CoolSky

Apricus Solar Collectors
Installation Manual

CoolSky Ltd

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TABLE OF CONTENTS

Solar Thermal Introduction

Introduction

CoolSky Ltd. are distributors in the U.K. and Ireland for the Apricus range of Evacuated Tube Solar Thermal Collectors. Since their formation in 2002, Apricus have quickly established themselves as a global company with offices in USA, France and Australia with sales in over 30 countries worldwide.

Apricus have a modern manufacturing facility that includes a 6,500 m^2 factory floor, administration offices and an R&D Centre.

ITW Universität Stuttgart 011-7S161 R

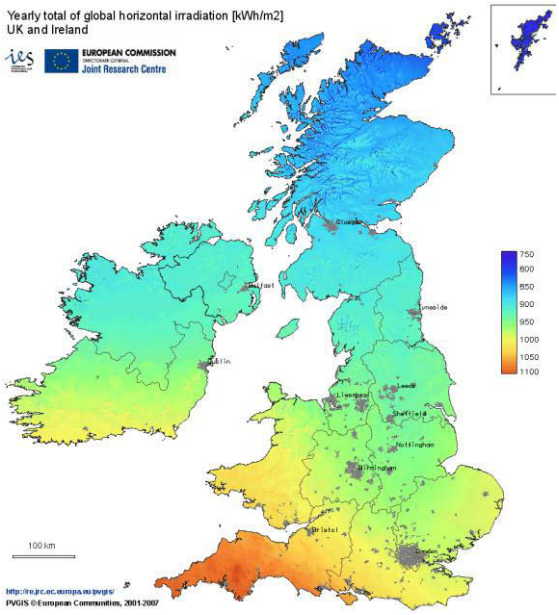
Apricus Collectors conform to the European Standard EN12975 and carry the European SolarKeymark Certification (*Licence No. 011-7S161R*) as a mark of their quality, reliability and performance.

SolarKeymark is considered to be equivalent to MCS Product Certification thereby qualifying the products for financial assistance under various funded schemes where available.

All Apricus collectors, components and packaging have been carefully designed so that they can be efficiently recycled at end-of-life.

Solar Energy

Solar Energy is the planet's most abundant source of energy with the added benefit that it is both clean and free.



(Source : EU Commission Joint Research Centre)

Whilst the UK and Ireland are considered to have mild and temperate climates there are parts of the UK that can receive annual radiation levels equivalent to 65% of the radiation that is received in places like Madrid, Spain, making both the UK and Ireland suitable locations for Evacuated Tube Solar Thermal Collectors.

The Apricus Evacuated Tube Solar Collector provides an efficient solution for the capture of Solar Radiation and is ideal for use in UK and Irish climatic conditions. Although the peak solar radiation period in the UK and Ireland is in the months from May through to August, the Apricus Evacuated Tube Solar Collectors are highly efficient and able to harness the energy of the sun throughout the year and to also provide a useful contribution to heating during the off-peak months.

Evacuated Tube Solar Thermal Collectors are able to capture the available Solar Energy and then transfer it as Thermal Energy to the water heating system, thereby raising the temperature in the hot water storage cylinder, and offsetting the reliance to on alternative fuels (such as coal, gas, oil or electric) to provide hot water. Up to 70% of the domestic hot water requirements can be met by the Apricus Solar Collectors.

Since solar radiation levels depend upon both the season and the daily weather conditions it is always necessary to incorporate a back-up water heater (typically standard fossil fuel boilers or electric immersion heaters) to ensure there is a sufficient supply of hot water all year round.

Key Components of the Solar Thermal System

Solar Energy is collected when the sunlight strikes the black selective absorber contained inside the evacuated tubes of the Solar Collector.

Each tube contains a copper heat-pipe that is in contact with the absorber. The heat-pipe contains a small quantity of water under a vacuum environment that allows the water to start boiling at temperatures as low as 30°C. The water vapour generated when boiling rapidly rises to the top of the heat pipe where it condenses and transfers its thermal energy to the condenser and into the copper header pipe within the manifold.

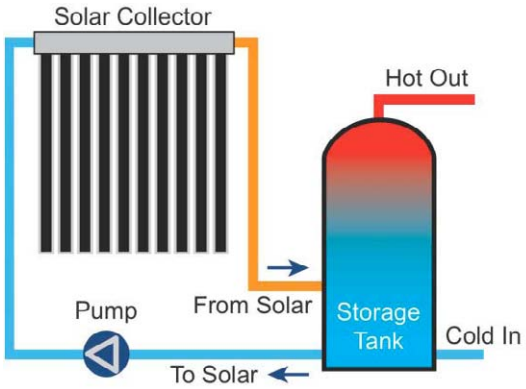


Fig. 2 Schematic showing the basic layout of a simple solar thermal system.

The condensed fluid then flows back down the heat pipe and is re-heated, thereby restarting the thermal cycle again.

A circulating pump moves the heat transfer fluid (a propylene-glycol anti-freeze mixture) through the copper header pipe within the manifold and back to the storage cylinder. A solar heat exchanger coil within the storage cylinder transfers the thermal energy from the heat transfer fluid into the water within the storage cylinder. The cooled fluid then returns to the collector manifold to be re-heated.
The operation of the solar loop is controlled with a temperature differential electronic controller. This ensures that solar fluid is only circulated in the solar loop when there is useful energy to transfer from the collector into the storage cylinder.

Back-up heating using a conventional fossil fuel boiler or electrical immersion should also be provided for periods when solar radiation is unable to meet the total hot water demand.

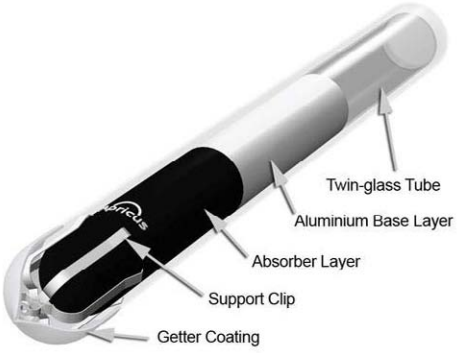
Apricus Collectors

The Apricus Collectors are available in 3 Standard Models as follows :

APSE-10	10 Tubes
APSE-20	20 Tubes
APSE-30	30 Tubes

All the Apricus Collectors are certified to the European SolarKeymark Scheme thereby ensuring the installer and end-user of the highest standards and quality in materials and manufacturing, which also qualifies the collectors for government funded schemes requiring MCS Certification.

The Apricus Solar Tube consists of a circular inner absorber tube that is coated with a selective absorber layer of Al/N on Al. This selective absorber provides each tube with a highly selective radiation absorbing surface, with typical absorption efficiencies of >92%. The absorber tube is encased within a strong borosilicate glass enclosure that is then placed under ultra-high vacuum conditions to ensure the ultimate performance in terms of thermal insulation.



A getter coating at the bottom of the tube is used to maintain the ultra-high vacuum level within the tube throughout its operational lifetime and to ensure maximum collector efficiency is achieved.

Apricus tubes have a round absorber surface within the tube, and hence, irradiation from the sun always strikes the absorber surface in a perpendicular direction. This ensures optimum collector performance whatever the time of day, morning, mid-day or afternoon. This is reflected in the excellent IAM (Incident Angle Modifier) figures for the Apricus Collectors which makes them the ideal choice of collector for the typical UK and Irish weather conditions where peak solar radiation is not guaranteed to be at mid-day.

Technical Specification of The Apricus Collector Range

Model :	**APRICUS APSE-10**
Aperture Area :	0.94 m^2
Gross Area :	1.56 m^2
Weight (Dry) :	35kg
Fluid Capacity :	0.2litres
Max Pressure :	8 bar
Stagnation Temp:	219°C
Absorption :	92%
Emission :	8%
Width x Length :	796 x 2005 mm
Height :	156 mm

Performance Figures :

η_0	62.6 %
a_1	1.595
a_2	0.013

Model :	**APRICUS APSE-30**
Aperture Area :	2.82 m^2
Gross Area :	4.35 m^2
Weight (Dry) :	95 kg
Fluid Capacity :	0.71 litres
Max Pressure :	8 bar
Stagnation Temp :	219°C
Absorption :	92%
Emission :	8%
Width x Length :	2196 x 2005 mm
Height :	156 mm

Performance Figures :

η_0	68.7 %
a_1	1.505
a_2	0.011

Model :	**APRICUS APSE-20**
Aperture Area :	1.88 m^2
Gross Area :	2.96 m^2
Weight (Dry) :	64 kg
Fluid Capacity :	0.52 litres
Max Pressure :	8 bar
Stagnation Temp :	219°C
Absorption :	92%
Emission :	8%
Width x Length :	1496 x 2005 mm
Height :	156 mm

Performance Figures :

η_0	62.6 %
a_1	1.595
a_2	0.013

Key Features

Manifold :

Material : Anodised Aluminium

Insulation :

Material : 50mm Glass Wool

Conductivity : 0.043 W/mK

Tubes :

Glass : 1.8mm Thick Borosilicate

Absorber : Al-N on Al

Rubber Components :

Material : HTV (UV Stable) Silicone

Max Temp. : 300 °C

Storage Cylinders

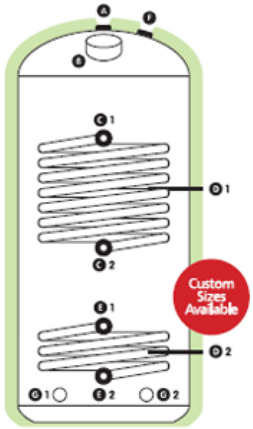
Both copper and stainless steel storage cylinders are available from CoolSky. These cylinders are specially designed and optimised for Solar Systems, comply with UK regulations, and are fully compatible with the Apricus Solar Collectors. Options are available for both vented and unvented systems.

As an added service we are also able to provide cylinders that are designed and manufactured to bespoke requirements.

Vented Solar Cylinders

The Standard Easy-Fit Vented Copper Cylinders are available in either twin coil or triple coil configurations and are specifically designed to work in conjunction with the domestic heating system.

Twin Coil Solar Cylinder



One or two coils are designed to transfer heat from an independent heating source, (eg. transferring heat from a central heating boiler or solid fuel boiler to the water in the solar cylinder) and the solar coil, which is manufactured from high efficiency finned tubes with a large surface area, to transfer heat from the solar panels into the solar hot water cylinder with maximum efficiency.

We are also able to supply custom sizes upon request giving you total flexibility in the design of your complete system. In general, solar cylinders are sized to suit the number of occupants and the solar thermal panel surface area.

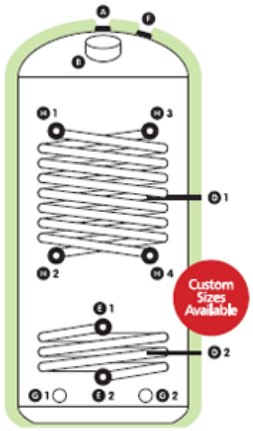
Nominal Diameters :

400 mm – Only Twin Coil Available
450 mm – Twin or Triple Coil
500 mm – Twin or Triple Coil
600 mm – Twin or Triple Coil

Nominal Heights :

1050 mm, 1200 mm, 1300 mm
1400 mm & 1800 mm

Triple Coil Solar Cylinder



Unvented Solar Cylinders

The Standard Easy-Fit Unvented Stainless Steel Cylinders are available in a twin coil

configuration and are specifically designed to work in conjunction with the domestic heating system.

Manufactured from Duplex Stainless Steel, these cylinders provide fast reheat and recovery and high value insulation. In addition, for installers they are also light and easy to handle

Standard Features:

- Duplex Stainless Steel
- 25 Year Guarantee
- Fast Reheat/Recovery
- High Value Insulation

Nominal Diameter :

545 mm – Only Twin Coil Available

Nominal Heights :

1102 mm, 1290 mm, 1478 mm,
1782 mm, 2041 mm

Pressure & Temperature Relief Valve (PTRV)

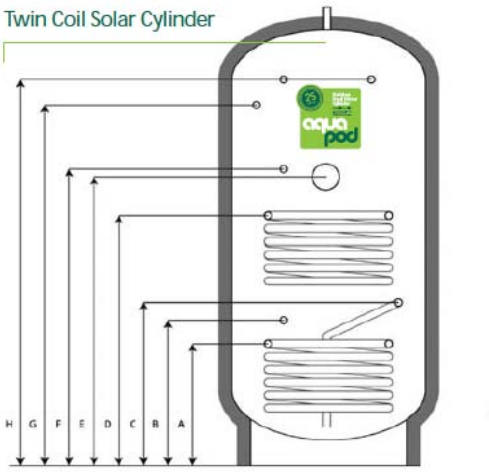
The storage tank must be fitted with a PTRV. All tanks should be supplied as standard with an approved valve.

Cool Tip

Rule of Thumb for sizing storage cylinder in domestic installations:

100 litres per m^2

Aperture Area of Collector



Type	Cap.	Hgt.	Dia.	A Coil	B B.Stat	C Cold	D T.Coil	E I.Heat	F Stat	G Soc.R	H T&P
TC150	150L	1102	545	299	354	399	651	702	706	N/A	890
TC180	180L	1290	545	299	354	399	675	734	738	N/A	1078
TC210	210L	1478	545	374	429	474	789	839	843	1159	1266
TC250	250L	1782	545	374	429	474	863	914	918	1409	1516
TC300	300L	2041	545	374	429	474	989	1039	1043	1609	1829

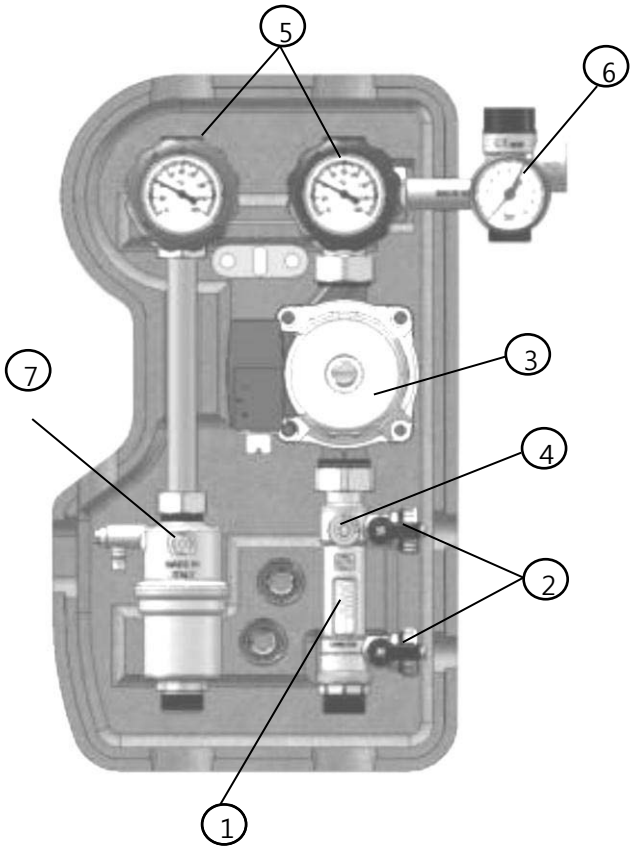
Building Regulations

The installation of unvented hot water cylinder for domestic applications is regulated under Building Regulation G3 for England and Wales, Technical Standard P3 for Scotland, Building Regulation P5 for Northern Ireland and Technical Guidance Document L for the Republic of Ireland. All local, relevant and up-to-date regulations must be adhered to by the installer. An example schematic safety control layout for a solar installation to comply with Building Regulation G3 (England and Wales) is given in the CIBSE Solar Heating Design and Installation Guide.

