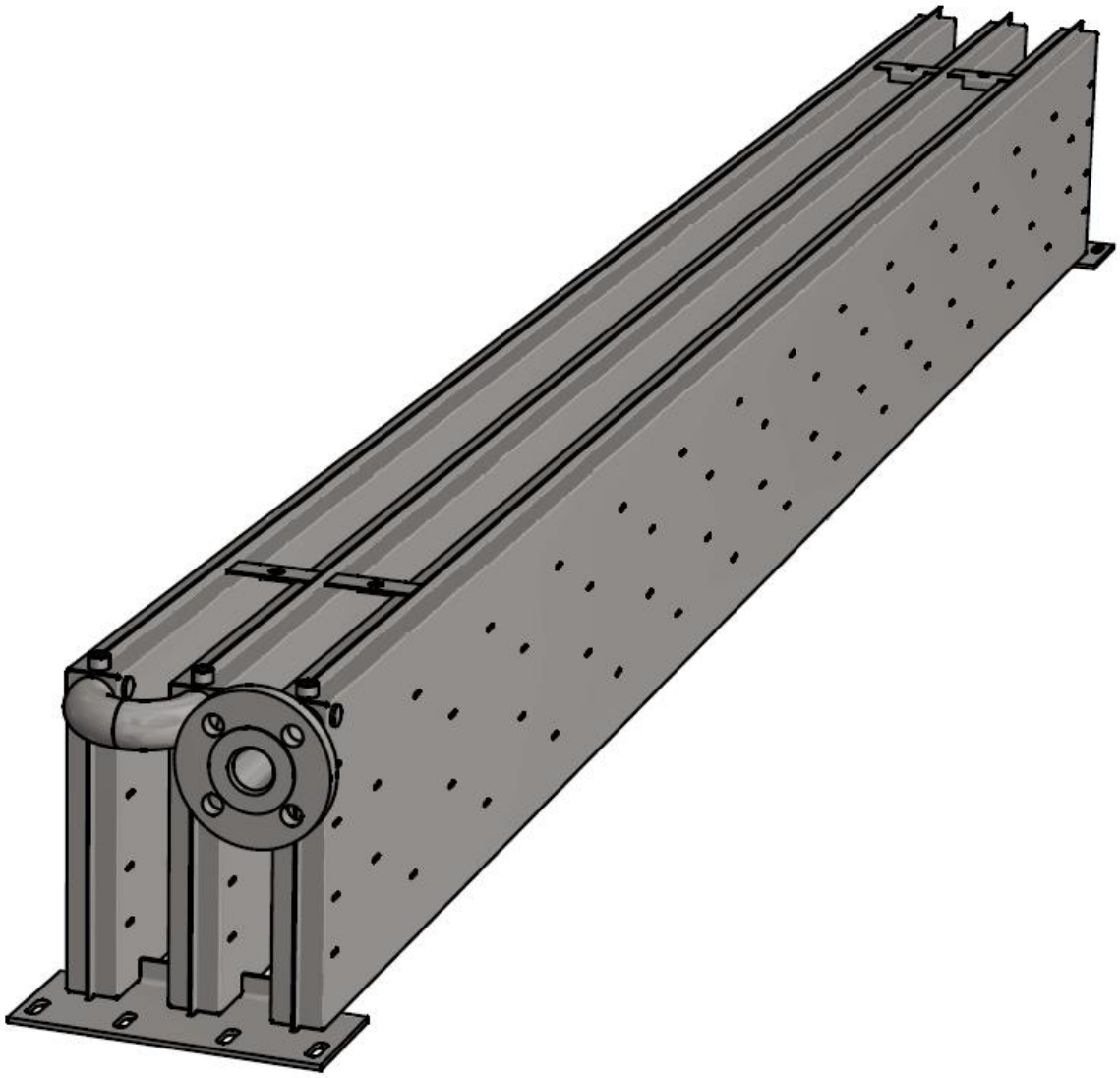
Renewables FIRST

Securing a clean energy future, profitably



FIRE FLO

Design Guide

Renewables First Ltd
The Mill, Brimscombe Hill
Brimscombe
Stroud, Glos, GL5 2QG

Phone +44 (0)1453 88 77 44
Fax +44 (0)1453 88 77 84
Email info@renewablesfirst.co.uk
www. renewablesfirst.co.uk

© Renewables First Ltd 2015 Company Registration Number: 6975396 VAT Number: GB 975 8598 37

Contents

1. Features 3

2. FireFlo technical data 4

2.1 Weights and dimensions 4

2.2 Materials 4

2.3 Operating data 5

2.4 Pressure loss 5

2.5 Heat transfer characteristics 6

3. Standard installation configurations 8

3.1 General 8

3.2 Wall-mounted arrangement 9

3.3 Bed-mounted, vertical panel arrangement 10

3.4 Bed-mounted, horizontal panel arrangement 11

3.5 Bed-mounted, embedded panel arrangement 12

3.6 Array mounting for static water applications 13

4. Collector system design 14

4.1 Typical system layout 14

4.2 Connecting multiple FireFlo assemblies 15

4.3 Overpressure protection 16

4.4 Expansion vessels 16

4.5 Provision for filling 17

1. Features

The FireFlo heat collector system has been developed as a cost effective and low maintenance system for extracting heat from flowing water. The system allows the high energy efficiency associated with water source heat systems to be realised.

By utilising flowing water and through their stainless-steel construction, the FireFlo system minimizes the surface area required to achieve the desired heat pump brine return temperature.

The FireFlo system is modular and so can be adapted for any sized heat pump system. There are also various mounting configurations which allow the system to be integrated into a wide range of watercourses.

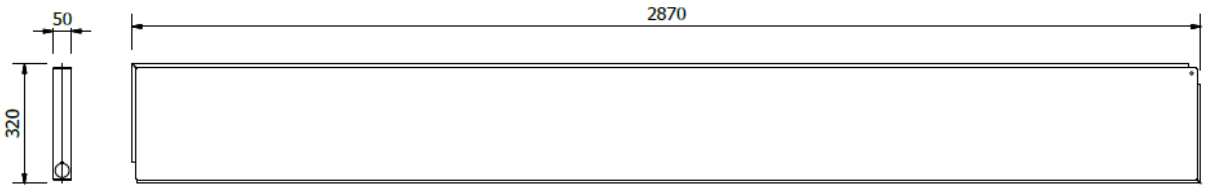
The standard FireFlo panel dimensions are 2870mm x 320mm x 50mm without the end connections. The mounting arrangement selected will affect the end connection configuration and hence the overall dimensions.

The standard pipework connection is a DN32 PN16 raised face flange. This allows for a connection with reliable sealing and easy connection to polyethylene pipework.

As standard, 3 collector panels should be mounted in series. This can be adjusted for a specific application if required.

The flat panel design of the FireFlo collectors allows them to be easily cleaned and reduces the likelihood of debris from the watercourse becoming caught up on the plates.

