SOLAR POOL HEATING. ENGINEERED FOR LIFE.

INSTALLATION MANUAL

SWIMMING POOL SOLAR HEATING SYSTEM

Before attempting installation, read these instructions and acquaint yourself with the component names.
Great care has been taken to make this an easy-to-follow procedure – a little time spent understanding the system and its parts will assure a successful, trouble free installation.

If at any time you have a question regarding this installation, contact your Heliocol Representative.

CAUTION – SAFETY COMES FIRST

HELIOCOL™

Contents

1 Introduction

Heliocol Solar Pool Panels are manufactured utilising state-of-the-art technology and production techniques. Heliocol collectors are sleek and simple, yet the ***patented overmoulded design*** *make them durable to last a lifetime. Correct installation is essential to the overall success of the system. Installed correctly, a Heliocol System is practically maintenance free, as it taps solar heat year after year.*

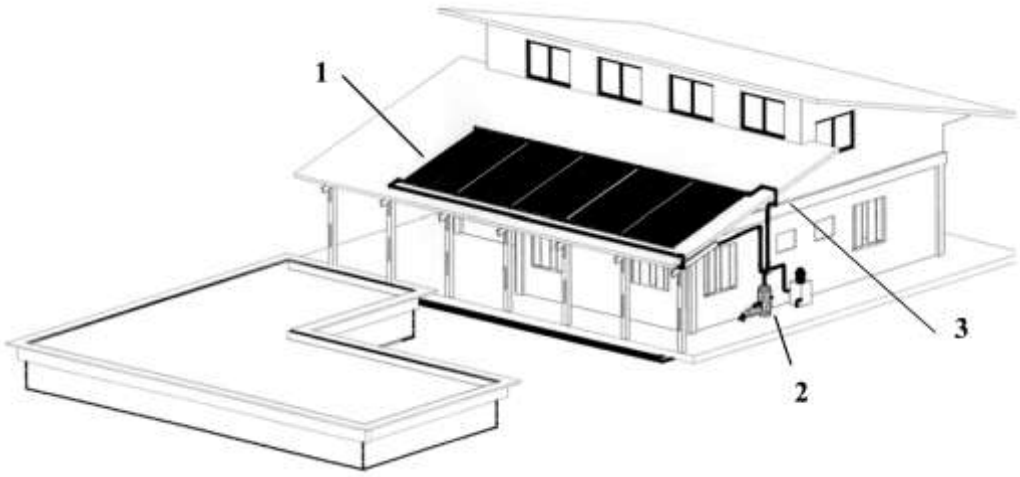
This manual contains easy, step-by-step instructions to help ensure that your installation meets our recommended standards. It also includes techniques and tips gathered from experienced Heliocol contractors that will save you time and effort.

Overview

Heliocol solar heating systems can be either mounted on a roof or on the ground. In either case the collectors may lie directly on the mounting surface, or, if a change of angle is necessary, on a specially constructed rack.

The illustration below is of a typical roof mounted system, highlighting the three basic areas:

1. The solar collectors
2. The existing water filtration system
3. The feed-and-return plumbing that connects between the solar panels and the existing filtration system.



Conventions used in this Guide

Table 1: Icons used in this Guide

Icon	Meaning
	Safety warning
	Important note
	General note
	Practical tip

Important: While this manual explains how to install Heliocol Solar Panels properly in typical situations, it cannot address all the possible individual cases. If you have any installation questions, contact your Heliocol representative for assistance. As the installing contractor, you are responsible for fulfilling top quality standards when installing Heliocol panels.

Safety precautions

Warning: There is no substitute for safety. Do not take short cuts. Always exercise extreme caution, care and good judgment when working on or around a roof or pool area.

Take care to avoid hazards such as **overhead electrical wires** or **loose tiles**.
Do not allow **extension cords** to trail into the pool or other stagnated water.
Disconnect the **power supply** to the pool when installing an automatic control system.
When working on a steep roof, use a **safety rope**.
Be sure to **secure ladders** so they do not slip or fall.
Wear shoes with good tread to **avoid slipping** on the ladder or sloping roof areas.
Do not leave materials or equipment on a sloping roof where they could fall off.
When working outdoors in warm weather keep yourself adequately **protected from the sun** and make sure to **drink regularly**.

Important: Avoid treading on Heliocol collectors! Wherever possible, the system should be installed so that all parts of it are accessible.

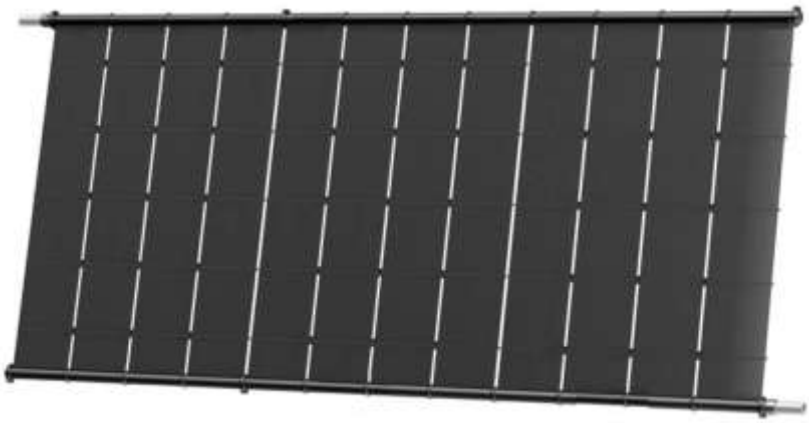
2 Basic Heliocol Terminology

Modules /panels / banks/ arrays

Heliocol collectors are manufactured as individual "modules", and connected together in the factory in groups of four modules to form "panels". You connect the supplied panels together to form "banks" of various lengths, depending on the individual requirements at your site.

A Heliocol solar heating system consists of one or more banks of collectors, connected to the swimming pool filtration system.

Panel – 4 modules welded to one another at the factory.



Bank – a system made of several panels joint together with PPC connectors.

3 Designing your system

This chapter describes the factors you need to take into account when designing your system, and the process of creating the plan of the system structure.

Important: At all stages of the design and construction keep in mind that you want to produce a system for the customer that will be as efficient and as *aesthetically pleasing* as possible.

Deciding on the location for the panels

The first thing to do is determine the location of your solar heating system. The following factors must be taken into account:

Collector area – The total panel area must be large enough to heat the pool efficiently. The exact optimum size depends on many factors in addition to the pool surface area, including climate, latitude, roof orientation and slope, winds, pool covered at night and the presence of local obstructions (such as overhanging branches) between the panels and the sun.

An approximate "rule of thumb" is to allow for a collector area equal to half the surface area **of the pool.**

Proximity to pool – The panels need to be as close to the pool as possible, although longer pipe runs are possible but may need an additional pump.

Orientation – Ideally the collectors should be mounted on a flat or north-facing roof, or an elevated ground mounted rack, facing north. Where necessary, East facing or West facing roofs can be used (in that order of preference). Then the system has to be sized to compensate for 'lost' time in the morning (west), and an afternoon (east)

Tilt – Be sure the planned position of the collector panels allows for them to drain naturally when the pool pump shuts off.

Preparing a schematic diagram

Once you have decided on the location for the panels, it is useful to prepare a schematic diagram of the system you wish to construct, taking into account the collectors sizes available.