Solar Pumping Station

A Pumping Station is required in the Solar Loop for the circulation of propylene glycol heat transfer fluid around the solar loop. The Pumping Stations are provided with the following key features :

1. Flowmeter, flow rate regulation and graduated scale regulation gauge 2-12 litre/min.
2. Isolation valves for filling/flushing of the unit. Connections ¾"M with safety chain and tap.
3. Circulating Pump - WILO solar STAR ST15-6ECO, connections 1"BSP - 130mm class. TF110, VDE, CE.
4. Return side isolation valve DN20, with integrated bracket. Connection ¾"M always open on one side.
5. Integrated high temperature check valves. Closure at 90° and opening at 45°. Check valve opening 2kPa (200mm c.a.)
6. Pressure gauge with integrated safety relief valve (typ. 6Bar) with discharge connection point for isolation valve and expansion vessel.
7. Air stop device with manual integrated vent.



Model Variations :

The CoolSky range of Pumping Stations are available with either ¾" Flat Face Male Gasket Fittings or 22mm Female Compression Fittings.

A High Head (8m) Pump Version is also available for larger installations.

Pump Sizing

Sizing of the Solar Pump

The standard CoolSky Twin Line Pumping station is supplied with a 3-Speed WILO ST 15/6 Eco Pump (6m head) as standard. This is suitable for most domestic installations with the pump speed selected to suit the pressure drop of the piping. Speed 1 is generally suitable for a short pipe run, such as on a single-storey house. Speed 3 can normally service a 3-storey, 90 collector pressurized system.

If the pipe run is very long or there are more than 90 tubes in the collector array, a larger pump may be needed. For these installations CoolSky supply a Twin Line Pumping station with a 3-Speed WILO ST 15/8 High Head Pump (8m head).

If multiple banks of collectors are installed in parallel, the head loss should be calculated based on the longest pipe run through a single bank of collectors and, then, the pump can be sized to meet the total flow rate requirements.

Please Note that Drain-back Systems will typically require a larger rated pump.

Flow Meter

The CoolSky Pumping Staions include a flow meter as standard to ensure that flow rates are at suitable levels and can be monitored. The flow meter includes a restrictor valve allowing the flow to be adjusted accordingly.

Flow Rate

A suitable flow rate range for each 30 tube collector is in the range of 1.5 to 3.0 litres per minute.

Cool Tip

Set the Flow Rate through the collector array to :

0.1 litre / minute / tube

That is :

1 litre / minute for 10-tubes

2 litres / minute for 20-tubes

3 litres / minute for 30-tubes

Solar Expansion Vessels

CoolSky offer a range of different sizes of Zilmet Solar Expansion vessels. These should be sized according to match the requirements of the system to which they are connected.

(note : solar expansion vessels should be installed with the hydraulic connection to the top as this will reduce heat transfer into the vessel, as shown above)

The Solar Expansion Vessels include 12, 18 and 24 litre versions which have been specially designed for solar. Other sizes are available upon request.

The Membrane

Inside the expansion vessel there is a special Zilan E solar membrane structured as a bag membrane that separates the gas from the solar liquid. The development of the membrane is a result from long term Zilmet field experience in the installation of vessels in thermal solar systems.

The membrane is stable with the Pre-Mixed Propylene-Glycol within the solar loop up to 50% mixtures and has a max. working temperature of 110° C. The vessel can accommodate short peaks of 130°C glycol temperature.

The Zilan E solar membrane is also less likely to trap air and consequently, there is a lower likelihood of corrosion damage to the steel vessel.

Expansion Vessels are manufactured in accordance with the PED 97/23/CE and EN13831 directives, which mean that they are fit for use in closed solar energy heating systems according to DIN 4757 and EN12977.

Cool Tip

The Cold-Fill Pressure of the Solar System should be :

1.3 + (0.1 x Static Height)

Where the Static Height is in Meters.

Expansion Vessel Pressure should be re-set to 0.3 Bar less than the Cold Fill Pressure.

Expansion Vessel Technical Specification

Max. Operating Pressure:	6bar
Membrane Temperature:	10° - +100°C
System Temperature:	-10° - +100°C
Factory pre-charge:	2.5 bar ±20%
Nominal volume:	12, 18 & 24 L
Colour:	White

Expansion Vessel Connection Kit

CoolSky also provide an expansion vessel connection kit to connect the expansion vessel to the safety group on the pumping station. Each kit includes a wall fixing bracket and a self-closing system isolation valve (so that the vessel can be removed for maintenance without draining the fluid from the system and to facilitate periodic gas charge checks).

A pre-formed stainless steel flexible hose is also provided to connect the vessel to the system at the connection point provided on the CoolSky Solar Pumping Station.

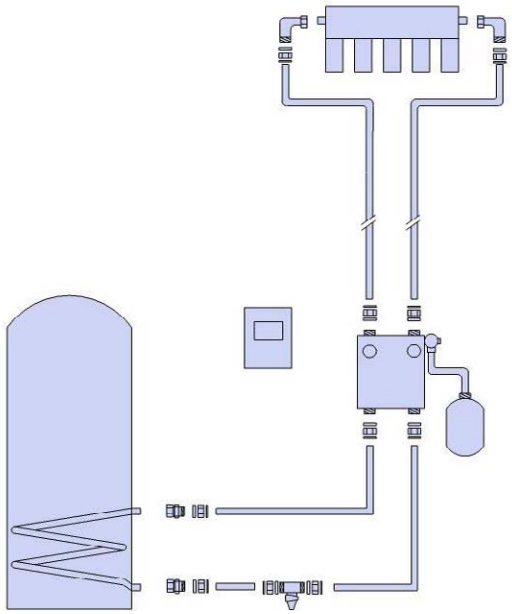
Cool Tip

Always check the internal pressure of the Expansion Vessel before fitting and reset to 0.3 bar lower than the intended cold-fill pressure of the Solar Loop.

It is recommended that the Pumping Station and Expansion Vessel are located as far hydraulically away in the Solar Loop from the Solar Collector as is practically possible. This is to protect the Pumping Station and Expansion Vessel from the very high temperatures (i.e. >200 °C) that can be generated by a Vacuum Tube Collector under stagnation conditions.

Mounting the Expansion Vessel

Always mount solar vessels in a vertical position and recognised best practice is to connect to the provided connection port on the pump station. Where possible, mount below the pump station to negate heat transfer.



Avoid mounting in close proximity to the solar collector where temperatures can exceed 130°C. In cases where this cannot be avoided, it is highly recommended that the expansion vessel be installed in conjunction with a heat protecting 'intermediate' vessel.

Intermediate Vessels

Intermediate vessels are also available and are recommended on solar thermal systems where it is likely that temperatures within the system will exceed the maximum allowable working temperature of the expansion vessel

or where the expansion vessel is in close proximity to the solar collector.

It is particularly important that an intermediate vessel is installed on systems where the volume of the collectors exceeds the volume within the flow and return pipework. This is because during stagnation periods, the very hot solar fluid in the collectors can reach vaporisation point. If this occurs, the very hot solar fluid is forced out by the vapour, into the expansion vessel.

Intermediate vessels have inlet/outlet connections and are installed just before the main expansion vessel (as shown above). The heat sink that the intermediate vessel provides, reduces the working temperature at the diaphragm, and hence considerably extends the working life of the expansion vessel.

Sizing the Expansion Vessel

To size an Expansion Vessel for a Solar Application the following equation can be used :

$$V_{EV} = \frac{(V_{SS} + n \cdot V_{COL} + \beta \cdot V_{SYS}) \cdot (P_{MAX} + 1)}{P_{MAX} - P_{EV}}$$

Where

V_{EV} = Nominal Expansion Vessel Size [L]

V_{SYS} = Total Volume of System [L]

V_{SS} = Volume of Safety Water Seal [L]
= 0.005 x V_{SYS}
or
= 3 Litres
(whichever of above is greater)

β = Solar Fluid Expansion Coefficient
= 0.13 for CoolSky Fluid

V_{COL} = Volume of Collector
= 0.3 Litres for AP-10
= 0.5 Litres for AP-20
= 0.7 Litres for AP-30

n = Number of Collectors

P_{SV} = Pressure Relief Valve Setting
= 6 Bar as CoolSky Standard

P_{MAX} = Allowable Max Pressure in Bar
= P_{SV} – (0.1 x P_{SV})
= 5.4 Bar (for a 6 Bar PRV)

H_{ST} = Static Height of System
= Height of Collector from Pump

PEV = Gas Pressure of Expansion Vessel
= 1 + (0.1 x H_{ST})

CoolSky recommend that an additional safety factor of 1.5 is applied to the V_{EV} value to account for the possibility of steam in the solar loop.

Examples of typical domestic Expansion Tank Capacities are given in the table below.

Apricus AP-30 Collector

Aperture Area [m^2]	System Volume [Litres]	Static Head [m]	Expansion Tank [Litres]
3	6.9	5	18
		10	18
6	7.6	5	18
		10	18
9	8.3	5	18
		10	18
12	9.0	5	18
		10	24

The above are based upon a system using the Apricus AP-30 Collector with 20 meters of DN16 Flexible S/S Pipework and a Heat Exchanger with 2 litre capacity.

The CoolSky Technical Design Team can provide assistance and support for the sizing of Solar Expansion Vessels for your installation if required.

Solar Thermal Anti-Freeze

CoolSky recommend that a Solar Thermal Anti-Freeze Fluid is 'always' used in Solar Collector Installations. CoolSky supply a pre-mixed (40% propylene glycol, 60% water) thermal transfer fluid with additional corrosion inhibitors for use with the Apricus Solar Collectors. The fluid is supplied in 20 litre drums.

Only Thermal Fluids that are formulated for use with High Performance Evacuated Tube Solar Collectors should be used, as these have special liquid corrosion inhibitors that are able to vaporise and condense effectively during normal collector operation.

The fluid is specially developed for Evacuated Tube Solar Thermal collectors and provides frost protection to -28°C.

Protective goggles and rubber gloves should be used when handling the thermal fluid.
A full Material Safety Data Sheet (MSDS) is available from CoolSky Ltd. upon request.

Disposal of the fluid should be in accordance with local regulations.

Although some Solar Controllers are provided with a Frost Protect Function it must be highlighted that this only functions when there is electrical power provided to the controller and pumps. In the UK and Ireland it is not unusual for extremely cold weather conditions to be accompanied by power outages due to falling power lines, thereby rendering the Frost Protection Function ineffective. Only the use of a suitable anti-freeze fluid will protect the solar collector from freezing in the combined conditions of extreme cold and power outage.

Apricus Evacuated tubes are not susceptible to damage in cold weather, and Apricus heat pipes are protected against damage that could result from the freezing of the water inside by the addition of a special frost-protection additive.

Within the manifold and pipework of the solar loop a suitable Solar Anti-Freeze fluid must be used. Contact CoolSky for details of suitable Anti-Freeze Fluids.

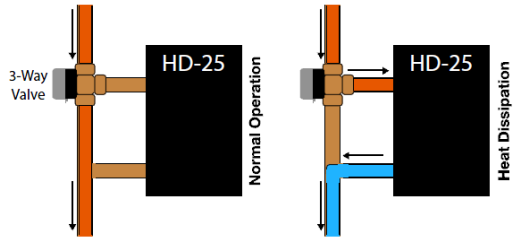
WARNING:

Failure to implement effective (and fail-safe) freeze protection may result in rupture of piping and substantial property damage.

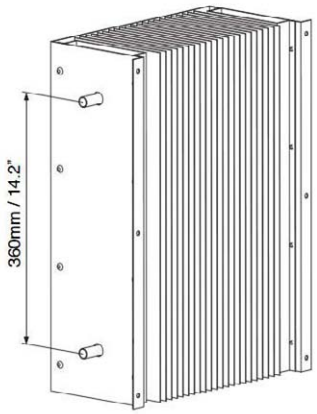
✖ *Freeze related damage is not eligible for warranty claims.*

Solar Heat Dissipater

The Apricus HD-25 is an air to water radiator designed to dissipate the energy produced by one AP-30 collector.



Heat dissipation may be necessary when solar thermal systems are designed for space heating applications which may produce more energy than is needed during warmer seasons, or for systems where there is an irregular or low summer demand, for example, schools, holiday homes and sports clubs.



The Apricus HD-25 is an ideal solution to protect from excessive overheating and can prevent premature ageing of the heat-transfer fluids used in the solar loop.

Materials of Construction

Piping:	Copper (Ag-Zn-Cu brazed)
Fins:	3A21 Grade Aluminium
Case:	3A21 Grade Aluminium

Dimensions

Height:	500mm
Depth:	172mm
Width:	375mm
Heat Transfer Area:	2.8 m^2
Gross Weight:	6.6 kg
Inlet/Outlet Pipe:	Ø15 mm x 1.0mm

Heat Loss Performance

When ΔT . 40°C, heat dissipation ≥1.3kW

For optimal performance ensure good natural air circulation.

Installation Guidelines

Max Flow Rage:	15L/min
Ideal Location:	Good natural air flow
Transfer Liquid:	Propylene Glycol (≤50%)

Safety Valve Discharge Container

A high temperature discharge container has specially designed to capture any propylene glycol fluid that is discharged from the Pressure Relief Vessel on the Solar Pumping Station and to allow its recovery during regular maintenance - neatly avoiding the issues of potential damage to those areas surrounding the valve.

The unit is manufactured from high temperature grade plastic material that is suitable for solar systems and up to 160°C short bursts of glycol/steam. The captured fluid is visible through the opaque tank which is supplied complete with a drain valve.