There are individual bleed points on each of the panels to allow any entrained air to be bled during filling and after the initial running of the system.



The budget price for a single FireFlo collector panel is £2,400 excluding VAT. Contact the FireFlo team for a quotation.

2. FireFlo technical data

2.1 Weights and dimensions

Assembly	Approx. empty mass	Approx. filled mass	Approx. filled volume	Overall dimensions (l x w x h)
Single panel assembly	35 kg	75 kg	40 litres	3086 mm x 406 mm x 140 mm
3 panel assembly	98 kg	218 kg	120 litres	3080 mm x 332 mm x 390 mm

Table 1: FireFlo mass and dimensions

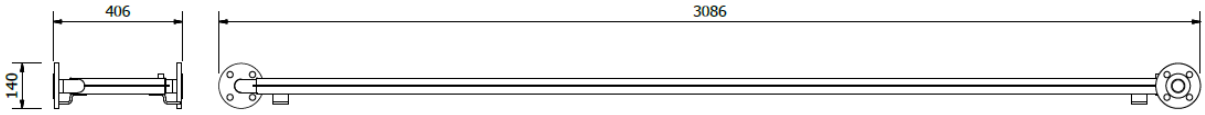


Figure 1: single panel assembly dimensions

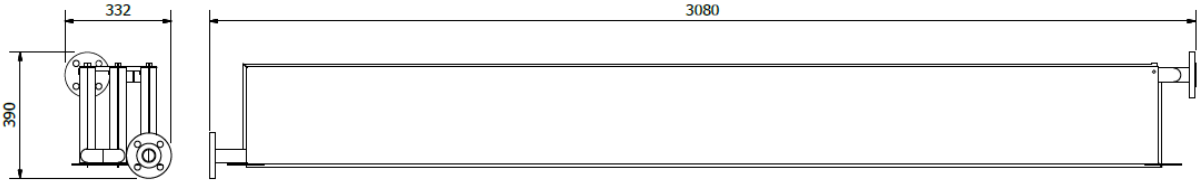


Figure 2: 3 panel assembly dimensions

Flow and return connections	DN32 PN16 raised face flanges
Bleed point connection	¼" BSPP

Table 2: FireFlo connection sizes

2.2 Materials

Side plates, dividers and brackets	Stainless-steel 304 2B [1]
Pipework and fittings	Stainless-steel 304 and 316 [1]
Bleed plug seal	EPDM

Table 3: FireFlo materials

[1] All stainless-steel 316 upgrade available.

2.3 Operating data

Recommended operating pressure	xx bar
Maximum operating pressure	xx bar
Burst pressure	xx bar
Recommended brine flow rate	0.9 l/s (can be adjusted to match heat pump specification)
Minimum brine flow rate	0.5 l/s
Pressure loss at recommended brine flow	4.6 kPa (3 panel assembly)
Minimum operating temperature	-10°C
Maximum operating temperature	50°C

Table 4: FireFlo operating data

2.4 Pressure loss

The curve below shows the pressure loss through a 3-panel assembly at varying brine flow rates. This is based on a brine solution consisting of water with 20% ethylene glycol at 0°C.

A single panel assembly will have approximately 1/3 of the pressure loss.

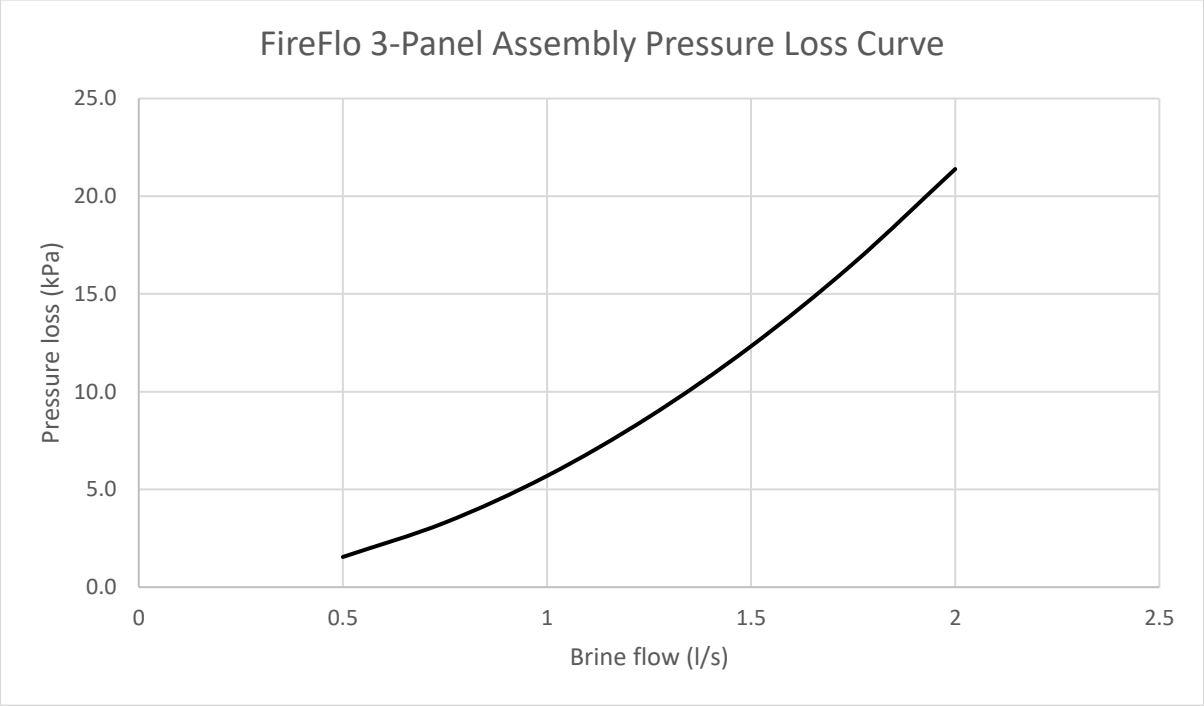


Figure 3: FireFlo pressure loss.

The recommended flow rate through the FireFlo panels is 0.9 l/s. Greater brine flowrates result in improved heat transfer but higher pressure loss. The benefit of increasing the brine flowrate reduce the more it is increased. It is recommended to operate the panels with a brine flowrate greater than 0.5 l/s to avoid a significant drop in the rate of heat transfer.

2.5 Heat transfer characteristics

The thermal energy collected by the FireFlo panels is dependent on a number of variables:

- Water velocity in the channel.
- Brine flowrate through the panels.
- Properties of the brine solution.
- Installation conditions.

Figure 4 and Figure 5 provide the expected FireFlo thermal output at a range of river velocities for the following conditions[2]:

- Recommended brine solution flowrate of 0.9 litres per second through each panel.
- 20% ethylene glycol brine solution (suitable for a minimum working temperature of -10°C).

The data in Figure 4 is relevant for a wall mounted 3 panel assembly (output given per panel, so multiply by 3 for the 3 panel assembly). The data in Figure 5 is relevant for a partially embedded single panel assembly.