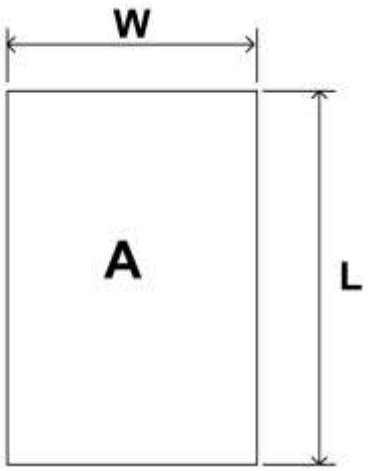
1. Fill in a "Site layout sheet". This will help you decide on the best system for your site.
2. Prepare a schematic drawing of the installation area. Include the proposed location of the feed and return lines.
3. Use the panel dimensions in the table below to sketch the system you will construct.

Tip: Roof areas often give the impression of being bigger than they really are, so be sure to actually *measure* the available area before making your drawing.

Note: Where possible construct your system using panels of the same length (if possible the largest length).

Table 2: Module/panel area dimensions

Item	Width	Length	Area
Panel			
HC-30	120 cm	232 cm	2.77 m²
HC-38	120 cm	292 cm	3.5 m²
HC-40	120 cm	325 cm	3.85 m²



Sample system layout

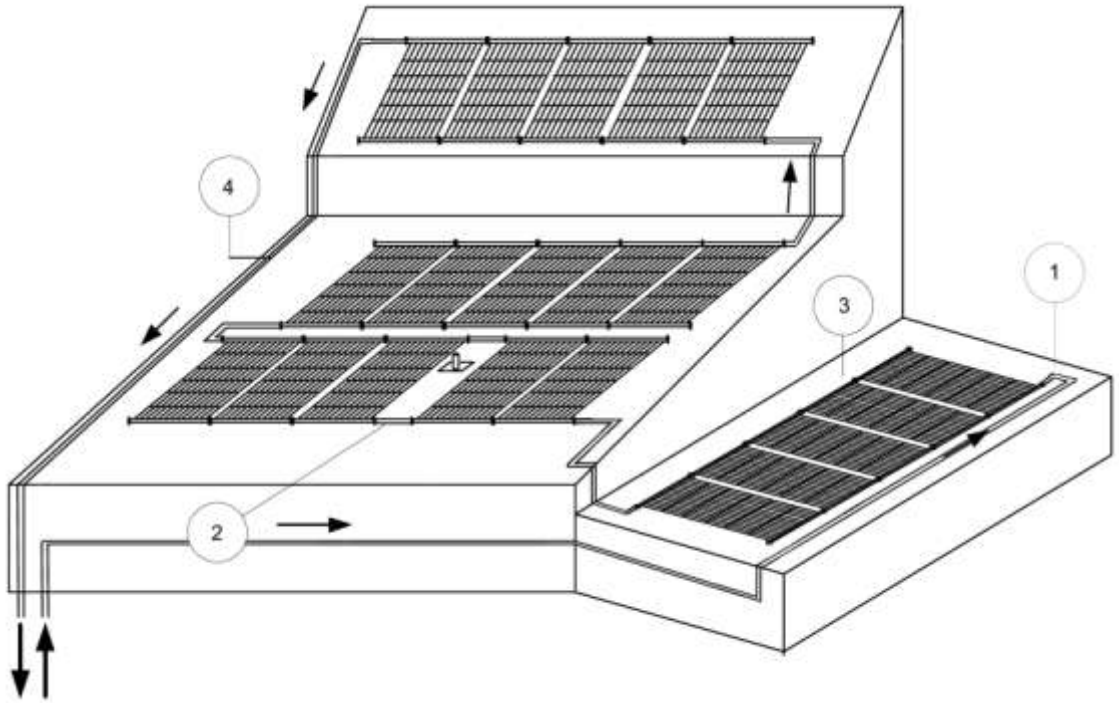


Figure 3.1: Sample collector system

1. Feed line to the farthest point from pump house and lowest point on system.
2. PVC pipe connecting across a large obstruction
3. Flat roof
4. Return line as short as possible.

Note: Full details of how to connect the supply and return pipes are given in Chapter 7.

Mounting racks

Where there is no roof space, or not enough for all the collectors, you may need to construct a rack to mount some or all of the Heliocol panels. The rack must provide a *stable* base for the panels to be secured to.

When designing a mounting rack the following considerations should be taken into account:

The tilt of the rack must be sufficient to allow the collectors to drain naturally when the pool pump shuts off.
When calculating the area for the rack, take into account that collectors expand and contract due to temperature changes under normal working conditions. Allow 5cm extra length per collector.
Allow room on the rack for the supply and return plumbing, and plumbing between collectors and banks.
The mounting rack must be stable, and able to support the weight of the collectors when filled with water, which is up to 5kg/m2.

Figure 3.2: Sample mounting rack

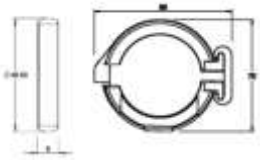
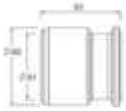
Note: Whenever unglazed solar collectors are installed on a rack, a substrate should be mounted on the rack prior to mounting the panel. This eliminates heat loss and stress created by wind blowing on the backside of the rack.

4 Parts and tools

Once you know the layout of your solar collector system, and how many panels/modules you require, this chapter will help you calculate which Heliocol and other fittings you will need to complete your installation.

This chapter deals with the following three categories:

Heliocol fittings and accessories
Other fittings
Tools

Description	Picture	Dimensional Data
PPC Set *(Plastic Panel Connector)* **Top, Bottom, Clip & O-ring**		
C.P.V.C Adaptor		
End Cap		

Heliocol fittings and accessories

This section summarizes the four basic types of connection to and between Heliocol panels, using Heliocol fittings.

Connecting between panels

To connect a panel to a panel, you need 2 PPC connector sets.
Each PPC consists of a clamp top and bottom, a rubber gasket, and a latch, one to connect the upper manifolds and one to connect the lower manifolds.

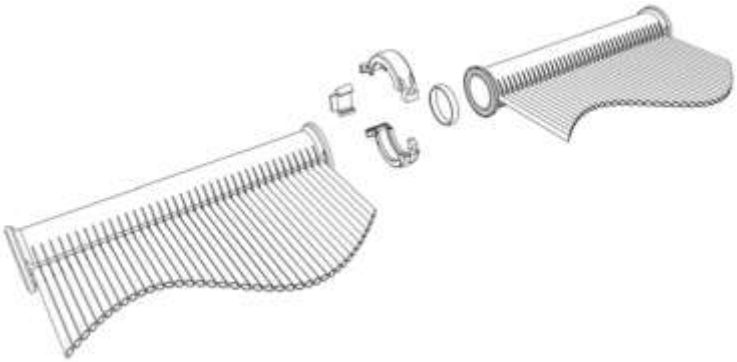
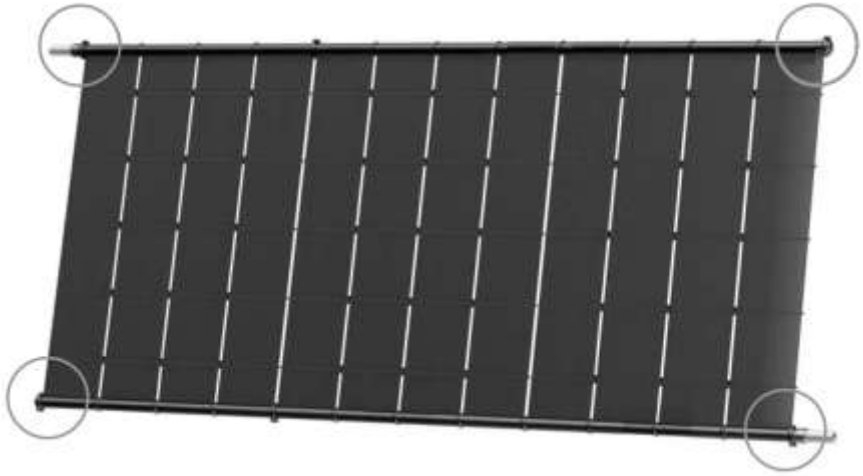