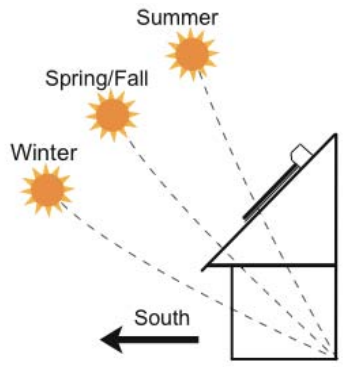
Technical Specification

Capacity	9.6 litre
Drain valve	integral
Size	300 x 270 x 130mm
Clearance required	440mm high
Construction	Plastic PE
Ambient temp	-5° - +50°C
Storage	-10° - +60°C
Short term discharge	160°C

Sizing and Designing your Solar System

When starting to design your solar system, the first issues to consider are regarding the installation site and the practicalities of installing the solar collectors.

This section will provide you with detailed guidelines about assessing the suitability of any given site for the installation of the Solar Collector.



Standard System Designs

CoolSky have developed a standard set of system designs, which represent the most commonly installed configurations in the UK and Ireland. We recommend adhering to these system designs. Any modifications to the design should be checked by a qualified engineer.

When using these designs it is important prior to installation, to confirm that the designs meet any local regulations.

All systems must be installed by authorised persons. Upon completion of the installation, the system may also need to be checked by a plumbing inspector prior to commissioning, depending upon local regulations.

Free Bespoke Design Service

The CoolSky Technical Design Team can also offer our customers a full bespoke design service. System designs and configurations for both small and large systems can be tailored to our customers particular requirements. Contact CoolSky for more details on our Free Design Service.

Collector Direction

Ideally the collector should face as close to due South as possible. A deviation of up to 15° to the East or West is acceptable and will have minimal effect on collector performance.

If installed due east or west, the solar collector output will be considerably reduced, with predominately morning output or afternoon output for each direction respectively. However, a dual collector option exists with one collector facing east and the second collector facing west. This is commonly referred to as an "East-West System".

NOTE: Installations at or near due East or West will mitigate the passive tracking effect of the round absorbers within the Apricus evacuative tubes. Collectors should not be installed facing a northerly direction.

Collector Orientation

The collector manifold is normally installed on the flat horizontal plane with the tubes pointing downwards from the manifold. The collector must not be installed up-side-down (tubes pointing upwards) or with tubes lying

horizontally, as the heat pipes will not function.

Drain Back Systems

In a drain-back configuration the collector must be positioned with 2cm of drop per meter.

Installation Angle

The solar collector must be installed at an angle of between 20-80º from horizontal to ensure optimal heat pipe operation. For optimum summer performance for Domestic Hot Water applications, as a rule of thumb the installation angle is typically set as :

Install Angle = 0.7 x Location Latitude

In areas prone to hail, a minimum angle of 45º is advisable. Similarly, in areas prone to high snow loads, 45º or higher is advisable to encourage the snow to fall off the collector surface.

Avoid Shade

Collectors should be located so that shading does not occur between 9am - 3pm which are the peak sun hours.

Partial shading due to small objects such as antennas and small flues is not a problem.

If installing multiple rows of collectors consider the shading of collectors on the row behind (especially in the winter).

Cool Tip

Rule of Thumb for Optimum Installation Angle

0.7 x Location Latitude

Location of Collector

The collector should be positioned as close as possible to the storage tank to avoid long pipe runs.

System Sizing

Domestic System Sizing

For residential domestic water heating applications basic "rules of thumb" exist that allow system sizes to be calculated using the methodology outlined below.

For space heating or commercial water heating system the sizing calculations are more complicated. The CoolSky Technical Design Team can assist our customers with a free design service for these systems. Using special state-of-the-art Solar Thermal design packages we can assist in the design and optimisation of all Solar Thermal systems no matter what the size.

How much hot water is needed?

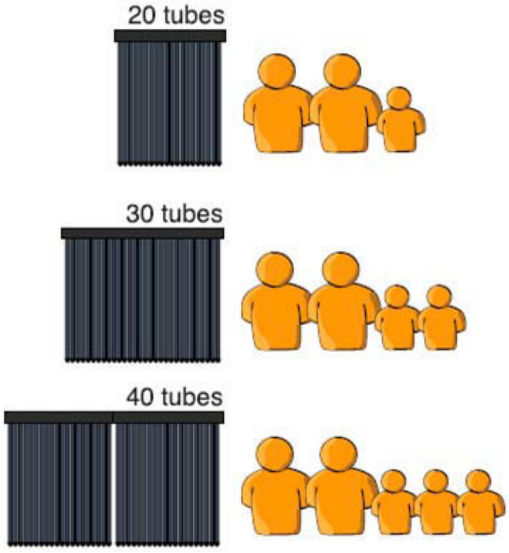
Ideally the exact daily hot water demand should be provided through metering. However, as this is not always available, the daily demand can be estimated using the following guidelines :

Consumption Demand	Liters of Hot Water at 60°C per person
LOW	15
MEDIUM	30
HIGH	60

Guidelines for Domestic Hot Water Useage

A general Rule of Thumb for UK / Ireland is to assume a requirement of 50 litres of Hot Water per person per day.

The graphic below shows typical sizing guidelines for collectors when used for Domestic Hot Water production in the UK and Ireland.



Guidelines for Collectors Sizing to Match User Demand for Domestic Hot Water

Cool Tip

Rule of Thumb to Estimate Hot Water Demand at 60 □C in UK and Ireland :

50 litres per person per day

Commercial Collector Sizing

Sizing a commercial system usually requires the use of professional modelling software. CoolSky can offer a free design service to our customers for these jobs.

The table below gives guidelines to typical Hot Water Demands in commercial applications.

Type of Building	Max. Liters of Hot Water at 60°C per person
Restaurant	6
Factory	15
Offices	14
Hotel 5*	136
Hotel (Avg)	114
Sports Facility	40
Hospital	128
Holiday Home	50
Camp Site	40

Typical Hot Water Demands in Commercial Type Properties.

Sizing the Solar Cylinder

Domestic Sizing

The storage cylinder sizes for domestic solar thermal installations should be sized according to the following minimum guidelines :

20 Tubes = 200 Liter cylinder

30 Tubes = 300 Liter cylinder

40 Tubes = 400 Liter cylinder

60 Tubes = 600 Liter cylinder

Cool Tip

Rule of Thumb to Size the Storage Cylinder :

10 litres per Solar Tube

The storage capacity can be a single tank or multiple tanks plumbed in parallel.

Using a smaller capacity tank will lead to the system reaching maximum temperature sooner, which will often result in wasted and/or uncollected energy.

If the installed collector area exceeds the storage capacity of the cylinder there will be wasted energy and excess heat in sunny weather. Letting the collector stagnate is an acceptable means of preventing excessive tank temperatures during summer, but stagnation periods should be minimised in frequency and duration for the sake of overall system efficiency. Otherwise, the longevity of the evacuated tubes may be compromised by more rapidly reducing the vacuum level.

Commercial Cylinder Sizing

Sizing storage for commercial applications is more complex than residential sizing and requires a detailed evaluation of hot water usage patterns.

Commercial applications are too varied in demand, peak demand, required output temp, etc. for set, rules to apply. Hot water usage patterns and the total hot water demand should both be considered. Use of modeling software is strongly advised when designing Commercial Systems and this is an area where CoolSky can provide system designs expertise to our customers.

Pipe Type and Size

Pipe Material

The solar collector loop can get very hot (i.e. 200°C under stagnation conditions) and therefore the only recommended material choices are copper (hard or soft coiled) or corrugated flexible stainless steel pipe.

Plastic Pipe (PEX) or Galvanised Pipe should 'NEVER' be used in any part of the Solar Loop within a Solar Thermal Collector System.

Pipe Size

When selecting the size of the pipe for the solar loop there are two main issues to be taken into account: flow rate and pressure drop

These two factors are closely related; a higher pressure drop will reduce the flow rate.

Pressure drop is increased with a smaller diameter pipe, as well as the presence of bends, elbows and other components that will restrict the flow of the water such as corrugated stainless steel piping.

A relatively direct, unobstructed flow path is highly desirable.

If there is the possibility that additional collectors will be added to the system in the future then it is recommended that a lager pipe diameter is used to accommodate the future system expansion / upgrade.

Number of Tubes	Pipe Size Cu / SS
10-40	15mm / DN16
50-90	22mm / DN20
90-240	25mm / DN25

Guidelines showing pipe sizing for typical domestic installations

Securing Pipes

Pipes must be secured in place with suitable brackets, straps, etc. according to plumbing code requirements for material and pipe diameter and to prevent vibration and placing stress on system components.

Internal Piping

Extra care must be taken to avoid any piping leaks inside the building. Avoid joints in attic or overhead spaces that could cause significant property damage if they were to leak. The CoolSky Standard Systems have been designed to minimize the number of hydraulic connections and we recommend the use of Flat Face gasket seals for the hydraulic connections where possible.

External Piping

Long external pipe runs should be avoided where possible. Pre-insulated pipes should have a sheath to protect the insulation from UV degradation.

Stagnation & Overheating

What is Stagnation?

Stagnation refers to the condition that occurs whenever the pump stops running. This could be due to pump failure, power outage or most commonly, as the result of a max tank temperature protection feature setting on the controller.

During stagnation, the collector, unable to actively dump heat, will continue to rise in temperature until the heat loss from the collector and piping equals the heat being absorbed. In strong sunlight with high ambient temperatures, the collector can reach peak stagnation temperatures from 160-220˚C. Hence, components that may be exposed to these high temperatures such as valves, plumbing or insulation should be suitably rated.

Pressure Loss with Height

Even though a system might be a closed loop and pressurized, there is always some pressure loss caused by height. This is extremely important to understand when deciding the system pressure. The loss of pressure is about 0.1 bar per vertical meter.

A low system pressure at the collector can result in bubbles (vapour) forming within the heat transfer fluid due to a lowered fluid boiling temperature. These bubbles can collect in high points in the solar loop piping, especially within the collector itself, and cause air locks in the system that will result in stagnation, because the pump does not have the power to push fluid through vapour pressure.

Size System to Avoid Overheating

The system should be sized so that overheating of the tank is difficult to achieve in a single day, even during hot, sunny periods.

For properly sized open and closed loop systems with suitable heat transfer fluid, it is acceptable for the system design to allow the solar collector to stagnate (i.e. stop the pump) from time-to-time to prevent overheating of the storage tank above the maximum cylinder set temperature. An expansion tank must be properly sized and installed to accept the increase in fluid volume due to thermal expansion and potential steam formation, in order to minimise or prevent release of fluid from the pressure relief valve.

If the system is over-sized, so that stagnation occurs often during summer months, the system must be able to stagnate repeatedly without damage or heat transfer fluid degradation. Using stagnation as a daily means of dealing with an oversized system is NOT recommended.

✖ *Gradual loss of vacuum in evacuated tubes over time during normal use is not eligible for warranty claims.*

Heat Dissipation

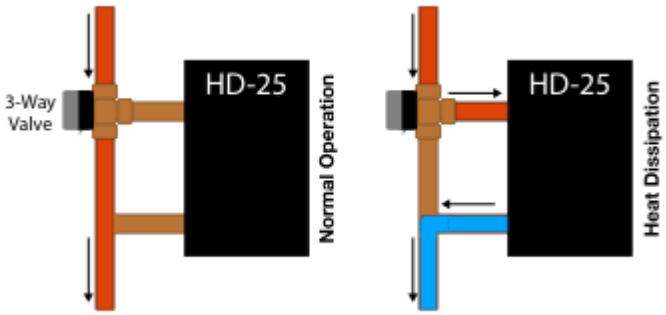
For systems designed for space heating that produce excessive summer heat output a heat dissipation loop should be installed.

CoolSky offer an Apricus kit specially designed for this purpose, the HD-25 Heat Dissipater. This unit can be installed above the pump station on the Flow Line from the

collector.

The unit is a finned fluid to air style radiator that can be used to dissipate heat from the system once the tank has reached the maximum temperature. The heat transfer fluid circulates through the copper pipe transferring heat to a set of large aluminum fins, which in turn dissipate heat to the surrounding air. Each HD-25 unit can dissipate up to 1.5kW or greater with active air flow and is suitable to dissipate the excess energy from one (1) Apricus 30-Tube Collector.

Note: The HD-25 is for external installation only.



Alternative Thermal Dumps

During the summer, heat can also be dumped into a hot-tub, jacuzzi, pool, towel radiator, large storage tank or underground thermal store.

Increased Angle Reduces Summer Output

Apart from installing a smaller collector, a good method of reducing summer heat output is to angle the collector for optimal winter absorption. This is achieved by installing the collector at an angle 15˚-20˚ above the latitude angle (so long as the collector remains within the recommended angles of 20˚ to 80˚). This angle corresponds closely to the angle of the sun in the sky during the winter, thus maximizing winter output. Conversely, during the summer when the sun is high in the sky, the relative surface area of the collector exposed to sunlight is reduced, lowering overall heat production by about 20-25%. This option is ideal for installations that use solar thermal for space heating. However, this depends upon the overall size of the collector array and a heat dissipation unit (or units) may still be required for larger arrays.

Connection of Multiple Collectors

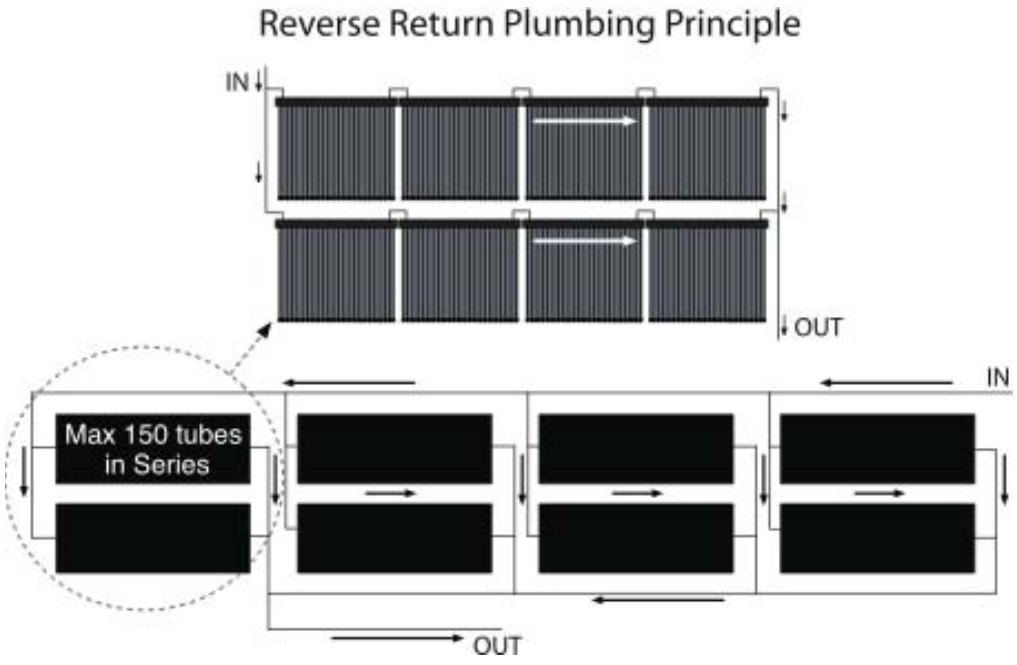
It is only recommended to connect up to 150 tubes in series (i.e. 5 x AP-30 Collectors with a maximum flow rate of 15 l/min through any Apricus Collector.