The data in Figure 4 can also be used for estimating the performance of the vertical and horizontal bed mounted arrangements (refer to section 3 for standard mounting arrangements).

The curves shown are for different watercourse temperatures and brine flow and return temperatures.

To obtain an approximate sizing for a UK application, the curve for a river temperature of 5°C and brine flow and return temperatures of -4°C and 0°C respectively should be used. 5°C is a typical minimum UK freshwater temperature, but this will vary between sites.

Contact the FireFlo team for assistance with design for a specific site.

[2] *Note: the brine flow and return temperatures stated in Figure 4 and Figure 5 have been used to calculate the mean temperature difference between the brine and the watercourse. This does not necessarily reflect the brine flow and return temperatures for a single collector assembly.*

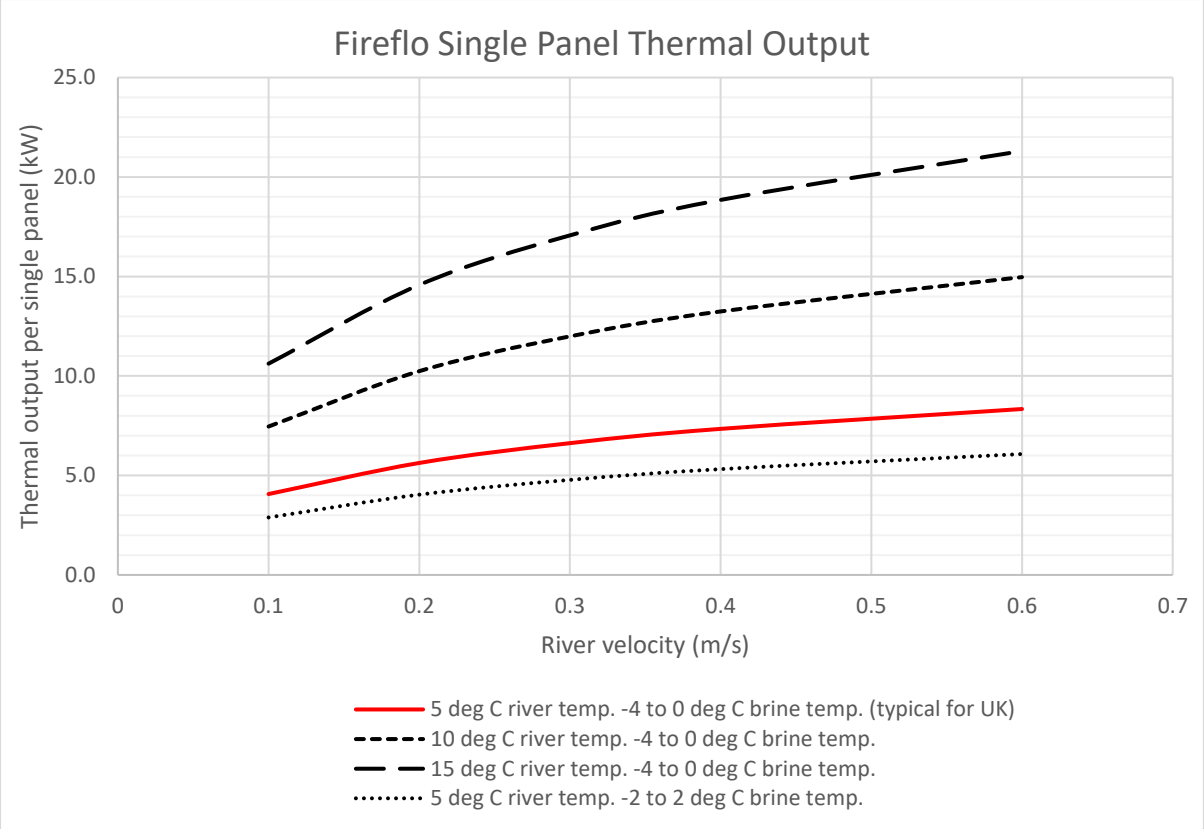


Figure 4: FireFlo thermal output when wall mounted (5°C river temp. -4 to 0°C brine temp. is used for a typical UK sizing).

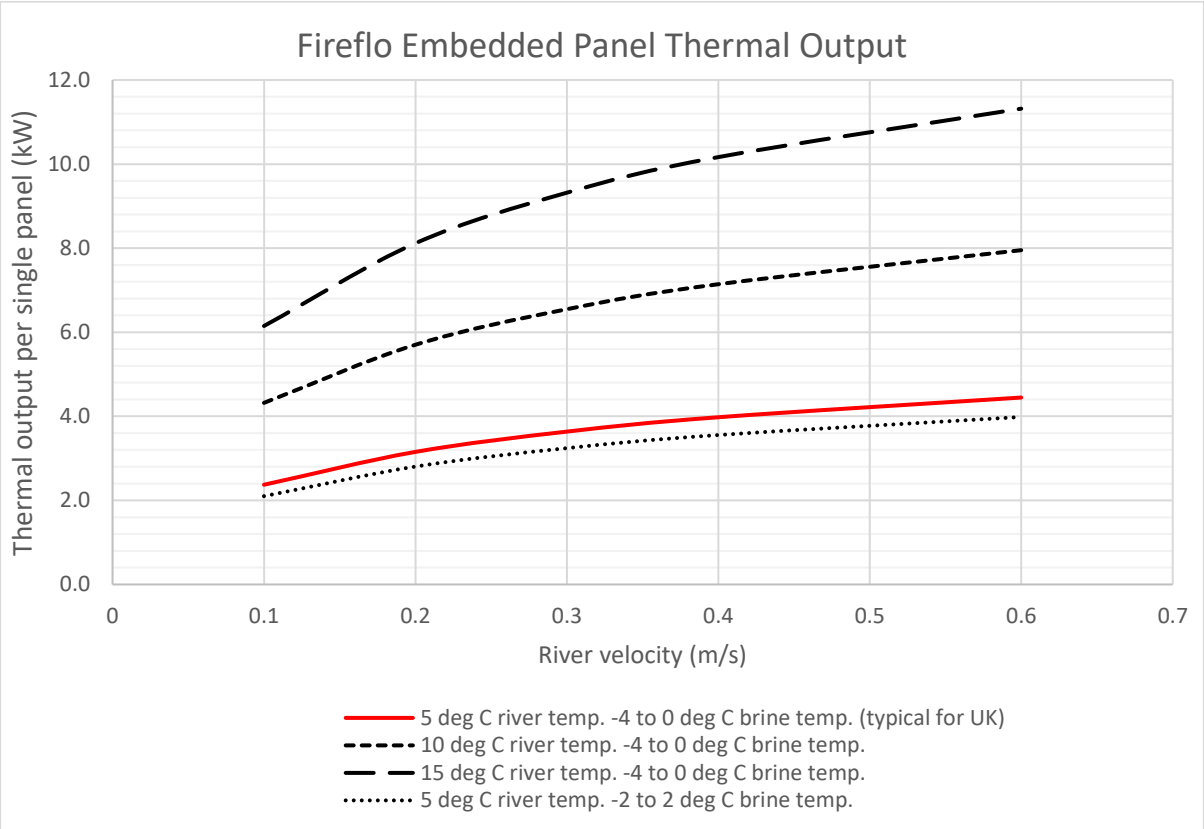


Figure 5: FireFlo thermal output when partially embedded.

