Apricus®
www.apricus-solar.com

AP Solar Collector
Installation and Operation Manual

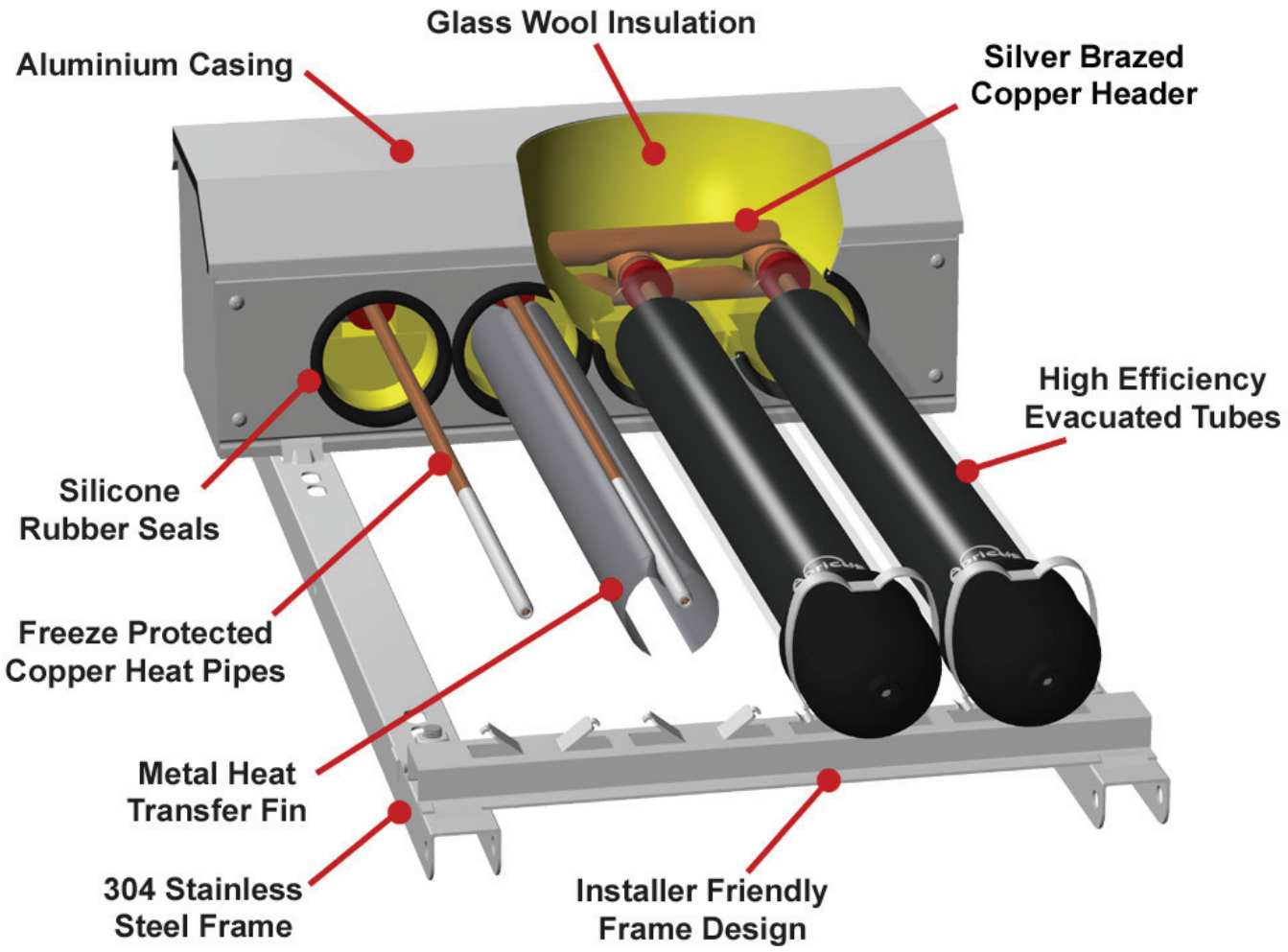
International Edition Rev. 1.5 (Sept 2005)

Introduction

Thank you for purchasing an Apricus AP solar collector. This unit is designed to provide years of reliable service, providing clean solar thermal energy. In order to ensure reliable and high efficiency operation, it must be installed in a correctly configured system.