✖ *Damage to collectors due to heat expansion and copper header distortion is not eligible for warranty claims.*

Balancing Flow through Collectors

When connecting multiple banks of collectors (a bank being 1-5 x 30 tube collectors in series) in parallel, the flow rate through each bank MUST be equal. Otherwise, some collectors will run cold, due to higher flow rate while others will run hot, due to lack of flow. This is not an issue for a single bank of up to 150 tubes connected in series.

Reverse Return plumbing, or "first in - last out", is an effective piping configuration that helps to ensure balanced flow. However, there are affordable, high quality flow setters or circuit setters available and they are often a better choice, as they minimize pipe run length, costs and heat loss. Below is a diagram of reverse return piping.



Wind & Structural Loading

Components must be able to withstand environmental forces such as wind loading, snow loading, rain and hail. They must also be securely and positively fastened to the structure.

Collector wind loading must be considered and the resulting stress on attachment points thoroughly examined.

The standard Apricus Frame and Frame Kits are all designed to withstand wind speeds of up to 130 mph (208 km/h) without damage, which corresponds to the mid-range of Category 2 cyclones (US Saffir-Simpson scale).

Table A provides peak vertical pull forces and horizontal (pushing) forces for an AP-30 collector. These values represent both rear and frontal winds. The highest force of 180 kg on the middle, front foot at a 60° collector angle is actually from a frontal, and not rear, wind as it is trying to tip the collector backward.

Based on the figures provided in Table A, the weight of individual concrete blocks or the strength of fixation points requirements can be determined.

NOTE :

A safety factor of at least 1.2 should be used, or as specified by local building regulations, whichever is higher.

Round Foot	Peak Vertical Pull Load [kg]			Peak Forward-Backward Load [kg]		
	30° Angle	45° Angle	60° Angle	30° Angle	45° Angle	60° Angle
Front Middle	22	8	40	59	100	180
Front Left/Right	15	13	43	32	74	100
Rear Middle	38	85	122	18	31	66
Rear Left/Right	32	78	114	17	24	58
Combined Load	156	275	488	127	327	808

Table A – Showing the Peak Loads on the Collector Feet when subjected to wind speeds of 130 mph (208 km/h)

If using concrete blocks under the feet, connecting the blocks together, particularly front and rear, is advisable as it can help spread the load. This applies particularly to the middle legs which are exposed to the peak loads. Before ballasting the system with concrete or other weights, be aware of the total weight live and dead load capacity of the roof structure and determine if the roof can safely handle this attachment method.

Other mounting methods in high wind regions may require inspection and approval by a licensed engineer or the local building authority.

NOTE :

It is the responsibility of the installer to ensure that the frame mounting is of suitable strength.

✖ *Wind related frame and collector damage is not eligible for warranty claims.*

Snow Load

The UK and Ireland as a whole are not generally considered to be areas prone to heavy snow falls. However, in areas prone to heavy or regular snow falls, or where the accumulation of snow on the collector is of concern, the solar collectors can be installed at an angle of 50° or greater to promote snow sliding off the tubes. In addition, it is advisable to raise the front of the collector frame 15 to 20cm off the roof surface as this allows the collector to sit above moderate snow falls and allow snow to blow away from under the collector. A front track extension available from CoolSky can be used for this purpose.

Each tube is strong enough to withstand >50kg loading, but roof attachment points may need to be reinforced. Please refer to local regulations regarding snow loading precautions.

✖ *Snow loading damage to the collector is not eligible for warranty claims.*

Hail Resistance

The UK and Ireland are not considered to be areas subject to extreme hail conditions.

The Apricus tubes are manufactured from robust borosilicate glass and are able to handle significant impact stresses. Testing and impact stress modelling shows that the tubes are able to withstand impact from hail up to 25 mm in diameter, and even larger when installed at angle of 45˚ or greater.

In areas prone to hail over 20 mm in diameter, or where hail impact is of concern, it is recommended that the solar collector be installed at an angle of 45˚ or greater to provide optimum impact resistance.

In the unlikely case that a tube breaks, it can easily be replaced. The solar collector can still function properly with one or more broken tubes, however, a reduction in heat output will result (depending upon how many tubes are broken). A broken tube should be replaced by authorised persons only.

✖ *Hail related damage to the collector is not eligible for warranty claims.*

Lightning Protection

It is advisable to earth-ground the copper circulation loop of the collector to avoid lightning related damage, or electrical safety issues. It may also help to prevent galvanic corrosion of the copper pipe which can result in blue staining of basins/baths etc.

Ultraviolet (UV) degradation

Any components installed outside must be able to withstand UV radiation without significant degradation. Colour fading is common, but cracking, peeling and other severe degradation should not occur during the design-life of any component in the system.

Coastal Regions

Apricus collectors are manufactured using 439, 301 and 304 grade stainless steels for the solar collector frames, clips and fasteners. These grades of Stainless Steel are corrosion resistant to salt water, and therefore, installation of the collectors in costal regions is not normally an issue.

In some coastal regions, the combination of salt spray and living sea microbes can result in rapid corrosion of the stainless steel. In such cases please contact CoolSky for further advice.

✖ *Corrosion related damage is not eligible for warranty claims.*

Back-Up Heating Source

Solar Thermal Collector Systems normally require a back-up heating system. Typically this is the existing gas or oil boiler that is used to boost the Domestic Hot Water (DHW) supply on days when there is insufficient solar radiation.

The existing boiler is used to boost the storage cylinder either using the top coil of a twin coil cylinder or the bottom coil of a secondary hot water storage cylinder that is fed by the solar pre-heat cylinder.

High Temperature Limits

Any components in close proximity to the collector can be exposed to brief periods of up to 160˚C temperatures, when the pump turns ON after stagnation. Therefore, the high temperature limits of all components in the system must be known and cannot be exceeded. It is also advisable to ensure that components (e.g. pumping station, expansion vessel, etc) are located hydraulically as far from the collector in the solar loop as is possible. Typically this will be hydraulically close to the storage cylinder.

Temperature Control

The solar controller should have a "max tank temp" function to protect the tank from being overheated. Hot water storage cylinders should comply with the local building regulations and be fitted with the appropriate safety features for over-temperature and over-pressure protection.

Anti-Scald / Tempering Valves

Anit-scald mechanisms are required in order to comply with the MCS MIS3001 Section 4.3.3 Requirement : "Incorporate a means to limit the water at all points of use to no more than 60°C or lower depending upon scald risk factors".

This requirement can be met by using Thermostatic Mixing Valves (TMVs) within 2000mm of all points of use to limit the temperature to no more than 46°C (or less depending upon the use). Alternatively a TMV at the outlet from the hot water cylinder limiting the output temperatures to 55°C to 60°C can be used or also by providing a thermostatic device to limit the solar input to the hot water cylinder. A combination of the above may also be acceptable.

Closed Loop Max Incoming Pressure

For closed loop systems, the solar loop must operate at no greater than 3.5 Bar and have an expansion tank installed to accept fluid expansion.

If a single wall heat exchanger is used, the solar loop operating pressure must be below the water main pressure.

Maximum Allowable Pressure

The maximum allowable operating pressure for the solar collector in any system

configuration (domestic or commercial) is 8 bar with pressure relief valve discharge rating at no more than 8.5 Bar or lower as specified by local building regulations.

The Pumping Station supplied by CoolSky comes with a 6 Bar Pressure Relief Valve (PRV) – therefore when using these pump stations the maximum allowable pressure is 5.5 Bar (or lower as specified by local building regulations).

When using other components, check the maximum pressure ratings for all components of the system and only use products that can handle the operational temperatures and pressures of the system design.

✖ *System pressures that exceed those requirements outlined above will void the warranty.*

Electrical Supply

Any electrical work must be completed by a licensed electrician and/or in accordance with relevant electrical codes and building regulations.

Power supply to the controller must be protected again water ingress.

Power supply to the controller must be disconnected when the cover is removed and/or work with the pump or other slave devices is conducted.

Labelling

All piping and components should be labelled with descriptive stickers/tags to allow easy identification during future troubleshooting, maintenance or upgrading. Labels must be durable enough to last for years and withstand normal handling, wet equipment rooms and high temperatures.

Building Considerations

Penetration Through Fire-Rated Assemblies

Any piping that needs to penetrate fire-rated assemblies needs to be prepared/finished in line with any relevant regulations.

Roof Penetration

Depending on the location and local codes, there may be various acceptable means of penetrating the roof. Flashing are often used to ensure a neat and water-tight penetration. Regardless of the method used, insulation of the solar lines and water-tightness must be ensured. Roof penetrations may not impair the function of the enclosure. All roof penetrations must be sealed to prevent water, vermin or any other intrusion.

Structural Supports

Any points of attachment for the solar collector or other system components must be of suitable structural strength to support the weight of the components plus any loads that may be encountered, such as wind or snow loading.

Any damage to structural supports caused by screws, drilled holes or other fastening methods must not undermine the structural integrity. Seek professional advice as required.

Applicable Codes

All roof penetrations must meet applicable codes, practices and building regulations. All members penetrated by solar system components must meet relevant codes.

Adjacent Materials

Materials adjacent to the solar system components should not be exposed to elevated temperatures.

Health & Safety Considerations

Anyone undertaking solar heating installations should obtain an up-to-date copy of the relevant UK HSE (Health & Safety Executive) Regulations and / or the Irish HSA (Health & Safety Authority) regulations and carefully review the contents

Working at Height

A Full Risk Analysis should be undertaken before any work is started with particular attention to work at height, how you plan to organize your work, accounting for the installation site, prevailing weather conditions and the experience and competence of others who will also be working at height.

Reference should be made to the Full Current Regulations and Guidelines before any work commences which state that a Risk Assessment must be undertaken for any work undertaken at height and to ensure that arrangements are in place to :

- Eliminate or minimise the risks from working at height
- Safe systems and methods of work are in place for the organisation and performance of work at height
- Safe systems and methods are in place for selecting equipment that is suitable to undertake the work
- Safe systems and methods are in place for protecting people from the consequences of working at height

The Regulations set out a basic hierarchy for managing and selecting equipment for work at height, as follows :

- Avoid working at height where possible
- Use work equipment or other suitable measures to prevent falls when work at height cannot be avoided
- Where the risk of a fall cannot be completely eliminated, then use equipment of other measures to minimise the distance and consequences should a fall occur

Under the regulations you are required to ensure :

- All work at height is properly planned and organized
- All work at height takes account of weather conditions that could endanger health and safety
- Those involved in work at height are trained and competent
- The place where work at height is done is safe
- Equipment for work at height is appropriately inspected
- The risks from fragile surfaces are properly controlled
- The risks from falling objects are properly controlled

General Safety Information

This section includes general Health and Safety Information. However, reference should be made to the current HSE / HSA regulations which take precedence.

Appropriate safety equipment must be used when installing the solar collector. The installer should consider the use of the following items in order to comply with the Health & Safety Regulations :

- Safety glasses, gloves and other required personal protective equipment.
- Well-maintained, properly-fitted safety harness, lanyard, rope and appropriate anchor for working on the roof.
- A harness attachment plan that ensures you aware of the safe working area with your particular harness setup.
- A first aid kit and the necessary training in First Aid.
- Consider on-site risks such as slippery roofs, exposed nails, hot plumbing, sunburn, high winds, etc.
- Safety on the roof is always an important consideration. Avoid roof work if it is raining and ensure that the inside of the manifold does not get wet. Do not let rain enter the evacuated tubes.
- Keep the evacuated tubes out of the sun until 2-3 minutes prior to installation. If you install the solar collector in direct sunlight, the heat pipes will become hot very quickly. Try to install the collector earlier or later in the day. DO NOT install the collector at night.

A minimum of 2 people are required to complete an installation. Do not attempt to complete an installation without a qualified and experienced installation team.

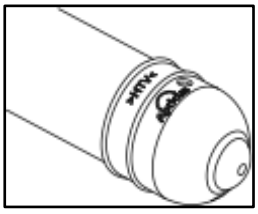
Roof work should not be performed without a second installer on-site. Each person performing work on the roof needs to have their own harness, rope, lanyard and anchor, in accordance with HSE (UK) or HSA (ROI) regulations.

Installation Guidelines

This section contains guidelines for the unpacking, inspection, assembly and installation of the Apricus Solar Collectors. Several of the more common types of Installation are covered in detail. For other installations or where further clarification is required please contact CoolSky.

Tube Unpack & Inspect

Check to make sure the evacuated tubes are all intact and the 'getter' at the bottom of each tube is still silver coloured by removing the rubber caps. The rubber cap should be immediately replaced after inspection to protect the bottom tip of the glass tube.



If a tube has a white or clear bottom, it is damaged and should be replaced. Any damage or breakages should be reported immediately upon delivery to CoolSky.

✖ *Damage to collectors and other components incurred during transport is not eligible for warranty claims.*

Shield Tubes from Sunlight

Do not expose the tubes to sunlight until ready to install, otherwise the heat pipe tip will become very hot and can cause serious skin burns. The outer glass surface should not become hot.

WARNING:

Wear safety glasses and leather gloves at all times when handling evacuated tubes and heat pipes. Never touch the inside of evacuated tubes or the heat pipe tip after exposure to sunlight.

Frame/Manifold Unpack & Inspect

Unpack the standard frame that is provided together with the manifold. Apricus solar collectors are come with a standard frame, which is suitable for flush mounting on roofs that have a suitable pitch.

For installation on low-pitched roofs, flat roofs or for wall mounts, an additional, adjustable frame kit is available. This additional adjustable frame will be packed separately from the manifold and standard frame kit.

Depending on the roofing material, the standard frame may be attached to the roof with flashed bracketing solutions (corrugated steel, asphalt), roof attachment straps (tiled, slated), stand-off bracket (tiled, slated) or round feet (asphalt, concrete).

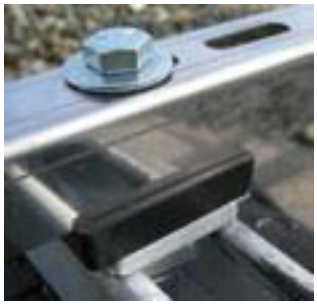
An adjustable frame kit designed and provided by Apricus is capable of turning the standard frame into a rack, in order to position the manifold and tubes at the ideal azimuth and tilt for almost any location.