3. Standard installation configurations

3.1 General

There are 4 standard mounting configurations that allow the FireFlo system to be adapted to a range of channel conditions.

For some mounting arrangements, the panels are provided as a 3-panel fabrication as standard. For other mounting arrangements, the interconnections between panels will be made up on site by the installer.

Mounting arrangement	Standard module	Minimum watercourse depth for full utilisation
Wall mounted	3-panel arrangement	450 mm for a single module, with an additional 420 mm for each additional stacked module
Bed mounted, vertical panels	3-panel arrangement	450 mm
Bed mounted, horizontal panels	Single panels	250 mm
Bed mounted, embedded panels	Single panels	>50 mm

Table 5: standard mounting arrangement summary.

The brackets required for each mounting arrangement can be supplied as a standard kit. Additional brackets can be supplied to assist with supporting connecting pipework.

The flow and return arrangement for the FireFlo assemblies will generally utilise 40mm PE pipe.

3.2 Wall-mounted arrangement

The wall-mounted panel arrangement uses a standard bank of 3 FireFlo panels which are supplied as a single fabricated assembly. These can then be fixed to wall mounting brackets and stacked in multiple layers if required and if the depth of water permits this.

If the mounting assembly is specified with an order, the correct brackets and fixings for the number of panel layers will be provided.

During installation, generally the wall brackets will be fixed in place initially. The FireFlo assemblies will then be mounted onto the cantilever brackets and bolted down. Each assembly of 3 FireFlo panels can be installed and removed independently of the other layers.

The flow and return connections for each FireFlo assembly are at opposite ends of the panels.

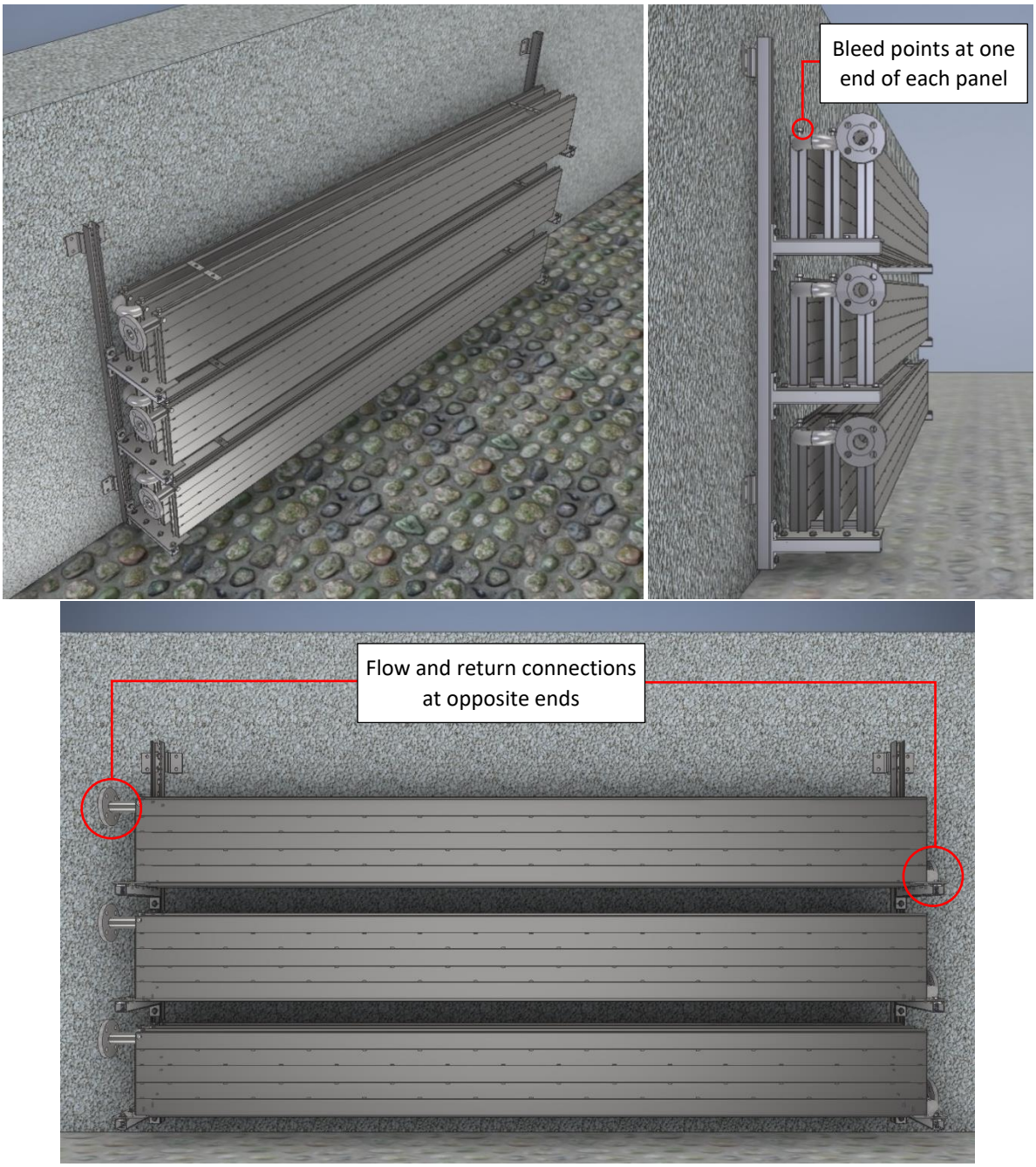


Figure 6: wall mounted FireFlo installation

3.3 Bed-mounted, vertical panel arrangement

The bed-mounted arrangement with vertically orientated panels uses the same standard bank of 3 FireFlo panels as the wall mounted arrangement.

The standard bracket arrangement allows the panels to be mounted to the base of a channel. The standard levelling brackets allow for direct mounting to a solid surface. Optional mounting plates can be supplied to allow for mounting to a soft bed. These can either be fixed down to the bedrock below or held down with earth anchors.

If the mounting assembly is specified with an order, the correct brackets and fixings for the number of FireFlo assemblies will be provided.

During installation, the brackets will be fixed in place initially. The FireFlo assemblies will then be mounted to the channel section supports.

The flow and return connections for each FireFlo assembly are at opposite ends of the panels.