Figure 4.1: PPC (Plastic Panel Connector) set

Ends of a bank

When all the panels in a row are connected together you will have four open ends. Two of these will be connected to the supply and return plumbing, and the other two will usually be blocked with end caps.



For each bank you will require:

2 End Caps, and

2 CPVC Adapters

Figure 4.2: Ends of a bank

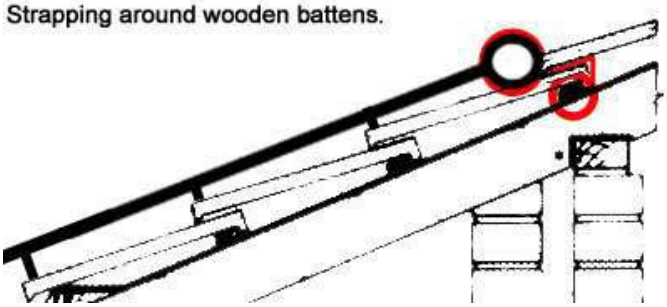
Securing panels to the roof

Panels are secured to the roof using 16mm Polypropylene Strapping. The standard installed requires 2 per panel on the top manifold.

On a tiled roof the strapping can be attached by a variety of accepted methods:

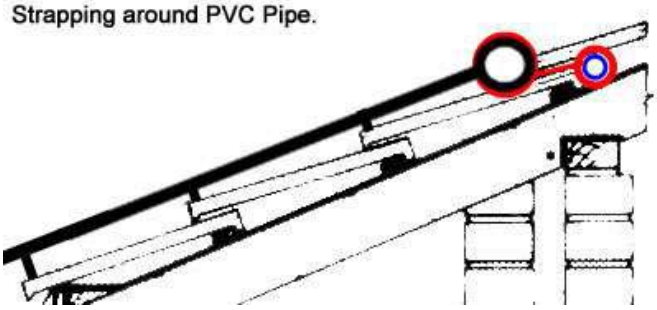
Directly around the wooden battens.

Strapping around wooden battens.



By looping the strapping through a piece of 50mm PVC piping and inserting the system up and under the tile such that it is trapped in position at the head of the tile.

Strapping around PVC Pipe.



It is advisable to coat the exposed strapping after the installation with a proprietary acrylic roof paint for additional UV protection.

Where necessary using anchor bolts and wide washers directly into the ridge tile. This method requires the application of a suitable waterproofing system over the washer / nut on display.

On an IBR / Harvey Tile Roof the best method is to use a wide shoulder Pop Rivet followed by waterproofing.

Heliocol fittings summary

Table 3: Summary of Heliocol fittings required

	PPC connectors	PVC adapters	End caps
For each panel	-	-	-
Between 2 panels	2	-	-
Between 2 panels across obstruction	4	2	-
For each bank ends	4	2	2

5 Hydraulics

This chapter deals with the hydraulics that needs to be considered before installation.

Panel configurations

Before you can start constructing the system you have designed, you must consider how the banks will be connected together. You must also take into account the maximum number of panels allowed per bank, as shown below.

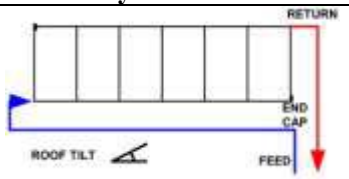
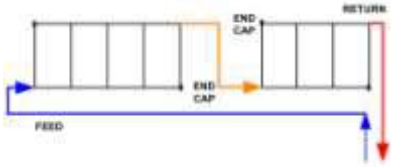
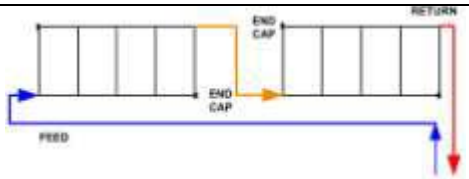
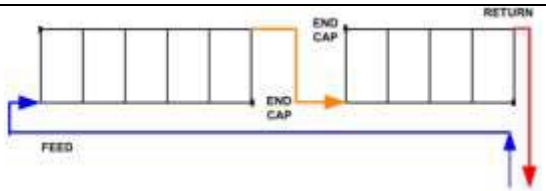
Table 4: Maximum number of panels allowed per bank

Panel type	Max. bank size
HC-30 (4'x8') Cat. 127108	12
HC-38 (4'x9.5') Cat. 127110	10
HC-40 (4'x10.5') Cat. 127111	10

These maximums may be exceeded if there is high-pressure flow or substantial back pressure on the system that will force adequate flow through every panel. In other cases you should divide the bank into two using one of the other configurations.

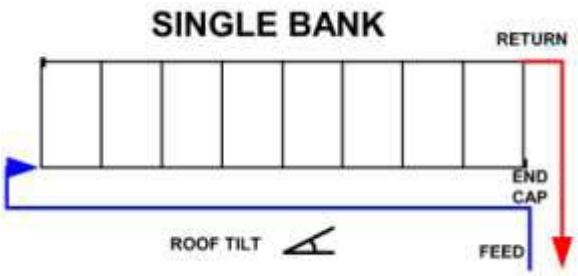
Banks in parallel can also be used for smaller installations, when space is limited.

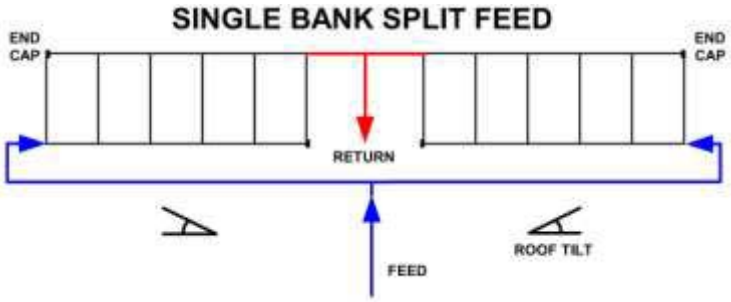
Guidelines for residential installations

	Panel Layout	Flow rate
Single Bank: It is not recommended to install more than 6 panels for this layout.		120 lit/min
Bank in Series: When installing more than 6 panels, it is advisable to use the split in series bank system. This will allow you to control the flow rate more efficiently. **Remember** that the largest bank is always installed first before the split then smaller bank. (A) 4 Bank – split – 3 Bank (B) 4 Bank – split – 4 Bank (C) 5 Bank – split – 4 Bank	 (A)	80 lit/min
	 (B)	80 lit/min
	 (C)	100 lit/min

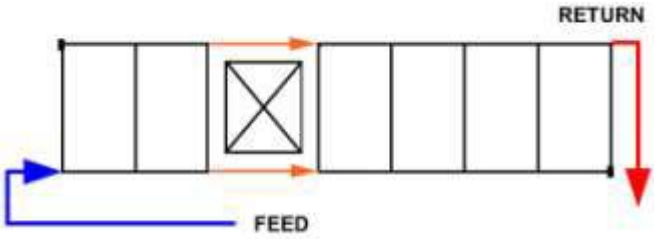
These configurations are calculated around availability from a pump in a residential configuration of ± 120 lit/m. Maximum subject to available flow in 10 in 1 bank but this is usually in dedicated industrial / commercial set ups.