Frame Material

All frame components are made of 439 grade stainless steel making the frame both strong and corrosion resistant. It is important that frame attachment points and externally supplied fasteners are also of suitable structural strength and corrosion resistance.

Galvanic Reactions

Zinc galvanized steel roofing or Uni-strut must NOT directly contact stainless steel as galvanic reaction between the two metals can cause premature oxidation of the zinc coating and the metal underneath. Apricus offers rubber pads which are perfect for separating the metals (see image below).



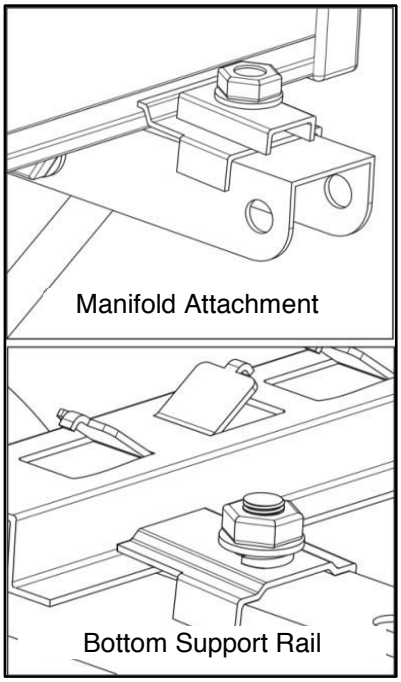
Fasteners

It is recommended that stainless steel fasteners are used. If using galvanized steel bolts, separate dissimilar metals using a nylon or high density EPDM/Silicone rubber washer.

Manifold and Bottom Support Track Assembly

The Manifold and Bottom Track are secured to the standard frame channels using special securing plates. These plates are attached to the frame channels before they leave the factory.

They only need to be LOOSENED in order to allow enough movement to fit the Manifold and Bottom Support Track in place. The plates are designed so that while somewhat loose, they enable the Manifold and Bottom Support Track to slide left and right for positioning and allow the standard frame channels to be easily adjusted side to side to suit the roof framing layout.



Tightening Nuts

Once correctly located, the nuts should be hand tightened ONLY using the supplied wrench, locking the Manifold and Bottom Support Track in place. **DO NOT** use a power tool or longer hand tool to tighten the nuts as stainless steel is prone to galling (cold welding, i.e.), if excessive friction or over-torqueing occurs (i.e. the nuts can lock to the shaft before they are completely seated, if they are over-tightened). The use of a lubricant on the threads, such as WD-40, will also help to prevent issues.

Split washers are supplied to ensure the stainless steel bolts do not loosen over time.

Cool Tip

When drilling the Stainless Steel always use a good quality drill bit. Take caution when using power tools and 'never' do any drilling of the frame whilst on the roof.

Inverted Bolts

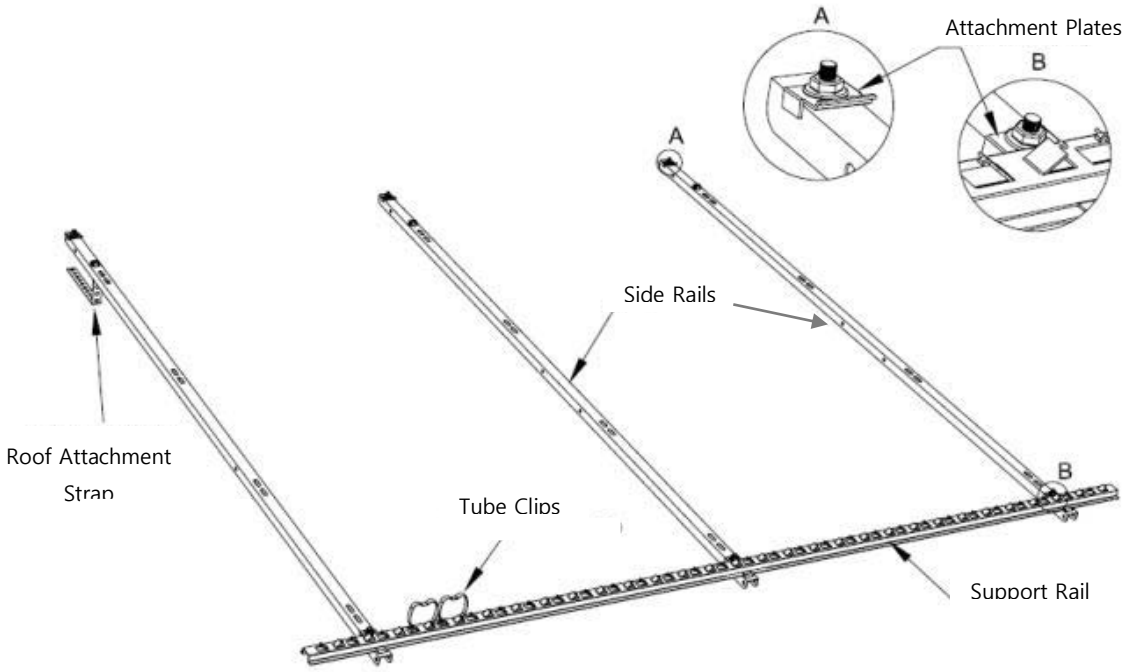
NOTE: Some bolts are inverted with the nut on top. This so you can see the threads and helps prevent you from loosening the bolt so much that the nut drops off. The bolt head is prevented from rotating by use of nut locks (i.e. rectangular washers), removing the need to use a second wrench underneath the frame and aiding a quick and easy assembly process.

Cool Tip

Any modifications to the mounting frame must be approved for strength and safety by a licensed engineer before installation.

Customizing the Frame

The standard frame, together with the adjustable angle frame kit components can be adapted to a wide range of different installation surfaces and situations. Any modifications to the frame design must be approved by a licensed engineer and done with structural integrity in mind, particularly in high wind areas.



Schematic showing the Apricus Standard Roof Frame (this is supplied with the Apricus Manifold in the same box)

Other System Components

For a typical domestic installation, in addition to the solar collector, storage tank, and pump station, some or all of the following components are also required :

- Solar Expansion Tank
- Copper pipe (straight and/or soft rolled) with additional insulation or Flexible Pre-Insulated Stainless Steel Pipe.
- An automatic or manual air vent
- Anti-Freeze based Heat transfer fluid
- Flush & Fill Pumping Cart
- Anti-scald valve
- Various plumbing fittings, valves, drain valves, etc.
- Scissor lift, cherry picker and/or ladders and harness equipment for roof work
- Labels and permanent marker to label system components and flow paths.

Cool Tip

All system components should be installed in a manner that allows access for maintenance and repairs.

Collector Installation

Flush Mounting on Pitched Roof

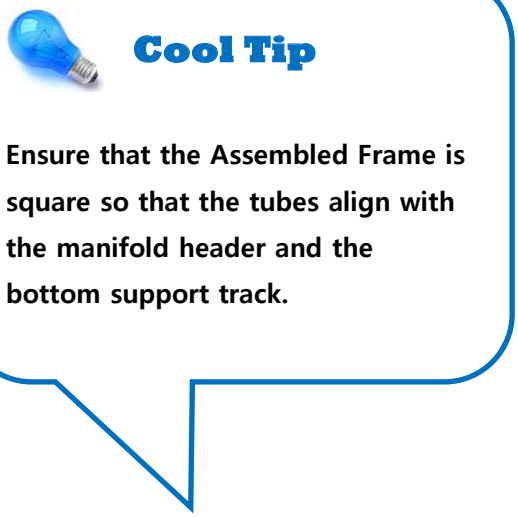
Installation Planning

Carefully plan the location of the collector frame and plumbing pipes in order to align with the roof framing members and develop the shortest pipe run possible to the storage tank. Any penetrations in the roof or building shell must be water-tight and sealed with standard roofing materials and/or appropriate sealants to avoid leaks and comply with local building regulations or requirements.

Securing to Roof

The manifold and bottom support rail can slide left and right in relation to the frame side rails, so there is some flexibility when selecting the location. The frame side rails should be located so that they lay flat, are parallel with one another and, if possible, aligned with the roof rafters. If the frame side rails cannot be aligned with the roof rafters, a 'noggin' may need to be attached between 2 rafters to provide an attachment point. Ensure that any additions or modifications to the roof structure meet structural requirement and local building regulations.

A Horizontal Brace is provided with the standard frame kit. This gives a useful indication of the typical spacing between frame side rails. Additional holes may be drilled in the horizontal brace to meet different roofing rafter locations.
The Horizontal Brace component is NOT structural and is simply to help with alignment, so it can be removed if it is incorrectly sized for the roof rafters or it is not convenient.



Drain-Back System

If installing a drain-back system, the frame must be rotated slightly to achieve a 2cm drop per meter to ensure that the manifold is sloped towards whichever header port will be the collector outlet (hot), to promote complete drainage.

Tiled and Slate Roof Installations

Roof Attachment Straps

Roof attachment straps are used for flush mounting on tiled/slated roofs 2 per standard side rail. One end of each strap should be secured to the underside of the

standard frame side rails using the supplied M8x20 bolts and nut lock assemblies, the other end to the roof rafter using two stainless steel coach screws. Once the upper straps are attached and tightened, adjust the bottom straps to ensure that they too are providing support to the frame.

Fragile Slates / High Wind Area

In areas of high wind or where the roof slates are fragile then the roof attachment straps should NOT be used.

A rigid solar stand-off bracket (similar to those shown below) and flashing is recommended. Care should be taken when cutting tiles/slates to avoid breakage, as new tiles/slates may not be readily available. It is recommended that in such cases a professional roofer is used.

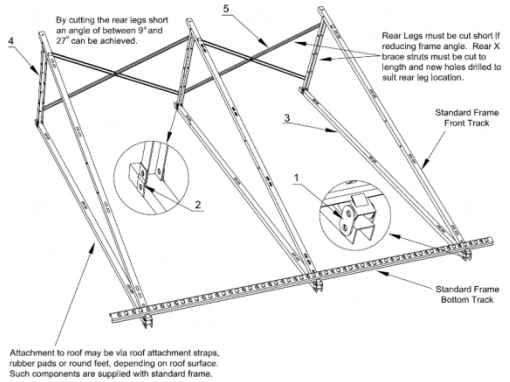
Manifold and Bottom Track Attachment

Once the standard frame channels are secured in place on the roof, the manifold and bottom track may be attached, taking care to ensure they are correctly aligned. The manifold and bottom track will lock into the frame, secured from above and below with the attachment plates that are already in place. Make sure that the Manifold and Bottom Support Rail are square with the frame side rails.

To ensure proper tube engagement, each tube in the Manifold should line up with the corresponding 'cradle' on the Bottom Support Rail. Each Tube is installed with the Heat Pipe snugly engaged within the Header with the opening of the glass tube inside the Manifold header. The bottom of the tube, protected by the Rubber Cap, locates in the 'cradle' between each set of prongs on the Bottom Support Rail, where it is held in place by the Bottom Support Rail Clip.

Mounting on Low Pitched Roof

If the roof pitch is insufficient, an adjustable angle roof frame kit (as shown below) can be used to increase the angle by 27°to 57°. Adjustable frame kits combine with the standard frame components to form a complete frame assembly.



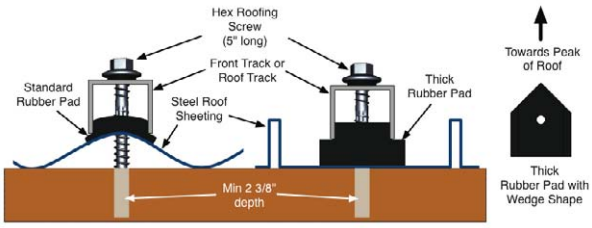
It is recommended that the adjustable frame kits are completely assembled on the ground before taking onto the roof – see next section.

Metal Roof Installations

For installation on a corrugated or ridged steel roof, either a Basic Metal Roof Kit or a Stand-Off Metal Roof Kit can be used to secure the collector to the roof.

The Basic Metal Roof Kit

This kit consists of Rubber Sealing Pads that are used to separate the frame from the roof and also to seal the hole. Addition of some silicone sealant or similar roof sealant beneath the pad and inside the hole is required thereby allowing the rubber pad to form a tight seal against the roof, preventing any water ingress. Three (3) attachments per track are required.



The Stand-Off Metal Roof Kit

For installations where longer bolts may be required to account for the height of the ridges such that the required depth of penetration into the rafter is achieved, or there is a desire to hold the collector frame away from the roof structure, the Stand-Off Metal Roof Kit is suitable.

Each kit consists of 4 or 6 large hanger bolts M10 x 250mm with integral rubber seals, attachment plates, rubber pads and the required nuts, bolts and washers for attaching to the collector frame side rails.

Addition of some silicone sealant or similar roof sealant beneath the pad and inside the hole is required thereby allowing the rubber pad to form a tight seal against the roof, preventing any water ingress. Two (2) attachments per track are required, thereby needing 4 for a 20-tube collector or 6 for a 30-tube collector.

Flat Roof Installation

The high angle frame is adjustable and appropriate for installations on flat surfaces and provides adjustment from 27°-57˚. The high angle frame kit combines with the standard frame components to form the complete frame assembly.

The high angle frame is supplied with Round Feet that are also suitable for attachment to concrete ballast on a flat roof.

For additional strength and support a rear X-Brace is supplied. The X-Brace has a series of elongated holes to allow adjustment of the location of the legs. If further adjustment is needed, additional ⌀9 mm holes may be drilled using a good quality drill bit.

Assembly of the Support Frame

When undertaking an installation that requires an adjustable angle roof frame kit (such as on a flat roof or a low pitched roof) it is recommended that the frame is completely assembled on the ground on a clear flat area. The collector frames are relatively light and can easily be carried onto the roof once assembled. Assembling on the roof is both dangerous and makes it easy to lose bolts and nuts that may roll away.

Frame Feet Anchoring

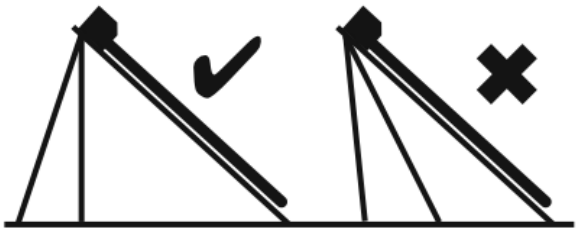
Frame feet should be bolted to the installation surface using 8 mm diameter stainless steel bolts or a similarly sturdy fastening method. (Galvanized bolts should be NOT be used as these can result galvanic corrosion).