Only employ the services of certified solar installers, and ensure the installation meets all relevant regulations.

The Apricus AP collector has been designed with ease of installation as one of the key design features. This manual includes a clear step-by-step installation guide. If any problems are encountered during the installation process please contact your local, authorised Apricus agent.



For more information on the AP collector please click here to visit the Apricus website.

Contents

1. Important Information

1.1. Local Standards
Installation must be completed in accordance with the relevant local standards and regulations.

1.2. Qualified Installer
Installation must be completed by qualified plumbing professionals.

1.3. Pressure and Temperature Control and Relief
Solar loop should be designed for normal operation at <500kPa via use of a pressure limiting (pressure reduction) valve on the mains cold supply line. System design must provide means for allowing pressure release at no more than 800kPa (113psi) and hot water dumping from the solar loop or storage tank once the temperature reaches 99°C (210°F). It is recommend that the lever on the pressure and temperature relief valve (PTRV) be operated once every 6 months to ensure reliable operation. It is important to **raise and lower the lever gently**.

1.4. Water Quality
Water in direct flow through the manifold header must firstly meet potable water requirements, and in addition the following:

Total dissolved solids	<	600 mg/litre or p.p.m.
Total hardness	<	200 mg/litre or p.p.m.
Chloride	<	250 mg/litre or p.p.m.
Magnesium	<	10 mg/litre or p.p.m.

In areas with “hard” water (>200ppm), lime scale may form inside the header pipe. In such regions, it is advisable to install a water softening device to ensure the long term efficient operation of the collector, or use a closed loop for the solar circulation loop.
If using a glycol/water mix, the water must meet the above requirements, and the glycol must be changed periodically to prevent the glycol from becoming acidic.

1.5. Metallic Corrosion
Both copper & stainless steel are susceptible to corrosion when high concentrations of chloride are present. The solar collector may be used for heating of spa or pool water, but levels of free chorine must not exceed 2ppm. In addition the warranty provided on the header when using for spa or pool heating is 2 years, which is the standard for spa and pool heaters. Chloride levels present in most reticulated public potable water supplies are safe for use in the collector provided there is no use of bore waters in the reticulated supply.

1.6. Freeze protection
Freeze protection should be incorporated into the system by use of a “low manifold temperature” setting on the solar controller, which turns on the pump if the manifold drops below a preset level (Eg. 5°C / 41°F). Alternatively a closed loop filled with a glycol-water mix may be used to provide freeze protection. Evacuated tubes are not susceptible to damage in cold weather, and heat pipes are protected against damage caused by freezing of the water inside.

1.7. Collector Gross Weight (Filled)
The collector header pipe is only of small diameter (15.6mm ID), and therefore the water volume contained in the header is only minimal. The installed filled weights (including standard frame) of the collectors are as follows:

AP-10 = 35kg / 77p AP-20 = 63.5kg / 139p AP-22 = 71.8kg / 157p AP-30 = 95.5kg / 210p

1.8. Wind Stress
When installing the collector, please consider the issue of wind resistance, and the resultant stress on attachment points. The standard frame, low pitched roof frame and flat roof frame are all designed to withstand wind speeds of up to 180km/h / 112mph without damage, but roof attachment points may not be as strong. For areas with the possibility for high-speed winds, additional reinforcement of attachment points may be required. If installing the low pitched roof frame or flat roof frame, stainless steel cables

may be used to further secure the frame, running from the top of the rear legs diagonally backwards. See Appendices A, B & C for frame assembly details.