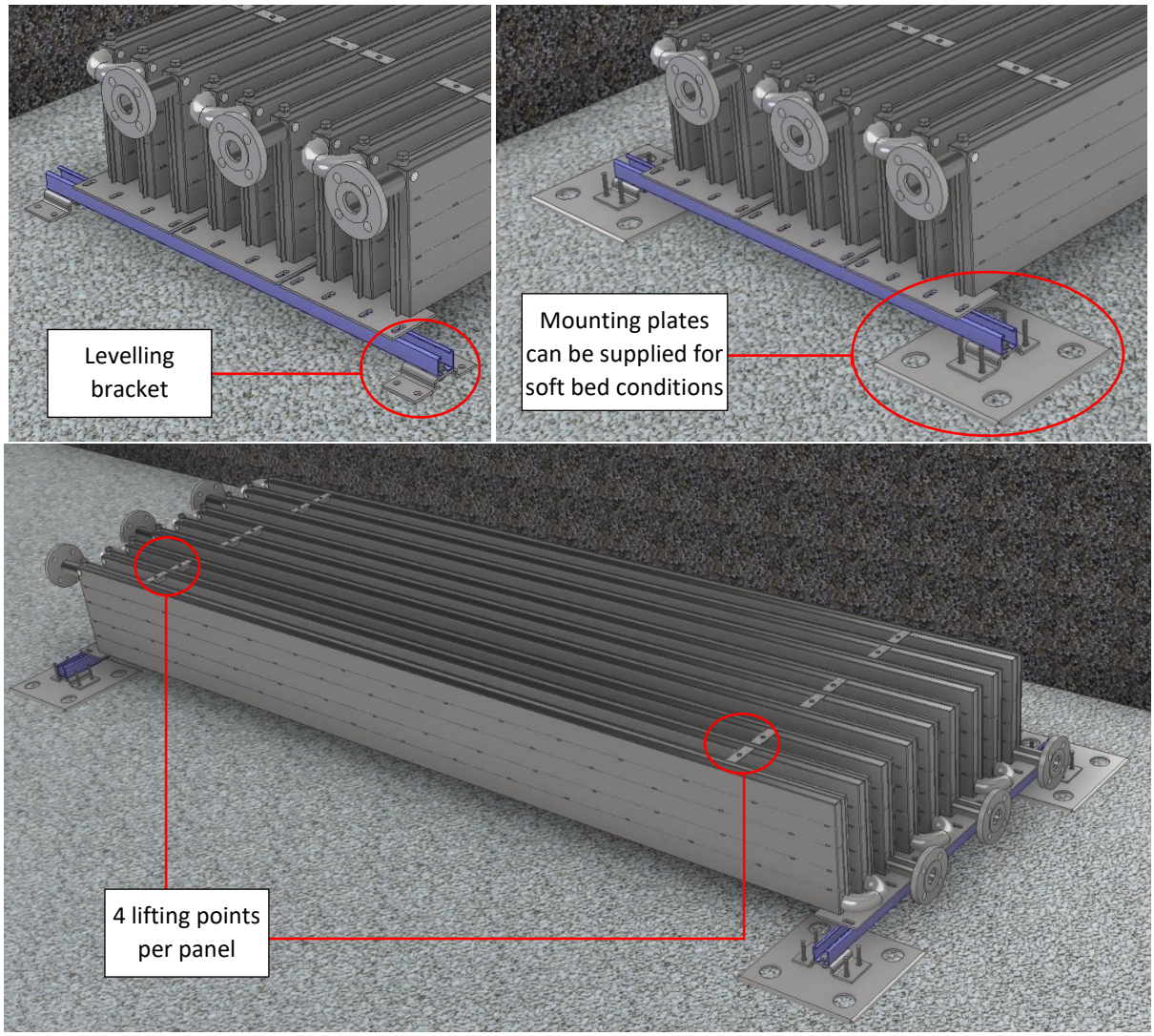


Figure 7: bed mounted vertically orientated FireFlo installation

3.4 Bed-mounted, horizontal panel arrangement

The bed-mounted arrangement with horizontally orientated panels uses single FireFlo panel assemblies. These can be connected in series with each other.

The standard bracket arrangement is the same as for the bed mounted arrangement with vertically orientated panels.

The flow and return connections for each FireFlo assembly are at opposite corners of the panel. The flange faces are parallel with the long edge of each panel.

The simplest mounting arrangement is 3 single panel assemblies connected in series and mounted side by side. However, the assemblies can also be installed inline if the channel is narrow. Additional interconnecting pipework is required for inline installation.

Panels are supplied with brackets mounted on side A or side B to enable simple interconnections (see Figure 8).