Basic plumbing & arrays layouts

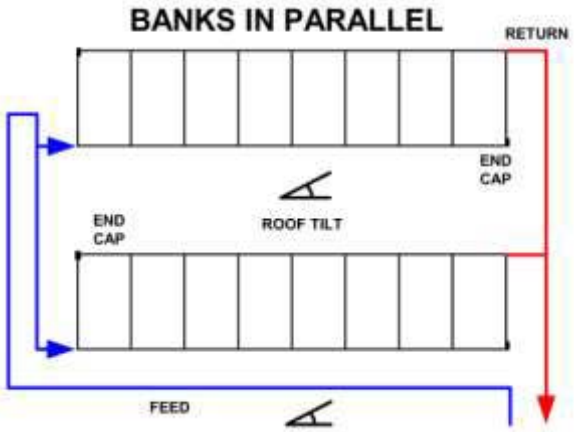


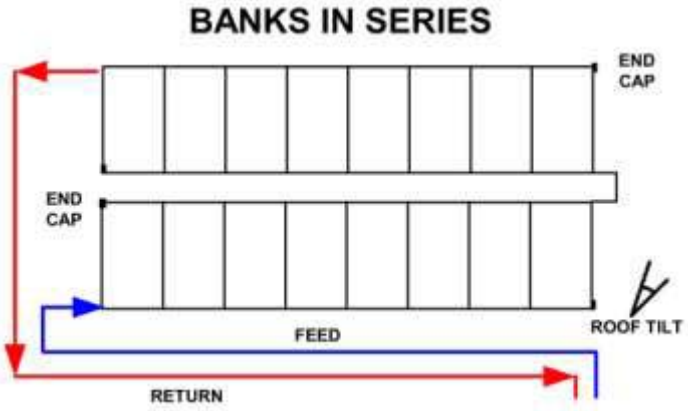


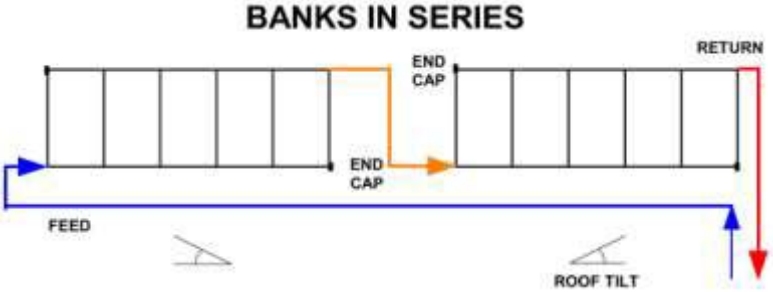
SINGLE BANK WITH OBSTACLE



Split around the obstacle or over the parapet or split level roofs







Plumbing

Water inlet /outlet

Inlets are always connected to a lower end of the bank; outlets to the upper corner diagonally opposite.

Using the "Reverse return" (Tichelmann) method would ensure balanced flow in all collector banks.

Pipe diameter

It is important that all plumbing connected to the system uses a diameter of PVC pipe appropriate to the size of your solar array. Too narrow a pipe will unnecessarily restrict water flow to the panels. Use the following as a guide:

Table 5: Recommended pipe diameters

Flow Rate	Recommended pipe diameter
0-10 m^3/h	40 mm
10-18 m^3/h	50 mm
>18 m^3/h	63 mm

For larger flow rates you may need to operate alternative series-plumbing techniques.

Plumbing runs

Plumbing runs should be as short as possible, especially the "Hot Return" pipe (to minimize heat loss).

Pipes should be supported every meter or so, to prevent sagging and movement.

Tip: Since 90° elbow fittings greatly restrict water flow, use as few of these as possible. In some cases two 45° fittings can be used in place of a 90° fitting.

Tip: When clamping pipes that run across the roof use clamps that allow 1cm for expansion of the pipe in hot weather.

Tip: When clamping pipes on the side of a building use clamps with a diameter equal to the pipe diameter, to prevent vibration and to assure a professional looking installation.

Balanced flow

If you install a split system, such as one of those shown in former page, it is essential that the piping is connected exactly as shown, to ensure equal water flow through both banks of panels. Water follows the path of least resistance, so if one plumbing run is shorter, more water will flow through it than through the longer one. This should also be kept in mind when designing a panel layout different to those shown.

For larger, more complicated configurations "balancing valves" may be necessary to maintain equal water pressure in all parts of the system.

Pump power

The power of the swimming pool filtration pump must be adequate to supply the Heliocol system with the minimum recommended flow rate necessary for the number of panels being installed. These recommended rates in litres per minute are:

Table 6: Recommended flow rate trough the panels

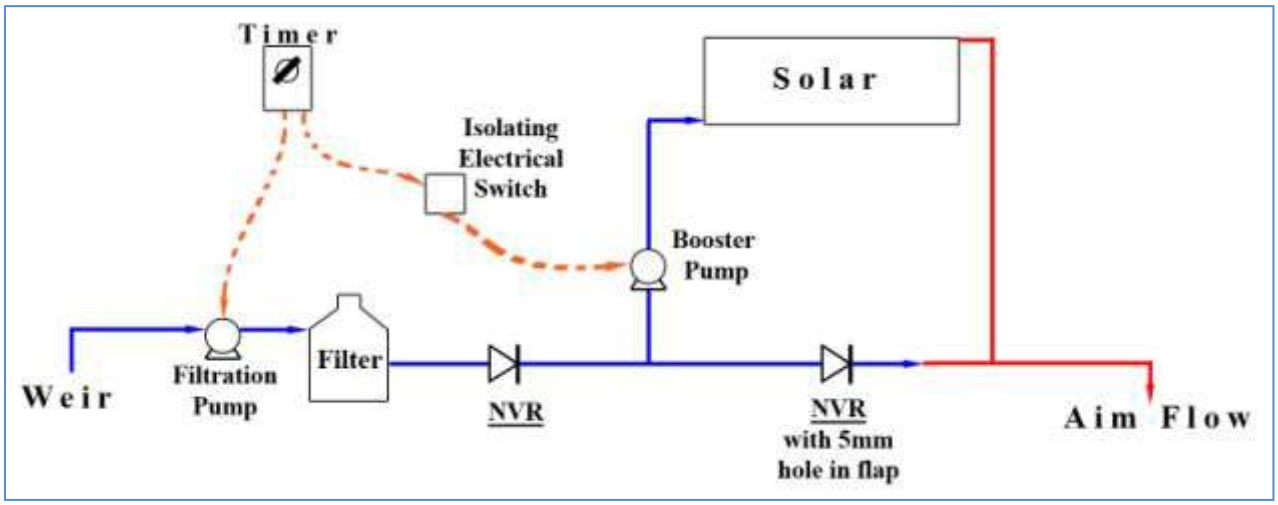
Panel type	Minimum Flow
HC-30 127108 (4'x8')	20 lit/m
HC-38 127111 (4'x9.5')	20 lit/m
HC-40 127111 (4'x10.5')	20 lit/m

For example: If you were installing ten HC-40 (4'x10.5') panels, your pump would have to be able to deliver 120 liters/m to the solar array. These recommended flow rates may be exceeded by as much as 100% without any detrimental impact on the performance of the system. The existing pool filtration pump is usually adequate for circulating the water through the solar system.