1.9. Hail Resistance

The glass evacuated tubes are surprisingly strong and able to handle significant impact stresses once installed. Testing and impact stress modelling proves that the tubes are able to withstand impact from hail up to 25mm /1" in diameter when installed at angle of 40^{o} or greater. The ability of the evacuated tubes to withstand impact from hail is greatly influenced by the angle of impact, and so installing the collectors at low angles does reduce their impact resistance. However, even when laying flat, impact by hail up to 20mm / 3/4" in size will not cause breakage.

It is recommended that in areas prone to large hail (>20mm / 3/4") the solar collector should be installed at an angle of 40^{o} or greater to provide optimum protection. As many populated areas in the world fall within the latitude of $\pm$30-70^{o} this angle is generally a common installation anyway.

If in the unlikely circumstance that a tube should become broken it can be easily replaced in a matter of minutes. 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).

1.10. Scope of Manual

This manual pertains only to the installation and operation of the solar collector. Details for the installation, operation and maintenance of the complete solar gas/electric water heating system including, but not limited to storage tank, gas/electric booster, pump, system controller, valves and other plumbing components should be provided separately by their respective agents/distributors/resellers/installers.

1.11. System Design and Installation

Please read all installation instructions carefully before beginning system design or installation. The system configuration may need to be customized to suit the specific requirements of the installation. Please ensure that any system design meets local building, water quality regulations.

2. Installation

2.1 Unpack and Inspect

2.1.1. Component List

Please familiarize yourself with the components listed on the packing list, which is included in the collector manifold packing carton. If any components are missing, or additional part are required, please contact your supplier who will have spares in stock.

2.1.2. Tube Inspection

Open the tube box(es), which contain both evacuated tubes and heat pipes. Check to make sure the evacuated tubes are all intact, and the bottom of each tube is still silver. If a tube has a white or clear bottom, it is damaged and should be replaced. Each evacuated tube contains a pair of metal heat transfer fins. As soon as the evacuated tubes are removed from the box, please put on the rubber tube caps, which are located in the manifold box. This will protect the bottom tip of the glass tube from being broken if knocked. Do not remove the and/or expose the tubes to sunlight until you install them, otherwise the inner tube and heat transfer fin will become very hot. The outer glass surface will not become hot.

2.1.3. Heat Pipes

If heat pipes are bent during handling, don't worry, they are not easily damaged. Just ensure they are relatively straight before insertion into the evacuated tube.

2.1.4. Frame

Unpack the standard frame kit that is packed together with the manifold (except for AP-10 manifolds). If a flat roof frame or low pitched roof frame is being used, those components will be packed separately from the manifold. It may be necessary to purchase bolts or other fasteners to suit the installation surface. The attachment plates and bolts required to attach the manifold and bottom track are already in place on the frame front tracks. For each frame front track, there are two extra sets of bolts that can be used for securing the roof attachment straps.

2.2 System Design

2.2.1. System Design

System design should be completed prior to commencing installation. Solar collectors need to be installed correctly to ensure high efficiency, and most importantly, safe and reliable operation. Please seek professional advice for the design and installation of your solar heating system.

2.2.2. Key Design Considerations

Consider issues such as pressure control, overheating, freeze protection and pump control when designing the system. Avoid reliance on freeze valves and other components that are prone to malfunctioning. Over-engineering a system can greatly increase cost, reduce efficiency and increase the likelihood of system failure. In most cases a standard system that has been approved by the relevant authorities should be used, as the efficiency and reliable operation of the system can be ensured.

2.2.3. Delta-T Controller Settings

Usually a Delta-T ON value of 7-10^{o}C / 12-18^{o}F and Delta-T OFF value of 2^{o}C / 3.6^{o}F is used. These setting may need to be altered slightly according to the location and system design.

2.2.4. Stagnation and Overheating

Stagnation refers to the condition that occurs when the pump stops running, due to pump failure, power blackout, or as a result of a high tank temperature protection feature built into the controller, which turns the pump off. If a PTRV is installed on collector inlet or outlet the collector will continue to increase in temperature until the limit of the temperature relief valve is reached, at which point hot water will be dumped from the system.