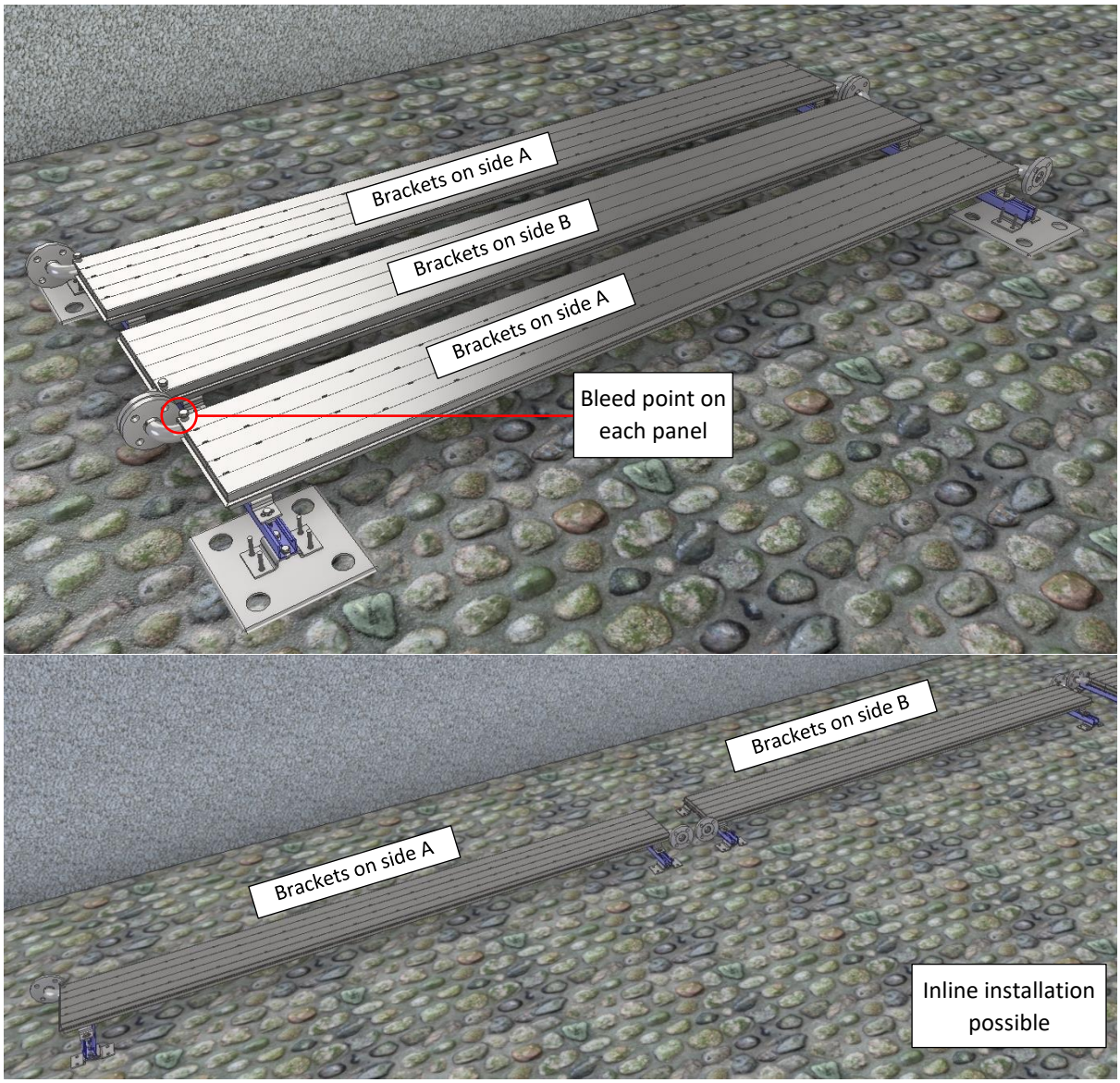


Figure 8: bed mounted horizontally orientated FireFlo installation

3.5 Bed-mounted, embedded panel arrangement

The bed-mounted arrangement with embedded panels uses single FireFlo panel assemblies. These can be connected in series with each other.

This mounting arrangement results in only one face in contact with the flowing water so is only recommended for shallow channels. Embedding the panels means that the additional obstruction in the watercourse is minimal.

Hold down brackets are fixed directly to either end of the panels for anchoring.

The simplest mounting arrangement is 3 single panel assemblies connected in series and assembled side by side. However, the assemblies can also be installed inline if the channel is narrow. Additional interconnecting pipework is required for inline installation.

Panels are supplied with brackets mounted on side A or side B to enable simple interconnections (see Figure 9).

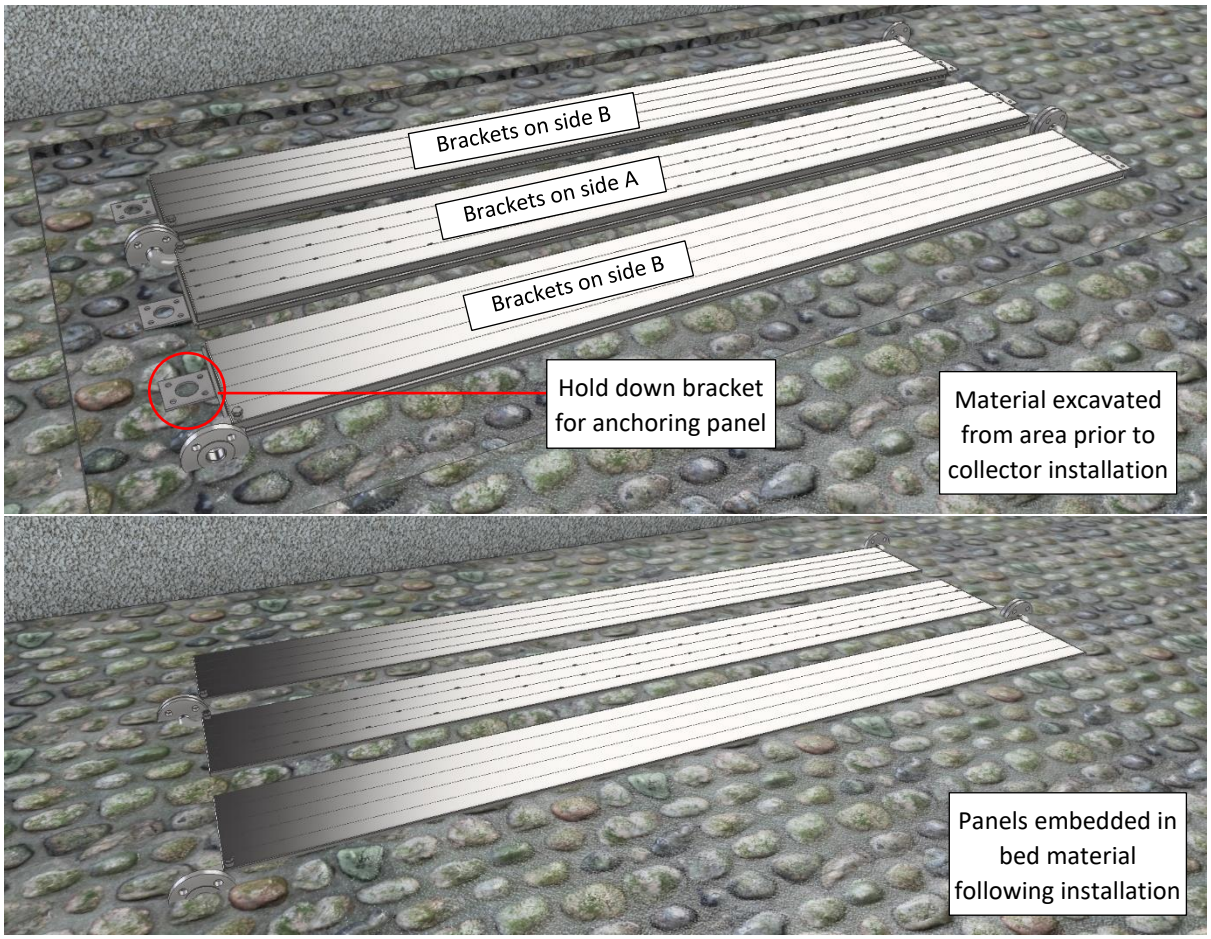


Figure 9: bed mounted, embedded FireFlo installation

3.6 Array mounting for static water applications

FireFlo heat collectors are designed for flowing-water applications, but they can also be used in static water (ponds, lakes, canals etc.) provided that enough collectors are installed to compensate for the reduced amount of heat collection that is possible from static water because of the reduced heat transfer (see Figures 4 and 5).

To facilitate installation the FireFlo collectors can be supplied with upper and lower brackets of the correct length to fasten the collector sub-assemblies together and also provide convenient attachment points for top-hung mounting arrangements or ballasting arrangements underneath the FireFlo collectors. Note that the large number of mounting holes provided on the bracket flanges are to give you multiple connection point options – just use an appropriate number of connections points in the positions that suite your application.

If using ballast weights underneath the collector array, it is best to use *just* enough ballast to hold the array on the bed in normal use, but still allows the array to float back up to the surface if the internal brine is displaced by compressed air, which makes it much easier to access the collectors for maintenance. When ballasted onto the bed, some type of spacer is normally added underneath the collector array so that it doesn't sit right onto the bed where it can be susceptible to silt accumulation. Suitable spacers can be hollow concrete blocks that are also used as ballast, or old plastic bread or bottle crates. A standoff of approx. 250 mm is recommended.