Generally, a x 0.75 kW pump is sufficient for a standard private pool solar system, unless there is an unusually long pipe run, a high roof, or a large number of panels. If you are not sure what your pump flow rate is, consult your Heliocol Representative or Pump Manufacturer for the pump's flow characteristics.

Booster Pumps

Under extreme requirements, e.g. of long runs and / or high lifts of 7m or greater there is no alternative but to install a booster pump in the solar delivery piping.



NOTES:

The booster pump should be normally 1 size smaller or the same size as the pump on the filtration unit. NEVER BIGGER.

The two pumps should be electrically interlocked to ensure that the booster can only operate when there is water exiting the filtration system. If not the booster can run dry and fail.
To enable the solar to be switched off when not required install an isolating electrical switch on the electrical feed from the timer to the booster pump.

Automatic drainage

The panels and the PVC pipe must be installed so that the water drains out of them when the pool pump shuts off. This is especially important in areas where freezing occurs.

To assist drainage a vacuum breaker is installed on the solar feed line above the 2-way valve, as shown in the drawing on page 19.

Important: Heliocol Solar Pool Panels are warranted against internal freezing on condition that they are installed to allow for automatic draining.

Compensating for lack of automatic drainage

If, due to unusual roof design or pool equipment location, it is not possible to achieve complete automatic drainage, manual drain down valves must be installed in appropriate places in the plumbing, or at the end of the bottom (feed) header.

Instead of installing an End Cap at the end of the header, place a CPVC and pipe to a ball valve for manual drain. These valves should be opened when shutting down the system for the winter months or when outdoor temperatures approach freezing point.

6 Installation

This chapter describes four basic installation processes:

Connecting panels together

Connecting panels across an obstruction

Securing panels to the roof (sloping or flat)

Gluing PVC joints

Connecting panels together

1
Lay the two panels side by side with the panel spacer bars facing down. Place a PPC connector (top, bottom, gasket and latch) at both ends where the headers meet.

2
Clean the groove of both headers and dry them.

3
Insert the gasket (420211) into the groove of one of the headers.

4 Connect the two headers by inserting the rubber gasket (420211) into the opposite header groove and fitting the ends of both headers into the plastic panel clamp.

Important: Make sure that the gasket sits snugly in the grooves of both headers, and is not squashed or pinched between the headers, as this could result in leaking.

5

Place the bottom half of the plastic panel clamp under the header end with the larger, flat portion facing *away* from the panel and the male "hook" aligned with the riser pipes.

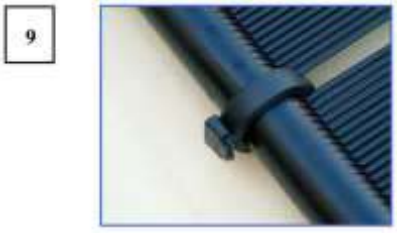
THIS IS MOST IMPORTANT.

Any other position will result in damage to the panel, as the other parts of the PPC are too wide to fit between the risers.

6

Interlock the tab in the top half of the clamp with the hole in the bottom half (120210B), swing the top half (120210T) round over the headers, then lock the two halves of the clamp together using the latch (120211) (do this by sliding the large end of latch over small end of the PPC assembly.)

7+8 Use channel lock pliers to tighten the latch grip by squeezing it with moderate force until it seats flush so it cannot slide out of its position.



9 The headers are now connected.

10 Repeat the procedure to connect the headers at the other end of the panels.

Bypassing a small obstruction

Small obstructions can sometimes be bypassed simply by unclipping some risers from the spacer bars and spreading them to either side of the obstruction.

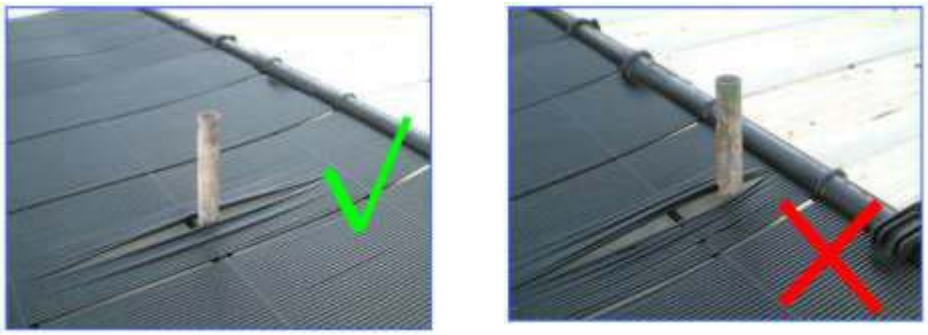


Figure 6.1: Bypassing a small obstruction

Important: If the obstruction is between one of the headers and the adjacent spacer bar this method must not be used, as it might cause a riser to become detached from the header. The Plastic Magen Warranty does not cover incorrect installation of this type.

Connecting across a large obstruction

For obstructions more than 15cm wide, or less than 30cm from one of the headers, you need to circumvent the obstacle using extension pipes between the manifolds.

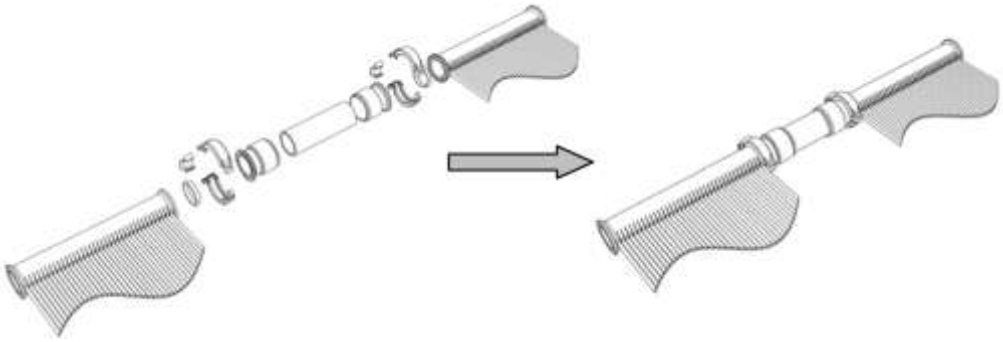


Figure 6.2: Connecting across an obstruction

Therefore, when connecting two panels/modules together across a large obstacle you need:

4 PPC sets

4 CPVC adaptors

2 lengths of PVC pipe cut to the required length.

7 Connecting to the existing Equipment

This chapter describes the standard (and most common) method of running the PVC pipe from the feed and return lines to existing ground level equipment. Some installations may require a more creative approach.