If a PTRV is not installed on the collector, steam will form in the header. Eventually some steam may feed back to the storage tank via the return line. The PRTV on the tank will open to release pressure or heat as required. Under such conditions the manifold will normally reach a maximum temperature of around 160^{o}C / 320^{o}F. Generally the heat returning from the collector in the form of steam is not enough to affect a continued increase in tank temperatures (ie. Heat input < tank heat losses)

Under normal use stagnation should rarely occur as a result of pump stoppage, since power blackouts normally happen during storms and not clear sunny weather. High tank temperature protection should only occur when hot water is not used for several days (when on holiday), and only during strong periods of sunlight (summer). If leaving the house for an extended period of time (more than 2-3 days), it is advisable to cover the collector panel or design the system with a heat dissipation device or alternative use for the heat, thus preventing overheating of the system and collector stagnation.

Stagnation of the solar collector will NOT damage the solar collector, however insulation used on the piping close to the manifold inlet and outlet should be able to withstand temperatures of up to 200 ^{o}C / 395^{o}F (Eg. glass wool or mineral wool – with an exterior wrap of aluminium foil, thus protecting against the elements).

2.2.5. Correct System Sizing 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. If the system is over-sized, such that excessive heat is often produced during summer months, some form of heat dump, or heat dissipation feature should be installed. Alternatively several of the tubes may be covered to reduce total heat output.

2.2.6. Solar for Central Heating – Preventing Overheating

If a system has been designed to provide contribution to central heating, it will often provide much more heat in the summer than is required for hot water supply alone. In such cases it is advisable for the home to have a spa or pool that can use the heat in the summer period or a heat dissipation device be installed.

2.2.7. Adjusting Collector Angle to Ease Overheating

For areas that have particularly high summer solar radiation levels, the collector may provide too much heat in the summer. 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 of around 15^{o} above the latitude angle. This angle corresponds closely to angle of the sun in the sky during the winter months, thus maximising the amount of exposed collector surface area (longitudinal IAM). Conversely, during the summer when the sun is high in the sky, the relative surface area of the collector exposed to sunlight is reduced, in effect reducing overall heat production considerably (by about 15%). This option is ideal for installations where solar thermal is being used for central heating.

2.2.8. Collector Direction

The collector should face the equator, which if in the Northern hemisphere is due South, and vice versa. Facing the collector in the correct direction and at the correct angle is important to ensure optimal heat output from the collector, however a deviation of up to 10^{o} from due North or South is acceptable, and will have minimal effect on heat output

2.2.9. Collector Plane

The collector manifold is normally installed on the flat horizontal plane, but may be installed at and angle of +/-5^{o} from horizontal as may be required if installing in a drain-back configuration. Vertical orientation of the manifold is not permitted, as the heat pipes will not function properly. The collector will not operate if installed with the manifold at the bottom and tubes pointing upwards (up-side-down).

2.2.10. Collector Angle

It is common for collectors to be installed at an angle that corresponds to the latitude of the location. See also point 2.2.7. Installing at an angle less than 20^{o} is not recommended as the heat pipes perform best in the range of 20-70^{o}. While adhering to this guideline, an angle of latitude +/- 10^{o} is acceptable, and will not greatly reduce solar output. Angles beyond this range may be used, but a decrease in heat output will result. An angle lower than the latitude will enhance summer output, while a greater angle will enhance winter output.

2.2.11. Avoid Shade

Collectors should be located so that shading does not occur for at least the 3 hours either side of 12 noon standard time. Partial shading due to small objects such antennas and small flues, is not of concern.

2.2.12. Location

The collector should be positioned as close as possible to the storage cylinder to avoid long pipe runs. Storage cylinder positioning should therefore consider the location requirements of the solar collector. The storage cylinder should also be located as close as possible to the most frequent draw off pipe runs.