Note that Figure 10 shows an example of a 9-collector array, with flow and return connections for each sub-assembly of three FireFlo collectors. Array connections can be configured in any arrangement to meet the specifics of your system flow and return parameters.

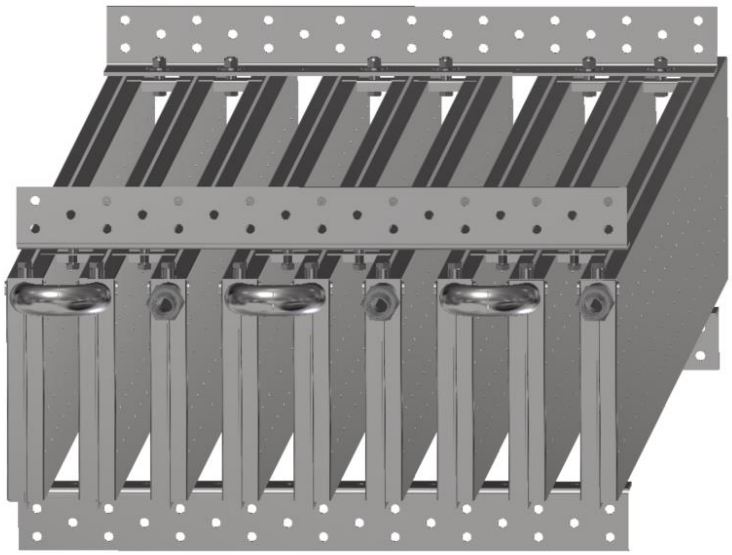


Figure 10: array mounting for static water FireFlo installation

4. Collector system design

4.1 Typical system layout

Figure 10 shows a typical collector system layout with the fill/purge system connected. Generally, this would only be connected during the initial filling process.

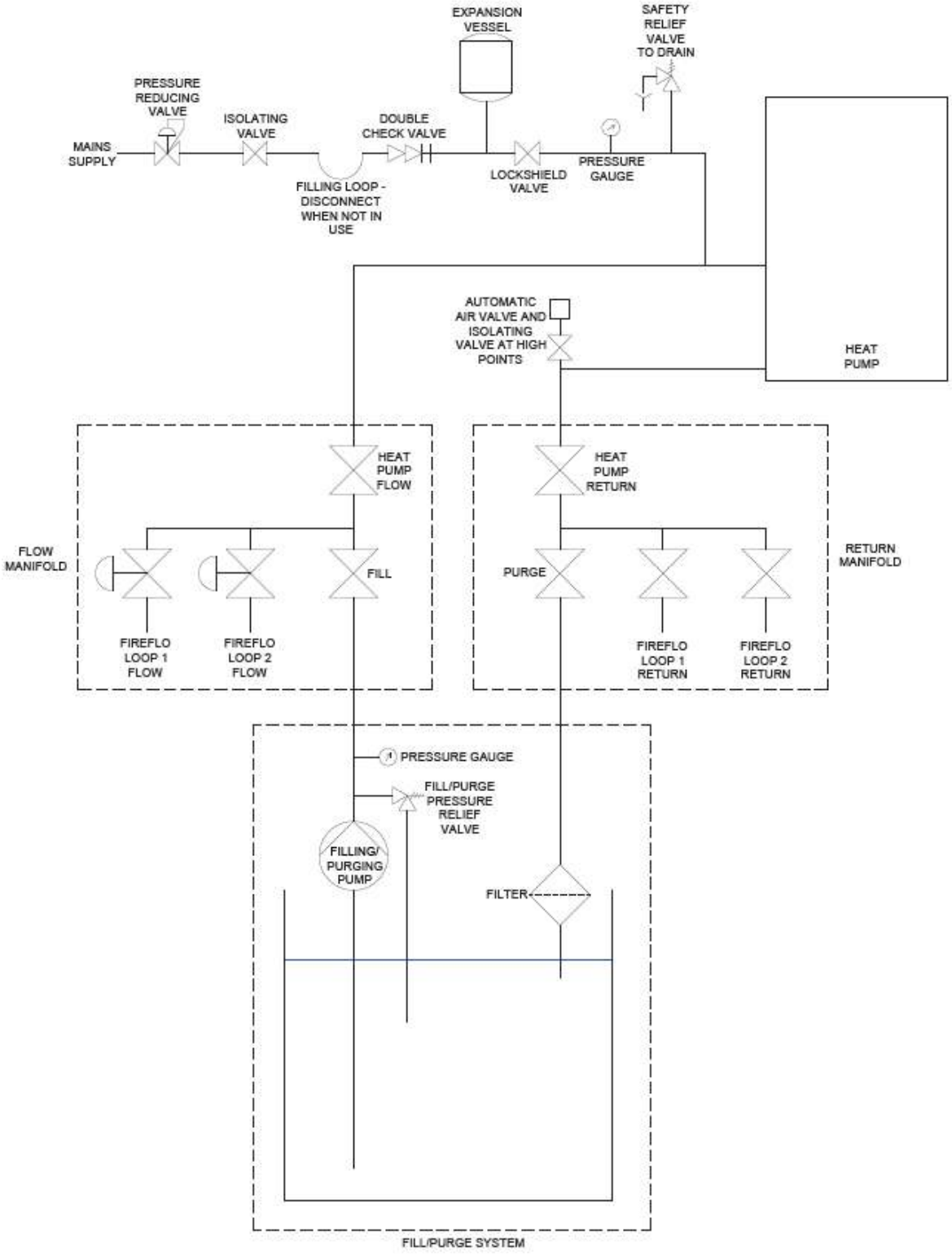


Figure 10: typical system schematic with fill/purge system connected

4.2 Connecting multiple FireFlo assemblies

Multiple FireFlo assemblies can be connected in series or in parallel. Series connection results in a greater flow through each collector. This provides a benefit in terms of heat transfer. However, it will also result in increased pressure loss. The decision to connect FireFlo assemblies in series or parallel is therefore mainly driven by the specification of the brine circulation pump.

Where FireFlo assemblies are connected in parallel, flow and return manifolds are required to supply each of the collector loops (as per Figure 10). If the collector loops do not have equal flow resistance, a commissioning valve will need to be incorporated into each collector loop. This will enable the flow through each loop to be balanced during commissioning.

Reverse return connection is one way of ensuring each parallel loop has the same flow resistance (see Figure 11).

Contact the FireFlo team to discuss your manifold requirements.