Whenever possible, the return line should have the shortest run and all pipes should run slightly "downhill" to allow for automatic drain-down of the plumbing and solar array. If this is not possible, manual drain valves must be installed as needed.

Note: If the existing pool machine room is near the house, you may prefer to complete the necessary plumbing there before connecting between roof and ground level. That way you will know exactly where the pipes should come down from the roof. However, if you will be trenching from the existing equipment to the Heliocol installation location this is not necessary.

Feed and return lines

Feed and return lines are connected using a PPC connector and a CPVC adaptor. The remaining two open corners of the bank are sealed using PPC connectors and end caps.

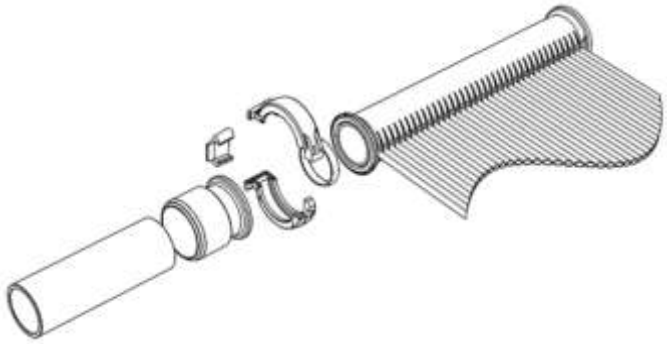


Fig 7.1: Connecting plumbing line to the collector

To connect the feed and return lines:

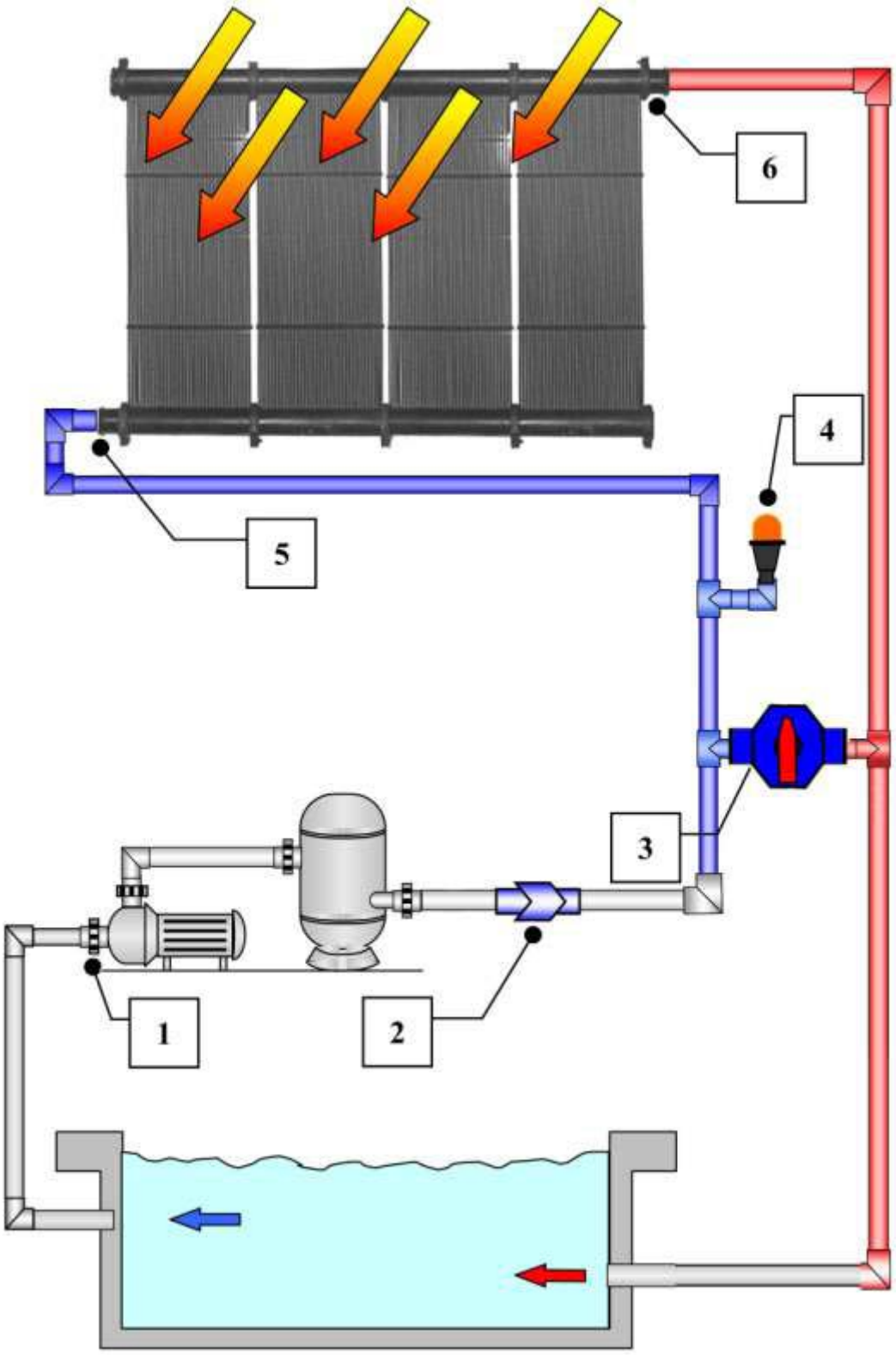
1. Connect the feed line to the low end of the bottom header, which should be the corner farthest from the pool pump, using a PPC connector and a CPVC adaptor.

2. Connect the return line to the top header on the opposite end of the bank. This gives the heated pool water the shortest route back to the pool.

3. Block the remaining two corners of the bank using **end caps** attached with PPC connectors.

4. Connect the feed and return pipes using reliable plumbing techniques.

Connecting with the existing filtration system



Plumbing guidelines

The figure above shows how a typical Heliocol Solar Pool Heating System is plumbed into existing pool plumbing. Even if your system is not identical to the one shown, the illustration can help you understand the flow of water from the pool, through the pump, filter, solar system and back to the pool.

Notice that the union check valve is plumbed in *after* the filter. This prevents the filter from being backwashed by the water draining down from the panels when the pump shuts off.

Notice also that the 2-way valve either diverts the water to the solar system or directly back to the pool. It Features a 5mm hole through the ball of the valve to enable water in the solar system to drain back to the pool when the pump shuts off.