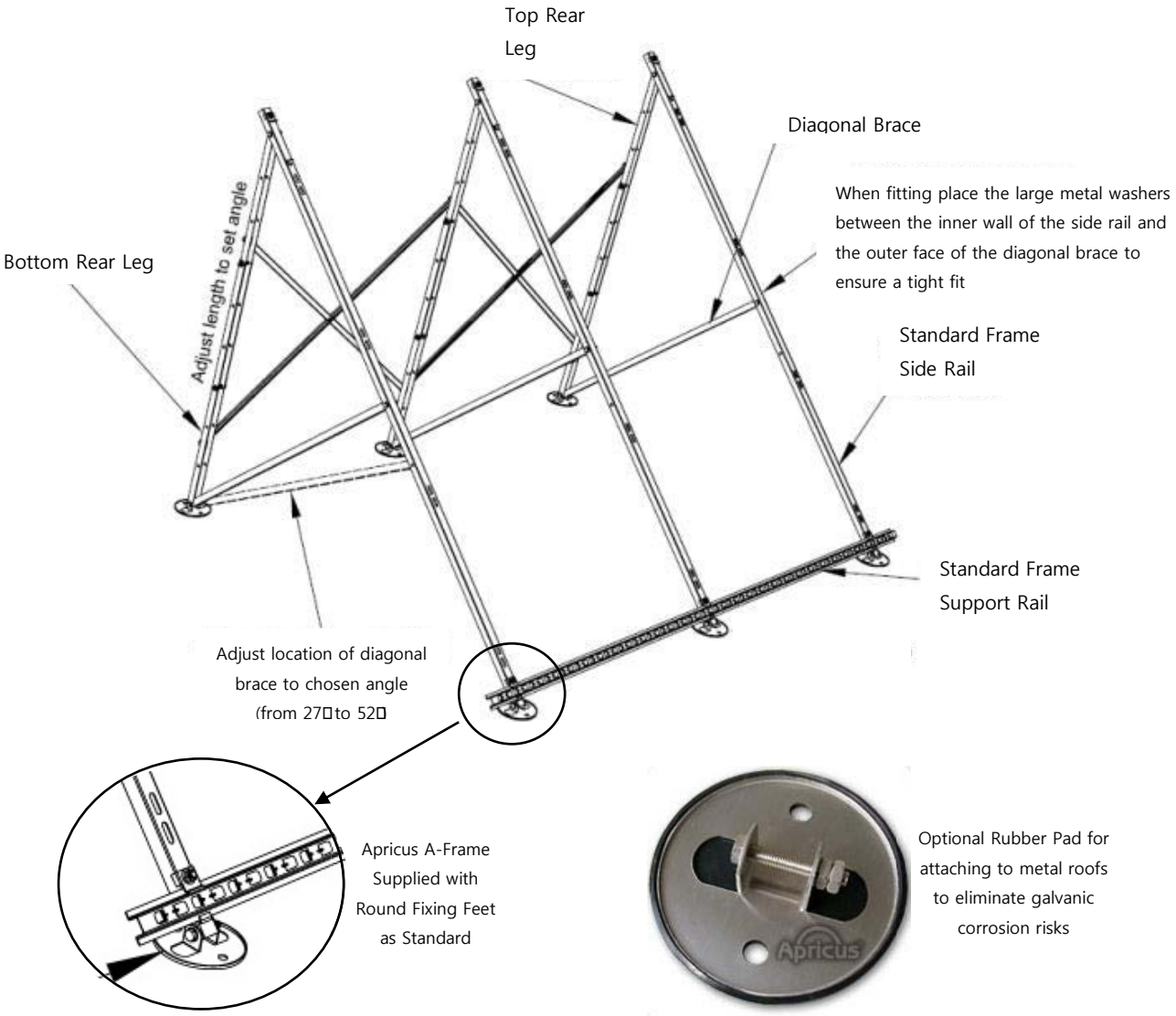
The surface or concrete block must be strong/heavy enough to withstand load during high winds. Consult a professional structural engineer for design requirements.

Adjusting Frame Angle

The rear legs of the high angle frame comprise two interlocking pieces (top and bottom leg), which allow the length of the rear leg to be adjusted, thus changing the collector angle from between 27° and 57°.

The rear legs must never be positioned greater than a 90° angle (perpendicular) with the roof surface, meaning the legs must be behind the position of the manifold, not in front. See diagram to below.





Rear Legs

Each rear leg has two pieces, a top and a bottom, which allows them to be adjusted. The two pieces must always be joined together by 2 bolts through two sets of holes each in each leg for structural support.

Lower Angles

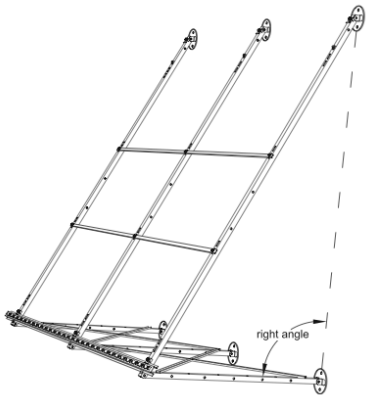
If an angle less than 27° is required the low angle frame kit should be used which provides an installation angle of 12°.

Higher Angles

If an angle greater than 57° is required, the mounting points of the rear feet may be raised. Raising the angle greatly increases the horizontal force during high winds and may require additional structural and/or hardware upgrades. Consult a building engineer for design requirements.

Wall / Façade Installations

The high angle frame kit may be used for Wall / Façade Installations. The legs are reversed so that they attach to the bottom of the standard frame side rails rather than the top. The legs should be position perpendicular to the wall and are adjusted and secured in the same manner as the Flat Roof Installation detailed in the previous section.



Surface Attachment

The method used for attachment to the wall will depend on the wall material.

- The round feet can be secured with stainless steel expansion bolts for attachment to brick or concrete surfaces
- Stainless steel coach screws of at least 8mm diameter or greater with high sheer strength that can penetrate into the wall framework can be used with wood or synthetic boarding surfaces.

Wall Strength

Always consider the weight of the collector and the structural integrity of the wall. If the wall construction is not suitable for the load, it will be necessary to reinforce the wall frame accordingly. Consult a building engineer for design requirements.

Recommended Angle

Ideally, do not install the collector beyond an angle of 80° (close to vertical) otherwise heat pipe operation will be impaired by 10% or greater. Installing vertically is permitted and will not void the warranty, but performance will be reduced.

Safety Considerations

If installing the collector on a wall above a walkway, keep in mind the danger of broken glass that could fall on pedestrians, if the tubes were ever damaged. (E.g. during an extreme storm due to flying debris or tree branch falling on the collector). It may be necessary for a barrier of to be installed below the collector to catch any falling materials, such as a clear roofing material.

WARNING:

For collectors installed above a pedestrian area, take appropriate measures to minimise injury risk in case a broken tube or glass fell onto the ground or people below.

Connection to Plumbing

Plumbing Connection

Once the frame has been mounted and the manifold attached, the manifold header may be connected to the system plumbing.

Delayed Commissioning

If the collector is to be installed (including evacuated tubes) prior to plumbing connection (e.g. on new house), high temperature resistant covers (aluminum foil) should be placed over the header inlet and outlet to prevent any contaminants (bugs, spiders, leaves, dust) entering the header. The solar collector will not be damaged by a period of dry stagnation that lasts less than 14 days.

If the collector is to be left for any significant period of time before being commissioned it is recommended that the collector is covered with an appropriate tarpaulin. Ensure that the tarpaulin is secured to the roof fixings – DO NOT secure any cover or tarpaulin to the glass tubes as this can result in damage / breakage of the glass under high wind conditions.

✖ *Damage to collectors and other components incurred by extended dry or wet stagnation is not eligible for warranty claims.*

Pipework

Suitable Pipe Materials

Only the following materials are recommended for use with High Performance Evacuated Tube Solar Collector Systems, as follows :

- Flexible Stainless Steel Pipe
- Copper Tube (hard or soft coiled)

Plastic Pipes (PEX) and Galvanised Pipes should NEVER be used in a solar thermal system

All pipework in the solar loop should be suitable insulated in compliance with local building regulations.

Insulation

Insulate Piping

Ensure all piping running to and from the manifold is appropriately insulated with a high quality insulation that complies with local building regulations in terms of its thermal conductivity and thickness required. Heat loss from the piping can be significant so particular attention should be taken to insulate any possible points of heat loss, particularly on outdoor piping.

Seal the Insulation and Sensor Port

Ensure the insulation is tight against the manifold casing, preventing loss of heat from the inlet and outlet. In order to prevent water from entering the temperature probe port and/or in between the piping and insulation foam, a high quality silicone sealant should be used to form a water-tight seal. This is also important to avoid water running down under the insulation along the copper / stainless steel pipe into the roof space.

Protect Insulation

EPDM (foam) insulation that is exposed to direct sunlight should be protected against UV related degradation. CoolSky supply Stainless Steel Flexible Pipework that is pre-insulated with high-grade EPDM Insulation with UV Protective sheath.

Installation of the Tubes

The Apricus solar collector is a simple "plug in" system. The heat pipe and evacuated tube assembly just needs to be inserted into the manifold. The contact between the heat pipe condenser/tip and heat pipe port in the header needs to be tight in order to ensure good heat transfer. Under normal use, once the heat pipes are installed they should never have to be removed.

WARNING:

Safety glasses and leather gloves must be worn at all times when handling evacuated tubes and heat pipes. Never touch the inside of evacuated tubes or the heat pipe tip after exposure to sunlight.

Heat Pipe Preparation

Do not remove the tubes from the box and/or expose the tubes to sunlight until ready to install, otherwise the heat pipe tip will become hot enough to cause serious skin burns. The outer glass surface should not become hot.

Heat Pipe Frost Protection

Apricus Heat Pipes contain a small amount of copper powder, which aids in heat transfer and provides freeze protection within the heat pipe itself. To ensure that the powder is at the bottom of the heat pipes, where is needs to be, before installing the tube and heat pipe, they should inverted (condenser end down), returned upright (condenser at top) and then shaken up and down a few times to ensure the powder has all returned to the bottom. This should be done at ground level.

Cool Tip

Activate the Frost Protection by inverting the tubes, returning to an uprights position and shaking.

Damaged Tube

If an evacuated tube is damaged for any reason (E.g. knocked heavily or dropped), it will need to be replaced.

Never throw heat pipes away, as they are very sturdy and will not be damaged even if the glass tube has been broken. They can be kept as spares, or inserted into plain spare evacuated tubes to provide a new fully functional tube.

Cool Tip

Do not install the tubes until system plumbing is completed, the solar loop is charged, the pump and controller are operational and fluid is currently circulating (set controller pump function to ON).

Application of Heat Transfer Paste

The Apricus Manifold box is supplied with a small tube of Thermal Heat Transfer Paste. This is a specially formulated paste that is designed to aid the conduction of thermal energy and is used to lightly coat the Heat Pipe Condenser to enhance its thermal conduction characteristics.

Cool Tip

Before use, the Tube of Heat Transfer Paste can be placed (cap downward) in a glass of warm water to allow the powder to re-mix through the paste as it may have settled during transport. This will ensure optimal thermal performance and will also make application and heat pipe insertion easier as the paste becomes thinner in the warmth.

While holding the spring plate in place, pull the heat pipe out of the evacuated tube by about 8 cm.

Apply a thin layer of the heat transfer paste around the body of the heat-pipe condenser (not the top round end).

This is easiest to do using a short length of insulation pipe. Squirt some of the heat transfer paste into the insulation, the use to coat each heat pipe tip with a thin layer and remove any excess from the tip. Using this method half a tube can coat 30 tubes.

Cool Tip

Apply the heat transfer paste using a short length of the insulation – squirt the paste into the insulation and use to thinly coat the surface of each condenser.

Heat Pipe and Evacuated Tube Insertion

Lubricate the top outer surface of the evacuated tube with a small amount of water. This facilitates easy insertion past the manifold rubber ring seal. A small pump spray bottle is the best method for carrying and applying the water.

NOTE: DO NOT SPRAY WATER INTO THE EVACUATED TUBE

Cool Tip

A small amount of water can be used at the tube of the glass tube, on the outer surface, to facilitate easier insertion past the manifold rubber ring seal.
NOTE : DO NOT LET ANY WATER GET INTO THE EVACUATED TUBE

Insert Tube

While ensuring the metal spring plate is sitting in the mouth of the evacuated tube, firmly hold the evacuated tube and guide the heat pipe tip in past the manifold rubber seal and into the heat pipe port.

Ensure the heat pipes are at the TOP DEAD CENTER of the evacuated tube and therefore aligned correctly with the heat pipe port.

Insert Tube - Rotating

Using no more than a 1/8th turn left and right twisting action, push the evacuated tube up into the manifold. The neck of the evacuated tube will push against the spring at the base of the heat pipe tip, forcing it fully into the port.

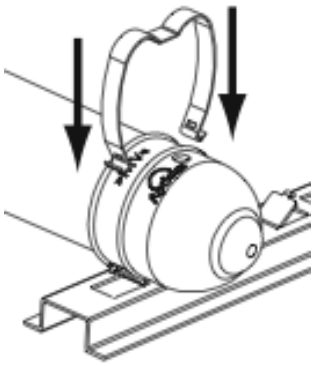
DO NOT over rotate the tube when inserting otherwise the heat pipe will be turned out of alignment with the top of the tube, which will prevent proper heat pipe operation.

Correct Insertion Depth

The heat pipe and evacuated tube are fully inserted once the black coating of the evacuated tube has disappeared up into the manifold and no clear glass above the coating is visible.

Securing the Tube

Position the rubber end-cap so it is aligned with the corresponding 'cradle' in the bottom support rail and the Apricus Logo facing upwards. This ensures that drain holes in the cap are properly positioned. It DOES NOT have to be pushed hard up on the tube.



As each tube is inserted secure the tubes to the bottom support rail using the stainless

steel securing clips as shown in the picture above. The bottom of the tube should sit so that the groove on the rubber cap lines up with clip point on the bottom track. Line up the clip with the hook on the bottom support rail and push down over the rubber cap.

Removal of the Securing-Clip

The clip can be removed by using a screwdriver or needle nosed pliers to pull each side of the clip down and outward. Very little force is required.

Post Installation Cleaning

Clean each evacuated tube with a fluid glass cleaner and cloth then dry clean with newspaper.

Commissioning The System

Ensure Expansion Vessel Pressure has been re-set correctly before filling the system.

Cool Tip

Expansion Vessel Pressure should be re-set to 0.3 Bar less than the Cold Fill Pressure.

Filling the System

It is recommended that the system is filled with the Anti-Freeze Fluid using a professional Flush & Fill Cart (such as that shown in the picture below).