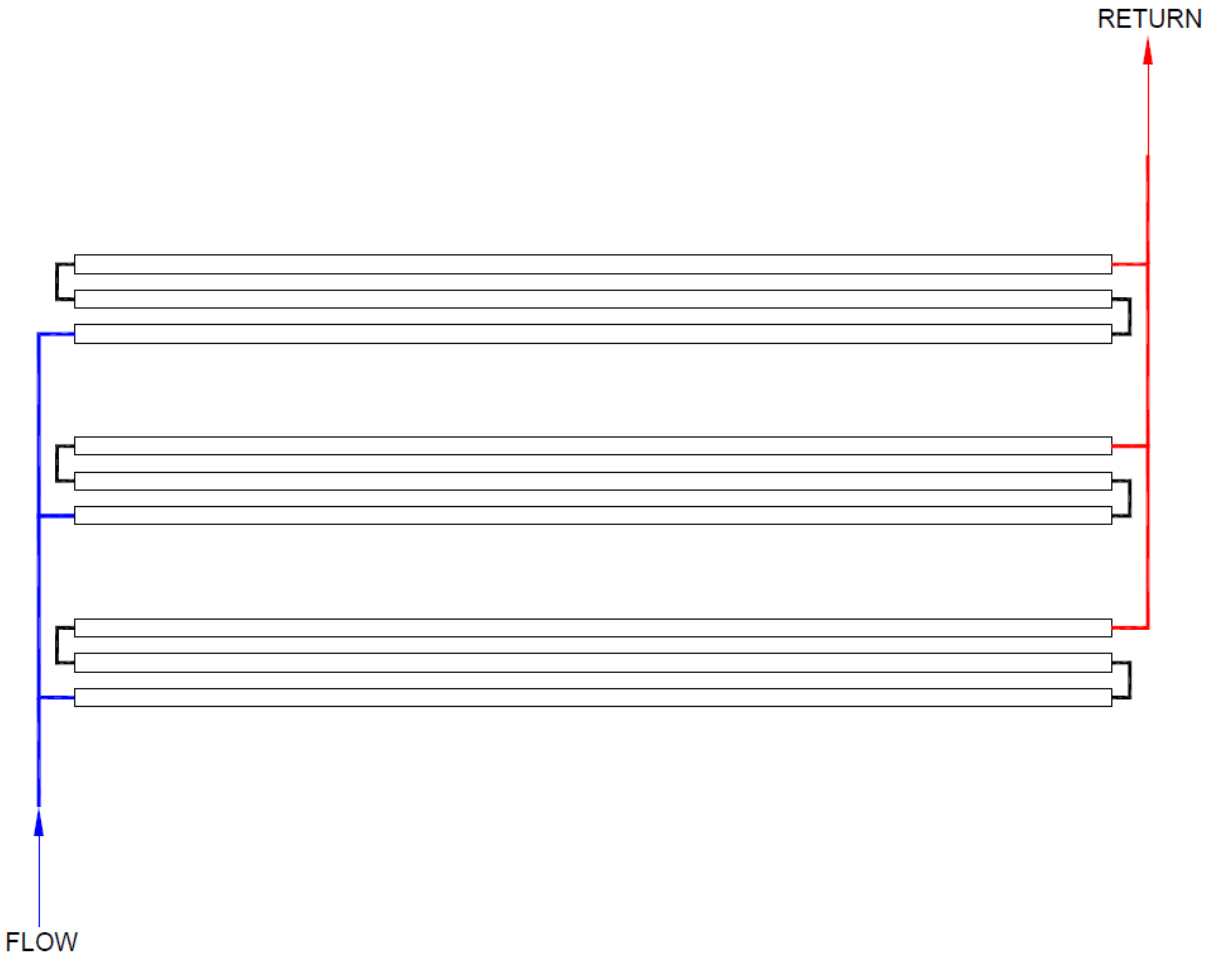


Figure 11: reverse return configuration

4.3 Overpressure protection

The Fireflo system must be protected from being over pressurised to prevent damage to the panels using a safety relief valve or rupture disc. This over pressure device must be located on the **flow** pipe between the brine pump and the first FireFlo panel. It should discharge to a foul water drain.

The overpressure device should be designed to discharge all available brine pump flow to the drain when the FireFlo panels are at their maximum operating pressure. When sizing the over pressure device, it is important to consider the difference in elevation between the overpressure device and the lowest point of the FireFlo panels. An example of sizing the overpressure device is given below.

Example:

- *Maximum allowable FireFlo operating pressure = 2.0 bar.*
- *Position of over pressure device above lowest point in FireFlo system = 3m (0.3 bar).*
- *Overpressure device maximum pressure at design discharge = 2.0 – 0.3 = 1.7 bar (pressure at which the design flowrate is discharged through the device).*
- *Brine pressure at location of overpressure device when brine pump is off = 0.5 bar.*
- *Pressure across brine pump during normal operation = 0.2 bar.*
- *Maximum brine pressure at location of overpressure device = 0.5 + 0.2/2 = 0.6 bar.*
- *Overpressure device minimum pressure at zero discharge flow = 0.6 bar (to prevent false trips).*
- *Selected overpressure device type = NABIC Fig 542 Safety Relief Valve.*
- *Selected overpressure device set pressure = 1.0 bar.*
- *Selected overpressure device pressure at design discharge flowrate = 1.1 bar (10% overpressure).*
- *Brine pump minimum differential pressure during overpressure event = 1.1 – 0.5 = 0.6 bar.*
- *Brine pump flowrate at minimum differential pressure = 60 kg/min.*
- *Overpressure device minimum size required = DN20*

NABIC Safety Relief Valves are suggested valves for overpressure protection and should be sized for the application.

If in doubt, contact the FireFlo team who will be able to quote a suitable overpressure device.

4.4 Expansion vessels

The FireFlo system should contain an expansion vessel to absorb pressure surges and fluctuations with temperature.

An approximate size for the expansion vessel is 5% of the brine circuit capacity. However, this should be discussed with the heat pump supplier.

The gas in the expansion vessel should be charged to the design pressure in the system at the location of the expansion vessel.

If in doubt, contact the FireFlo team who will be able to quote a suitable expansion vessel.

4.5 Provision for filling

Connection points for filling the collector system with brine solution should be incorporated.

The filling pump system must incorporate a pressure relief valve to prevent the FireFlo panels being over pressurised by the filling pump. The pressure relief valve connected to the filling pump must be set sufficiently low such that the maximum operating pressure of the FireFlo panels is not exceeded. The pressure relief valve setpoint should correspond to the desired system operating pressure.

Air bleed points must also be incorporated at any high points in the system. The use of automatic deaerators at high points is also recommended (above water level only).

Incorporating a manual fill connection supplied by mains water is also recommended. This connection must follow WRAS regulations and be disconnected when not in use. The manual fill loop should be connected to the cold-water supply via a double check valve. The manual fill connection will ease the process of topping up the system when air is bled following the initial filling process.

The manual fill connection should be fed via a pressure reducing valve. The pressure reducing valve setpoint should be set to a pressure above the desired brine loop pressure, but sufficiently low to prevent the FireFlo panels being over pressurised. This manual fill loop should also contain a shutoff valve and should be disconnected after filling so that the system is isolated from the water supply.

The overpressure device must remain connected during the initial filling process and whilst using the manual fill connection.