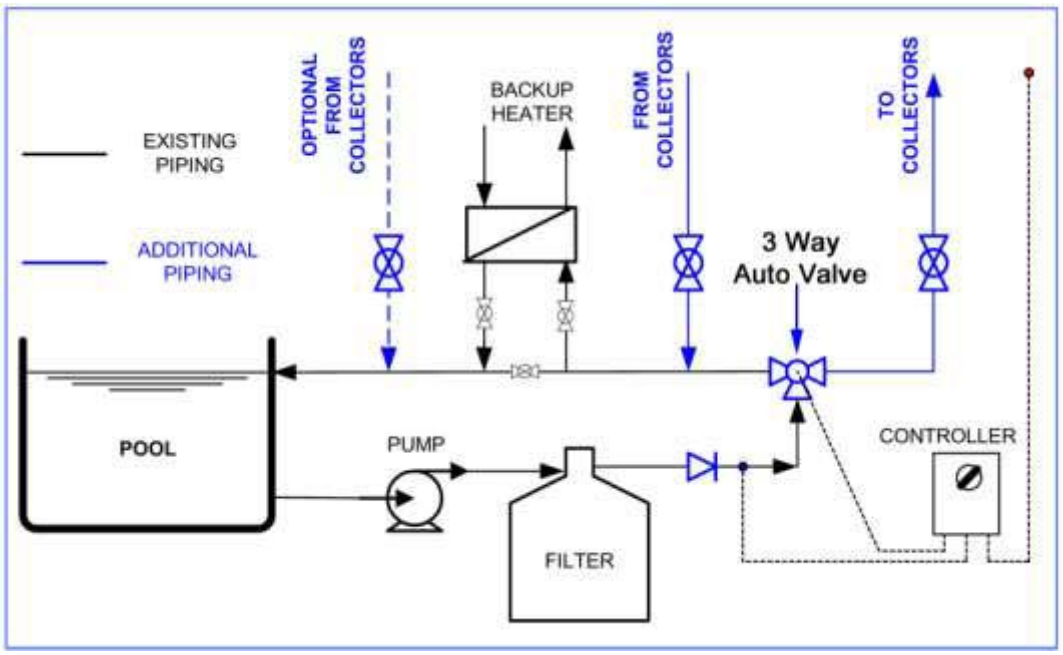
1. Using the existing circulation pump the water flows through the filter and then directed to the collectors.
2. Check valve for preventing backwash of the filter when the collectors drain down.
3. 2 Way valve that directs the water to the collectors when there is efficient sun radiation.
4. Vacuum release valve for automatic draining of the panels after the solar system shuts off.
5. Inlet to the solar panels at the lowest side of the bank, using the “reverse return” method.
6. Outlet from the solar panels back to the pool.

Automatic systems (Private & public pools)

The basic difference between the manual system just outlined and an automatic system is the use of a motorized 3-way valve, which is controlled by two sensors. In cloudy weather the connection with the pool is automatically shut off so as to maintain the warmest temperature possible. The two sensors will read: (1) temp of cool water coming from the pool and (2) the heat of available solar radiation.

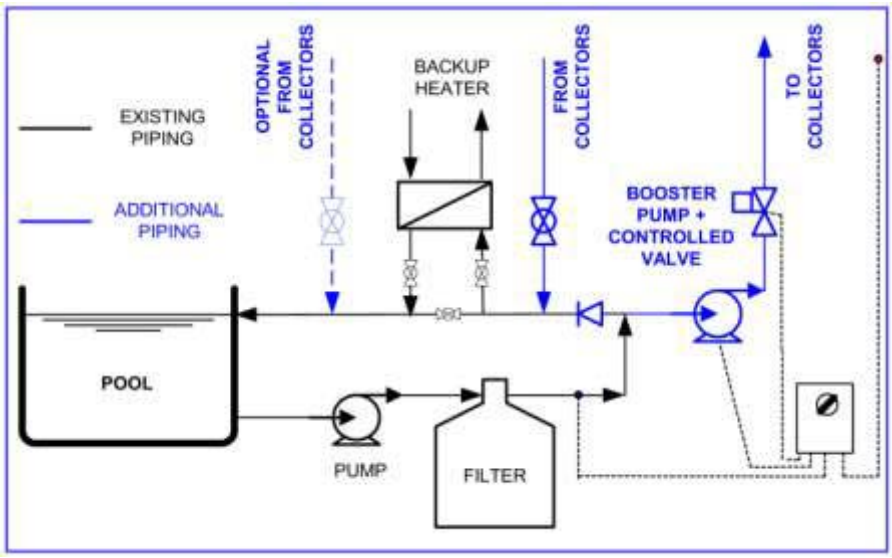
Important: Make sure that the radiation sensor which is located on the roof is exposed to the sun in the same way the collectors do. In a windy region a transparent plastic cover can be installed over the sensor.

Private pool basic plumbing



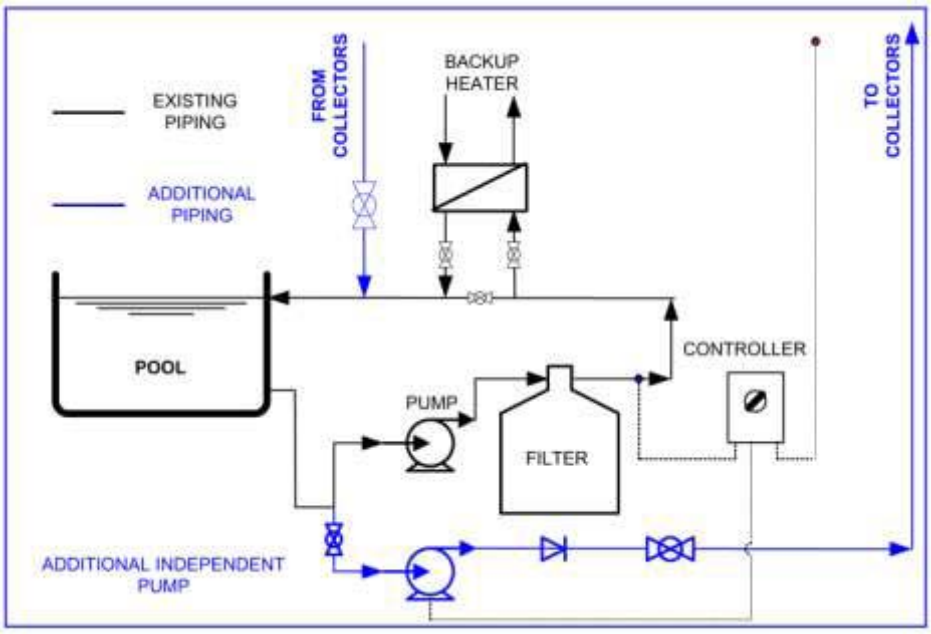
When the existing filtration pump is sufficient to deliver the desired discharge to the collectors and there is no need for additional booster pump, the system plumbing and control is based on the existing pump and a motorized 3 way valve that directs the pool water to the collector when there is sufficient sun radiation.

Public pool basic plumbing



The additional booster pump should be installed after the filter, using a "T" joint on the main filtration pipe. The automatic control commands both the booster pump and the 2 way valve after it. (The 2 way valve is installed in order to prevent undesired low water flow through the collectors caused by the main filtration pump).

Public pool basic plumbing 2



When there is a need for total separation between the solar piping and the filtration piping it is advisable to pump the water to the collectors by an independent pump that takes the water directly from the pool and returns the heated water directly to the pool.

8 Operation

Turning the system on (manual systems)

1. Turn the pool pump off.
2. Turn the 2-way valve to the “closed” position.

Solar ON

3. Turn the pool pump on.
4. Set the pool pump timer, if used, so that the pump will run when sun is shining on the solar panels. Usually 8:00 AM to 4:00 PM, but this will vary with geographic location and time of year.
5. Wait 2-3 minutes and check in the pool inlets that slightly warmer water is entering the pool through the water inlet.

Important: During the cooler months of the year it is essential that the pool surface be covered at night with a “pool blanket” to minimize heat loss. Low night time temperatures may lower the water temperature more than the solar system can recover during the day.