Cool Tip

The Cold-Fill Pressure of the Solar System should be :

1.3 + (0.1 x Static Height)

Where the Static Height is in Meters.

When used correctly these stations ensure that all the air is purged from the system during the filling process.

Flush & Fill Cart

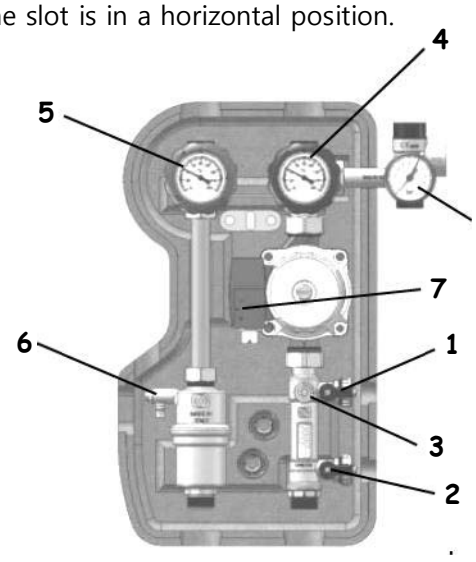
In addition, it is also essential to have either an automatic or manual de-aerator / air-scoop so that any accumulation of air in the system can be regularly vented. The CoolSky Pumping stations are supplied with a ready-fitted manual air-scoop to allow for further air bleeding of the solar loop if required.

Commissioning Method

Connect the Flow Hose from the Flush and Fill Cart to the Filling Valve (1) and open the valve.

Connect the Return Hose to the Drain Valve (2) and open the valve.

Close the Restrictor Flow Valve (3) so that the slot is in a horizontal position.



Open the Cold Check Valve (4) by turning so that the 45° indicator is facing upwards.

Open the Hot Check Valve (5) by turning so that the 45° indicator is facing upwards

Pour the Anti-Freeze fluid into the Flush and Fill Cart and then fill the solar system (follow the manufacturer instructions for the

operation of the solar cart). The Solar System should not be flushed nor pressure tested with water only as it is not always possible to completely drain all the water from the system upon completion and this can result in an increase freezing risk of the system.

The Solar System should be flushed using the Flush & Fill Cart for a period of at least 15 minutes to ensure the fluid is completely deaerated. During this operation it is good practice to momentarily open the Restrictor Flow Valve (3) to ensure any trapped air in this region is cleared.

After flushing for 15 minutes the following procedure should then be undertaken :

Close the Drain Valve (2) whilst the Flush and Fill Cart is still running. Carefully monitor the system pressure on the Pressure Gauge (6) and allow to increase to the recommended cold-fill pressure.

Once the recommended cold-fill is reached in the system the Flow Valve (3) should be shut and the power to the Flush & Fill cart turned off.

Monitor the system pressure gauge for any drop in pressure that may indicate a leak in the pipework.

Open the Restrictor Flow Valve (3) so that the slot is in a vertical position.

Close the Cold Check Valve (4) by turning so that the 90° indicator is facing upwards (i.e. the gauge is now in the correct orientation).

Close the Hot Check Valve (5) by turning so that the 90° indicator is facing upwards (i.e. the gauge is now in the correct orientation).

Manually vent any air in the system from the Manual Vent Port (6)

The Solar Loop Circulating Pump should then be run on its highest speed using pump speed selector (7) for 15 to 30 minutes. Refer to The Solar Controller Operation Manual to run the pump in continuous mode. (Remember to return the controller to automatic mode after commissioning).

If necessary manually vent any air in the system from the Manual Vent Port (6)

Cool Tip

Set the Flow Rate through the collector array to :

0.1 litre / minute / tube

That is :

1 litre / minute for 10-tubes

2 litres / minute for 20-tubes

3 litres / minute for 30-tubes

Select the required pump speed for normal operation using the pump speed selector (8) and regulate the flow using the Restrictor

Flow Valve. The Flow rate can be read on the sight glass.

Remove the flush & fill hoses from the pumping station and attach closing caps onto the valves to seal them.

Re-Check System for leaks.

Ensure all valves are in operational positions.

Ensure Solar Controller is set to Automatic Operation.

Post Installation

Collector Operation

Once all the tubes are installed and the system is fully commissioned, the solar collector will begin to produce heat after a 5-10 minute warm up period when the sun is shining. Check the controller and pump for correct operation and adjust settings as required. Make sure that you have changed the controller setting from ON to AUTOMATIC.

Clean Up

Once the system is confirmed as operating correctly, ensure the installation site is cleaned of all rubbish that should be recycled, whenever possible.

Chemicals, paints and heat transfer fluids must be disposed of in line with their MSDS guidelines provided by the manufacturer and in line with local regulations.

Maintenance & Repair

Once installed and operational the solar collector is virtually maintenance free. Other system components such as the pump, heat transfer fluid require periodic inspection and may need to be replaced in the future. Please refer to the documentation provided by the manufacturer of these other components.

WARNING

Apart from maintenance specifically outlined as "OWNER", any maintenance or repair MUST ONLY be performed by authorized persons. At no time should any inspection or maintenance be performed by the homeowner, if it involves climbing on the roof or any potentially unsafe behaviour. The solar collector warranty will be void, if non-authorized persons attempt to maintain or repair the solar collector or associated system components. The solar system operates at high pressure and high temperature and can cause damage to property and severe personal injury, if not correctly operated and maintained.

Periodic inspections by an authorized Apricus installer is recommended to ensure optimum system operation.

The following maintenance may ONLY be completed by AUTHORIZED PERSONS

Broken Tube

If a tube breaks, it should be replaced as soon as possible. Whilst the system will still operate normally and safely with a broken tube, it will be at a slightly reduced level of performance. To ensure maximum collector performance any broken tubes should be replaced.

Always wear safety goggles and gloves when handling broken glass and clear away any broken glass immediately to prevent injury.

To replace a tube

Remove the tube clip(s), slide broken tube out and carefully pick up any glass pieces.

Avoid touching the glass wool insulation with bare hands, as it can cause mild skin irritation.

Remove the heat pipe and insert a new evacuated tube & heat pipe.

If the heat pipe is not easily removed (as is commonly the case), it can be left in place and a new evacuated tube inserted by carefully guiding the heat pipe down the groove between the evacuated tube inner wall and heat transfer fin.

Insulation

The pipes running to and from the collector should be completely insulated. Insulation should be checked periodically (at least once every 3 years) for damage or gaps, especially exterior EPDM foam insulation.

For any insulation that has external exposure to weather conditions ensure that the protective cover is in good condition, replacing if required.

Heat Transfer Fluid

Heat transfer fluids that are exposed to stagnation temperature may break down over time, which will cause the fluid to become acidic and loose anti-freeze properties.

The fluid will generally become "sludgy," which can reduce circulation efficiency. Ideally, heat transfer fluid should be inspected and tested annually, but least once every 3 years. The following checks should be completed on the Thermal Transfer Fluid :

Check for cloudiness or sludging that would indicate fluid breakdown.
Check pH, should be within the range specified by the manufacturer.
Use an Anti-Freeze tester to check freeze protection level.

If the fluid shows signs of degradation it should be replaced.

If the system is severely clogged up with 'sludgy' degraded glycol it may be necessary to clean the system using a proprietary solar cleaning fluid prior to re-filling the system.

Heat Transfer Fluid – Top Up

If there has been a drop / loss of pressure in the solar loop it will need to be recharged / re-pressurised.

The solar system should only be topped-up with the SAME glycol fluid as was used to originally fill the solar loop.

Water must NEVER be used to top-up the system as this can result in the dilution of the anti-freeze protection and leave the system susceptible to freezing.

Draining the Collector

During system maintenance or in draining the collector manifold may be required. If the building is going to be vacant for longer than 45 days at a time, the system must be drained and the collectors covered with a tarpaulin.

Any fluid drained for the system that is intended for disposal should be disposed of in line with local regulations.

Freezing

As freezing conditions are always a possibility in the UK and Ireland (particularly in the winter months) CoolSky always recommend the use of a Solar Thermal Anti-Freeze Fluid in the Solar Loop.

Whilst some system designs try to accommodate for freezing conditions with special functions in the system controllers, it is not unusual for periods of heavy frost in the UK and Ireland to be accompanied by power outages. Hence, any Frost Protection Functions in control units will not operate, thereby exposing the collector to a freezing risk.

Maintenance Schedule

It is recommended that as a minimum the following maintenance schedule is followed:

Component	Time Frequency	Inspection
Insulation	3 years	Check for degradation
Controller	3 years	Check data-logger operation, system settings.
Pump operation	3 years	Check flow rates, pump noise, vibration etc.
Solar Collector	3 years	Check tubes for any vacuum loss
Heat Transfer Fluid	1 year	Check appearance, pH and anti-freeze level reading.
System Pressure	1 year	Check system pressure is correct

Other Components

Other parts of the system such as the storage tank and the back-up heating / boiler should be serviced and inspected according to their specific manufacturer's maintenance guidelines.

Troubleshooting Guide :

Problem	Possible Cause	Suggested Solution
Pump not coming ON during good solar radiation conditions	Temperature Sensors not working properly	● Check that sensors are installed correctly : - Are they wired to the correct terminal blocks in the solar controller - Ensure wires are secure ● Check that sensors wires are not damaged ● Check the Resistance (Ohm) valve of the sensors and confirm with PT1000 Temperature chart (as a guide 0°C is 1000 Ohm and 100°C is ~1385 Ohm)
	Controller Settings Incorrect	● Check controller is set to Automatic Operation ● Check maximum tank and collector settings
	Controller Max Temperature Setting has been reached	● Check maximum tank and collector settings
Pump is cycling ON and OFF during good solar conditions	Partial Shading of Collector	● Check collector location for possible shading
	Excessive System Flow Rate	● Reduce flow rate by adjusting restrictor screw on the flow meter ● Reduce the Pump Speed (Select Slower Speed)
	Controller Settings Incorrect	● Check if differential (dT function) is correct. dTMin may be set too high. Trying reducing to 2°C.
Pump is always ON even during minimal solar radiation	Insufficient Flow Rate	● Check flow gauge for proper flow rate ● Adjust restrictor screw on flow meter ● Check that all isolation valves are open
	Air-Lock in Piping System	● Release air from air vent on pumping station ● Run pump at highest speed setting for a period of time and then release any accumulated air from air vent on pump station (return pump speed to normal settings)
	Sensor Location too Low	● Bottom Cylinder sensor (typically T2) should be slightly above the level of the solar flow port on the cylinder. If below the flow port, the pump may run continually.
	Controller Settings Incorrect	● dTMin may be set too low. Increase by 2 or 3°C.

Troubleshooting Guide (continued) :

Problem	Possible Cause	Suggested Solution
Poor Solar Heating Contribution (Compared to previous output at same time of year)	Increased hot water demand	● Check if hot water demand from the property has increased which would reduce the % of contribution from the solar collector even with the same level of output
	Insufficient flow rate	● Check flow gauge for proper flow rate and check pump operation if flow rate is insufficient ● Adjust restrictor screw on flow meter to increase flow rate ● Check heat transfer fluid pH, Colour and viscosity as it may need to be flushed and replaced
	Partial Shading of Collector	● Check collector location for shading or accumulation of snow. If accumulation of snow is an issue the ensure installation angle is increased to least 45°.
	Heat Loss from Pipes	● Check that insulation is still in good condition with no exposed hot pipes
	Damage to Evacuated Tubes	● Check that evacuated tubes are all intact and that the getter at the bottom of the tubes remains silver coloured
	Heat Pipes Not Operating	● Check that heat pipes are making good contact in the manifold header and are hot at the condenser tip
	Scale build up in Plate Heat-Exchanger	● Follow manufacturers recommendations for dealing with scale build-up
	Thermosiphoning	● System may be reverse thermosiphoning at night. Ensure check valve in pump station is working
	Insufficient Pump Run Time	● Not Applicable for Variable Speed Pumping ● For Standard ON/OFF Pump Operation ensure the pump is running for long enough to transfer the heat from the collector to return to the cylinder – carefully monitor the return line to check. Reduce dTMin value slightly if required.
Cont'd		

Troubleshooting Guide (continued) :

Problem	Possible Cause	Suggested Solution
Poor Solar Heating Contribution (Compared to previous output at same time of year)	Pump Cycling too Long and Dissipating Heat	● dTMin value set too low ● T2 Sensor (Bottom Tank) too low in tank and always reading cold water – move to correct location
	Excessive Tank Heat Losses	● Insulate both the hot and cold water pipes connected to the storage tank. A check valve (spring not flap) on the cold and hot pipe in close proximity to the tank will help reduce heat migration up the pipe ● Insulate and exposed fittings and valves on the storage tank. DO NOT impair the operation of the PTRV.
Not Enough Hot Water	Back-Up Heating	● Is back-up heating system functioning normally.
	Faulty Temperature Mixing Valve	● Check operation of Temperature Mixing Valves
	Increased Hot Water Demand	● Has demand in the property for hot water increased ● May need installation of larger capacity boiler ● Boost settings on controllers may need revised ● Larger storage tank / collector array may be required
Intermittent short bursts of cold water when showering	Faulty Temperature Mixing Valve	● Check operation of Temperature Mixing Valve.
Pump Running at Night	Temperature Sensors not working properly	● Check that sensors are installed correctly : - Are they wired to the correct terminal blocks in the solar controller - Ensure wires are secure ● Check that sensors wires are not damaged ● Check the Resistance (Ohm) valve of the sensors and confirm with PT1000 Temperature chart (as a guide 0°C is 1000 Ohm and 100°C is ~1385 Ohm)

Troubleshooting Guide (continued) :

Problem	Possible Cause	Suggested Solution
System Operation is Noisey	Air in System Piping	● Release air from air vent on Pumping Station ● Purge system of air – run on maximum pump speed for a period of time, then release air from manual air vent on pump station. Return pump to normal speed settings. ● If above operations have not been successful the system may need purged using Flush & Fill cart to remove entrapped air
Fluid Dumping from the Pressure Relief Valve on the Pumping Station	System Over-Pressurised during installation	● Confirm cold fill pressure (in Bar) is in agreement with guideline of 1.3 + (0.1 x Static Height) where static height is in Meters. - If over-pressurised release some fluid pressure (only under cold conditions)
	Faulty Expansion Tank	● Replace expansion tank on the pumping station.
	Faulty Pressure Relief Valve	● Replace the Pressure Relief Valve

The following basic maintenance or inspection MAY be completed by the HOMEOWNER

Home-Owner Maintenance

Cleaning

In most cases, periodic rain will keep the evacuated tubes clean. If particularly dirty, they may be washed from a safe location with a high-pressure water spray. If the collectors are located where they are easily and safely accessible, a soft cloth and warm, soapy water or glass cleaning solution may be used.