Turning the system off (manual systems)

1. Turn the pool pump off.
2. Turn the 2-way valve to the “open” position.

Solar OFF

3. Turn the pool pump on to filter the pool as needed.

9 Troubleshooting

This troubleshooting section will help you identify and solve any problems as quickly as possible.

There are air bubbles in the pool when the solar heater is operating

Diagnosis #1: There may be air coming into the pump through an air leak on the suction side of the pump due to the pump working harder to move the water through the solar system.

Pump Answers:

1. Check that the pump trap lid is secured tightly.
2. Check the "O" ring on the pump trap lid. Clean, lubricate or replace as needed.
3. If you have a suction type pool cleaner, remove it. If this eliminates the air bubbles, use it only when the solar system is off.
4. If the pump has a clear lid and you can see air bubbles in the trap, use a garden hose to run water over the lid, and each joint individually, to see if the air bubbles will clear up. If the lid is opaque, listen to pump noise to check that it is operating smoothly. Repair any air leaks.

Diagnosis #2: If the vacuum breaker is installed on the roof, there may not be enough water pressure in the system to keep the vacuum relief valve closed, so air could be drawn into the water as it flows through the valve.

Install Answers:

1. Check that the filter is clean. Backwash to reduce pressure.
2. Locate the vacuum breaker on the feed line and put a solid end cap at the end of the upper header where the vacuum relief was located.
3. Install a ball valve on the return line and throttle back the flow to produce more backpressure on the system.

Some of the solar panels are warm to the touch while others are cool

Diagnosis: There is not equal flow through all of the panels. Warm panels indicate low water flow.

Pump Answers:

1. Check that the filter is clean. Backwash to reduce pressure.

2. The pump may not be providing enough water to the solar system. Check water flow using a flow meter. Increase pump power to maintain recommended flow.

3. If there is a suction type cleaner in the pool, disconnect it. If this eliminates the problem, use it only when the solar system is off.

Install Answers:

1. If the system is a single row array and there is adequate flow, use a Ball Valve on the return line to throttle the flow back to increase backpressure on the system. This will even out the flow through the panels. If the array contains more panels than the maximum recommended on Page 11 of this manual, change the array to a double row or single row split feed as shown in on Page 12.

2. If the system is a double row or a single row split feed array and there is adequate flow, install a Ball Valve on the return side of the set of panels that are the coolest to throttle back the flow through these panels and force more water through the warmer panels. If any section of the array contains more panels than the maximum recommended on Page 11 of this manual, make changes as needed to correct this.

Water coming from the system is not as warm as it should be

Diagnosis #1: The water is flowing too fast through the panels

Install Answer:

Test water flow rate. Water flow through a single panel should be less than 2500 liters per hour. Adjust the Two-Way Valve to by-pass some of the water.

Diagnosis #2: Seasonal normal operation

Answer:

In the cooler months of the year, or on cool or partly cloudy days, the temperature rise through the panels may only be 2° or 3° C. Use the back of your hand to feel the water temperature difference at the pool return inlet.

10

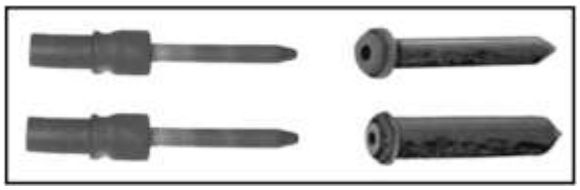
Replacing a damaged riser tube

In the event of a riser getting damaged and leaking, one of the advantages of Heliocol collectors is the ease with which the leaking riser can be removed, the leak repaired, and a replacement riser attached to maintain the uniform appearance of the panel.

A damaged riser is replaced using a Heliocol riser repair kit (consisting of two rubber sleeves and two plastic plugs), and the broken riser itself.

Note: Water does not run through the replacement riser. The purpose of the replacement is only to maintain the uniform appearance of the panel.

Figure B1: Heliocol riser repair plug (left) and sleeve (right)



Cat. No.1202910 for panel **with** header **ribs**

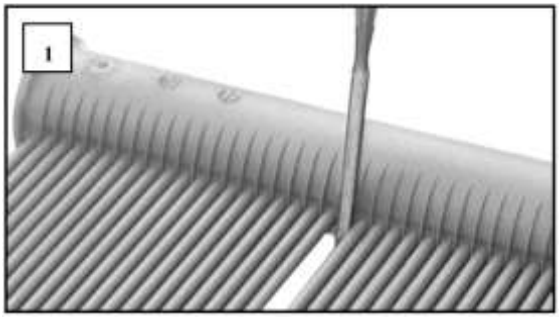
Cat. No.1203910 for panel **without** header **ribs**

Figure B2: Heliocol riser repair tools:

Specific Heliocol repair handle
Cat. No. 1202880

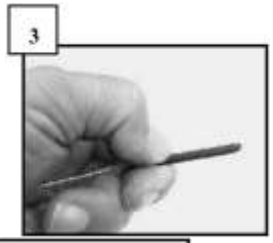
7 mm Chisel

Important: Do not use a chisel more than 7mm wide, as you might damage the adjacent risers as you remove the broken riser.



1 Using a 7 mm chisel, and holding the flat side of the chisel towards the header, cut through the damaged riser, flush against the header. A round hole is created in the manifold header.

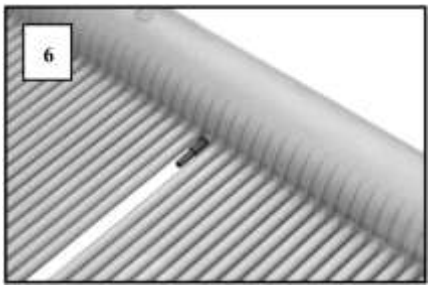
Repeat at other end of riser and save the removed riser for use in the repair.



2 Spray the rubber sleeve with silicon spray and pull it over the small metal pin of the Heliocol repair handle.

3 Stretch and relax the rubber sleeve couple of times over the metal pin.

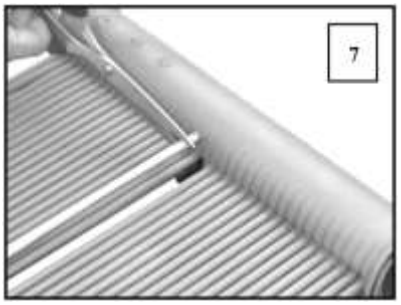
4 Using the repair handle gently push the rubber sleeve into one of the holes created by the removal of the riser, until only the head is showing.

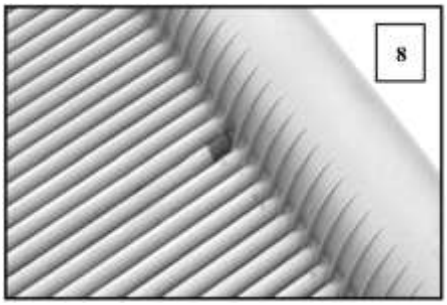


5 Push a plastic repair plug all the way down into the repair sleeve. You may use the rear part of the handle to push it firmly into the sleeve.

6 The hole is plugged and will not leak.

Repeat steps 4 and 5 for the hole in the header at the other end of the panel.





7 Cut the removed riser so it fits exactly between the broad heads of the plastic pins.

8 Fit the riser onto the stubs of the two repair plugs.

The panel is now leak free while its uniform appearance is restored.