During autumn, leaves may accumulate between or beneath the tubes. Please remove these leaves regularly to ensure optimal performance and to prevent accumulation of ignitable material (if in high fire risk area). The solar collector will NOT cause the ignition of flammable materials. Such cleaning may only be completed by the homeowner if the tubes are easily and safely accessible.

Inspection

If there is any problem with the system, the installer will, generally, ask the homeowner to inspect various portions of the system before making a service call. The following inspections may be performed by the homeowner, ONLY if they are easily and safely accessible.

a) The pump station foam casing may be removed (pulled toward you and off) to check the following system information:

i) Pressure gauge reading
ii) Temperature gauge reading
iii) Pump operation (i.e. sound)
iv) Flow meter reading
v) Visual Inspection of Fluid through the Flow Meter Sight Glass

b) Visual check for degradation of pipe insulation

c) Visual inspection of solar collector tubes

d) Any fluid blow off into Catchment container

Decommissioning Instructions

Decommissioning of the Solar System MUST only be undertaken by a competent and trained person due to the high temperatures (>150 ºC) and high pressures (> 6bar) that can exist within the solar loop.

The system should be decommissioned when cool and ideally in low light conditions – early morning on a cloudy day would be ideal.

All electrical units should be isolated from the mains power supply before removing the power, sensor and earth connecting cables.

The collector loop can be drained from the drain valve in the solar loop. Be AWARE that hot glycol that may be in the solar loop. Carefully drain all the fluid from the solar loop should and gather in a suitable container and dispose of in accordance with local regulations.

Once the collector is fully drained the pipe-work can be disconnected from the system and the collector can be dismantled and the components set aside for recycling.

End of Life Recycling

Once the Apricus Solar Collector has reached the end of its usable life, it can be efficiently recycled. Below are the main materials used in the solar collector, all of which can be readily recycled where facilities exist.

Aluminium
Manifold casing and heat transfer fins

Silicone Rubber
Tube caps, header inlet & outlet seals, tube seals and manifold end covers

Glass Wool
Insulation within manifold

Copper
Manifold header pipe and heat pipes

Borosilicate Glass
The Evacuated Tubes

Stainless Steel
Mounting Frame, tube clips, nut and bolts, and evacuated tube support spring

Galvanized Steel
Heat transfer fin clips

Paper
Boxes and tube supports

Polyethylene
Packing bubble wrap

Product Registration

Customers / Installers are strongly recommended to register their installation with Apricus. This can be easily done online at **www.apricus.com** and following the links to ***Product Registration***.

A detailed installation record is then maintained by Apricus that will greatly help with any future warranty claims or servicing of your system.

Disclaimer

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Glossary of Terms

Temperature Mixing Valve (TMV)

A valve installed between the solar water heating system and the fixtures to automatically mix the hot water with cold water to achieve a safe outlet temperature of 50°C. A mixing valve must stop all hot water flow if there is a loss of either cold or hot water supply.

Closed Loop

A system that, typically, has an anti-freeze heat transfer fluid circulating through a closed, pressurized solar collector piping loop. This "freeze resistant" fluid is separated from the mains pressure water by a heat exchanger and typically should also contain a rust inhibitor. Closed loop systems are used in areas where freezing conditions are common.

Drain-back

A system that uses potable water or heat transfer fluid in the solar collector loop, but the fluid drains back down into a tank when the pump turns off, thus preventing overheating or freeze related issues.

Expansion Vessel

A metal tank with an internal rubber liner or bladder which is pressurised with air on one side of the bladder and accepts fluid from the closed loop on the other side. Because air can be compressed, the expansion tank can accept the increase in fluid volume that results when the temperature of the system increases. This prevents dumping of fluid from the pressure relief valve.

Solar Flow Line

The plumbing line supplying heated fluid FROM the Collector TO the Storage Cylinder or heat exchanger.

Solar Return Line

The plumbing line supplying heated fluid FROM the Storage Cylinder TO the Collector.

Insolation

Solar radiation level, expressed in kWh/m2/day. Peak solar radiation is about 1000 W/m2.

Pressure Relief Valve

Pressure relief valve is normally incorporated into the pump station of closed loop or direct flow systems. It opens if a set maximum pressure limit is reached, thus preventing damage to the system components.

Pressure & Temperature Relief Valve (PTRV)

The Pressure & temperature relief valve combines a pressure relief valve with a temperature sensitive core which will open to dump hot water if it reaches very high temperatures (typically 90°C or higher). PRTV are common on hot water storage cylinders to providing a safety mechanism for the release of pressure and heat if overheats for any reason. The pressure relief and temperature relief settings of the PTRV must comply with local building regulations.

Important Information

INTRODUCTION

The information contained herein is for guidance only with regard to the safe use and operation of domestic hot water and heating systems. The installer / user should reference the applicable National Standards in force that take precedence over any guidance contained in this document.

BACTERIA IN WATER SYSTEMS

Legionella bacteria are always present in man-made water systems, however, it is only in high numbers that the bacteria can cause illness. As the resulting Legionnaires' Disease can be fatal, there has been a considerable amount of research to define the characteristics of the bacteria.

Whilst legionella is typically associated with larger heating systems, such as hotels, hospitals, factories or air conditioning cooling towers etc. it can also be present in smaller domestic and residential systems.

Research shows that the bacteria are encouraged to colonise and thrive in conditions where the water temperature is between 20°C and 45°C, where the water is stagnant, an accumulation of debris exists, or scale and corrosion are present.

Scientific research shows that the legionella bacteria in the cylinder is killed in a matter of seconds at 70°C, and that 90% of the bacteria is killed after 2 minutes at 60°C, or after 2 hours at 50°C.

BACTERIA IN SOLAR SYSTEMS

Solar irradiation during the winter periods in the UK and Ireland may only contribute to approximately 10-20% of the hot-water demand by pre-heating the incoming cold water feed, by way of example, to temperatures of 20°C to 30°C. This lower energy contribution from the solar collector can still reduce fossil fuel consumption during the winter periods. However, the risk of lower temperature water, between 20°C and 45°C, being held in the cylinder for a period of time is increased, as is the associated risk of legionella bacteria growing.

Therefore, there is the requirement to incorporate a means to prevent bacterial growth (legionella) at all foreseeable flow rates before DHW distribution. One way of achieving this requirement (as detailed in MCS MIS3001 Standard 4.3.4) is through the use of a secondary means of heating the water to at least 60°C.

The relatively low volume of cylinder storage in small systems combined with typically high throughputs reduces the risk of bacterial proliferation. However, where a high risk of bacterial proliferation exists or the end-users are in a high risk category or the installation is a large system (e.g. hospital, nursing home, hotel, factory etc.) the solar store should be designed to be regularly sterilised. This sterilisation should be accurately controlled by time and temperature, and ideally occur at the end of the day to maximise solar contribution.

RISK ASSESSMENT

The competent installer should be capable of assessing the risks associated with the installation of the heating and hot water system in order to identify potential areas of risk, and to then implement the necessary actions to avoid or control the identified risks.

The installer should undertake a FULL risk assessment of the whole system (i.e. heating and hot water). If the installer does not feel they have the appropriate skills to undertake a risk assessment then assistance from a professional consultant should be sought.

If the installation is not intended for a domestic house and is intended for a commercial or industrial use (e.g. hospital, nursing home, factory, hotel, guest house, leisure centre etc.) then contact CoolSky Technical Support Office for guidance and advice on correct design solutions

REFERENCE DOCUMENTS

The installer should make himself familiar with the requirements of the following applicable documents and any other local or national regulations and guidelines in relation to legionella in hot water systems :

Issuing Body	Document
Health & Safety Executive (UK)	Code of Practice and Guidance L8
Health Service Executive (Ireland)	National Guidelines for the Control of Legionellosis in Ireland, 2009
Microgeneration Certification Scheme (MCS)	MIS3001 Standard – Requirements for Contractors Undertaking the Supply, Design, Installation, Set to Work Commissioning and Handover of Solar Heating Microgeneration Systems (Version 2.0)
Energy Saving Trust (EST)	CE131 : Solar Water Heating Systems – Guidance for Professionals, Conventional Indirect Models

IF IN DOUBT SEEK ASSISTANCE FROM A PROFESSIONAL CONSULTANT

COOLSKY LTD.

Standard Limited Warranty Terms & Conditions

GENERAL

CoolSky Ltd. warrants the Solar Collectors and Accessories (the "Products") supplied to be free from defects in workmanship under normal usage for the applicable Warranty Period from the effective date. This Limited Warranty extends to the End-User of the product at the original installation location, and is not transferable. In the event of a defect, malfunction or other failure of the Products occurring within the applicable Warranty Period which is not caused by any misuse or damage to the Product while in the possession of the End-User, CooSky Ltd. will remedy the failure or defect within a reasonable amount of time. The remedy will consist of repair or replacement of the Products, or refund of the purchase price, in the sole discretion of CoolSky Ltd. However, CoolSky Ltd will not elect to refund the purchase price unless it is unable to provide a replacement, and repair is not commercially practical and cannot be made within a reasonable timeframe. After a reasonable number of attempts by CoolSky Ltd. to remedy any defects or malfunction, the End-User will be entitled to either a refund or replacement of the product or its component parts. The remedies stated herein are the sole remedies for defects within the applicable warranty period.

LIMIT OF LIABILITY

EXCEPT FOR THE EXPRESS LIMITED WARRANTY PROVIDED FOR HEREIN COOLSKY HEREBY DISCLAIMS AND EXCLUDES ANY AND ALL OTHER WRITTEN OR ORAL EXPRESS WARRANTIES OR REPRESENTATIONS. ANY IMPLIED WARRANTY OF MERCHANTABILITY OR IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE MUST ARISE UNDER LAW TO APPLY, AND IS HEREBY LIMITED IN DURATION TO THE DURATION OF THE WRITTEN LIMITED WARRANTIES PROVIDED HEREIN UNLESS OTHERWISE BARRED BY ANY APPLICABLE STATUTE OF LIMITATION. COOLSKY DISCLAIMS ANY RESPONSIBILITY FOR SPECIAL, INDIRECT, SECONDARY, INCIDENTAL, OR CONSEQUENTIAL DAMAGES ARISING FROM OWNERSHIP OR USE OF THESE PRODUCTS, INCLUDING PERSONAL INJURY, INCONVENIENCE, LOSS OF USE OR LOSS OF INCOME. NO AGENT OR REPRESENTATIVE OF COOLSKY HAS ANY AUTHORITY TO EXTEND OR MODIFY THIS WARRANTY UNLESS SUCH EXTENSION OR MODIFICATION IS MADE IN WRITING BY A CORPORATE OFFICER. WHERE ANY DISCLAIMERS AND LIMITATIONS CONFLICT WITH APPLICABLE LAW, THE APPLICABLE LAW SHALL PREVAIL.

WARRANTY PERIOD

The Warranty Periods for Products supplied by CoolSky Ltd. is limited to the benefit of any such warranty that is provided to CoolSky Ltd. by the manufacturer of the Products. Where, the Manufacturer Warranty differs from that stated herein, the Manufacturer warranty takes precedence.

Component	Warranty Period	Effective Date
Solar Collector : Copper Heat Transfer Header	15 Years	Installation Date*
Solar Collector : Mounting Frame	15 Years	Installation Date*
Solar Collector : Evacuated Tubes and Heat Pipes	10 Years	Installation Date*
Heat Dissipater Unit	10 Years	Installation Date*
Solar Controller Unit	2 Years	Date of Manufacture
Pipes, Valves, Fittings	1 Year	Date of Purchase

* installation date as recorded on the installation commissioning form, purchase invoice date, or, if neither are available, the date of manufacture plus sixty (60) days.

WARRANTY EXCLUSIONS

This warranty shall be void and shall have no effect if:

a. The design or structure of the Products are attempted to be modified or altered in any way, including by not limited to attaching non-CoolSky approved appliances or equipment;
b. The Products are not installed or repaired in accordance with applicable local codes;
c. The Products are not installed by qualified, suitably licensed persons;
d. The installer had not received Product installation training by CoolSky Ltd. or an authorised partner:
e. The installation was not completed in line with the guidelines of the then current CoolSky installation manual;
f. System is exposed to excessive system pressure;
g. Solar collector is exposed to flow rates in excess of 15Lpm;
h. Any system component is damaged due to freezing;
i. Any system component leaks due to corrosion;
j. Non-approved heat transfer liquids are used;
k. Damage to the collector header is caused due to heat buckling;
l. Failure is due to wind, hail, storms or other acts of God;
m. Failure or loss of efficiency is due to lime-scale formation;
n. Failure is due to lightning damage, electrical power interruption or dirty power supply;
o. Electrical devices are installed in an environment that exceeds their specified operating range;
p. Temperature sensors fail due to water ingress, electrical shorting, or electrical interference;
q. Failure of the circulation pump due to running the system dry;
r. Product serial tag or other identification is defaced or removed;
s. Product is relocated from its original point of installation;
t. Collector is not commissioned and / or is left to stagnate for a period exceeding 14 consecutive days;
u. Any operation exceeds the documented design limits of the system components.

HOW TO OBTAIN WARRANTY CLAIM SUPPORT

End User Obligations

In order to obtain performance of any obligation under this warranty, the End-User must:

1. Firstly determine if the Product is within the applicable Warranty Periods. This can be determined by :
   a. Referring to the installation commissioning form, or
   b. The original purchase invoice, or
   c. The serial number and manufacturing date will need to be read off the Product serial tag.

   NOTE : Some Products may be installed in a location that is not accessible to the End-User and so the information may only be obtained by a qualified service technician.

2. Contact the Installer :
   a. Contact the company who installed the original Product, or, if unknown or unable to be contacted,
   b. Contact CoolSky Ltd. directly :

CoolSky Ltd.
42 Milecross Road
Newtownards
BT23 4SR
Northern Ireland, U.K.

Email : info@cool-sky.co.uk
Tel : +44 (0)28 9182 9470

The following information may be required to determine if the Product issue is eligible for coverage under the terms of this Limited Warranty :

a. Information related to the manner in which the Products were installed
b. The history of operation
c. Any repairs that may have been made
d. Evidence that the Products were installed by a qualified, licensed contractor.
e. Evidence that the Products were installed in accordance with the applicable Products Installation Manuals and any special written design or installation guidelines by CoolSky for this project.
f. Evidence that the Products were installed in accordance with all applicable local and national building, plumbing and electrical regulations.

CoolSky Ltd., 42 Milecross Road, Newtownards, BT23 4SR, Northern Ireland, U.K.

Tel : 028 9182 9470 **Email : info@cool-sky.co.uk** **Web : www.cool-sky.co.uk**

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Apricus Solar Ltd. are a global supplier of Solar Thermal Collectors and associated components.