2.2.13. Expansion Vessel – Minimising water wastage

In any hot water system, be it solar, gas, electric or combination thereof, expansion of water will occur as the water heats up. When water expands it has to be released as it cannot be compressed like air can. Generally this water is released via the pressure release valve, which is mounted on the tank or solar collector loop.

For example:
A standard household has a 250L / 70G gas or electric heated hot water tank.
The cold water temperature is 15^{o} C / 59^{o}F, target hot water temperature is 65^{o}C / 150^{o}F.
This represents a rise of 50^{o}C / 91^{o}F, which results in the water expanding by 5L / 1.3G (2%).

Water cannot be compressed, so the additional volume of water is released from the tank via a PRV. Such venting can happen several times per day, corresponding to each time a large volume of hot water is used, and the tank re-heats.

If the average household vents 10L / 2.64G of water per days; that is around 3650L / 964G of wasted water per year! This is not the case for mains pressure systems, and not open vented system.

There is a simple solution to this problem, which is inexpensive, reliable and easy to install – it is called an expansion vessel (AKA: Pressure Tank).

An expansion vessel is essentially just a mild steel tank with a butyl (rubber) diaphragm inside. One side of the diaphragm is filled with air (set at a certain pressure, ~150kPa / 21psi), the other side with the water from the hot water system. As air can be compressed (unlike water), as the water in the system expands, the expansion vessel can accept some of this volume by compressing the air. If sized correctly, the expansion vessel can accept the full expanded volume of water, thus preventing any venting. This simple addition to the system can prevent nearly 4 tonnes of water a year from being wasted!

2.3 Mounting Frame

All AP solar collectors are supplied with a standard frame, which is suitable for flush mounting on a suitably pitched roof. For low-pitched roofs or installation on flat surfaces, additional frame kits are available. Depending on the location, the standard frame may be provided with either rubber pads or roof attachment straps.

2.3.1. Frame Material

All frame components are made of ≥1.5mm thick 304-2B stainless steel making the frame both strong and corrosion resistant. It is important that frame attachment points and fasteners are also of suitable structural strength and corrosion resistance.

2.3.2. Galvanic Reaction Between SS and Zinc Galvanised Steel

Zinc or Zn/Al galvanized components should NOT be installed in direct contact with stainless steel, as galvanic reaction between the two metals can cause premature oxidation of the zinc coating and the steel underneath. If the roof surface is galvanised iron (corrugated iron), refer to section 2.4.4 for installation guidelines. Avoid using galvanised steel bolts; instead use stainless steel components. If galvanized components are used, avoid direct contact between the two metals by using the rubber/plastic separators.

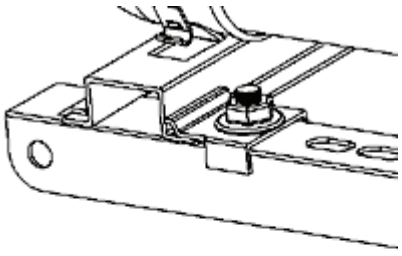
2.3.3. Roof Installation

Three types of roof installation are outlined in this guide:

1. Flush installation on a suitably pitched tiled or shingled roof. See section 2.4
2. Installing on a roof with insufficient pitch. See section 2.5
3. Installing on a flat surface. See section 2.6

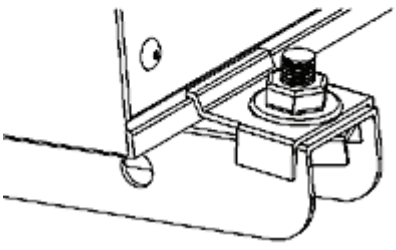
2.3.4. Manifold and Bottom Track Attachment

Both the manifold and frame bottom track are secured to the frame front tracks using special attachment plates. These plates are already attached to the front tracks when shipped, so they only have to be loosened to allow the manifold and bottom track to be fitted.



The clips are designed such that when loose, the manifold and bottom track are able to slide left and right. This allows the front tracks to easily be adjusted to suit the roofing surface.

Once correctly located the nuts should be tightened using the supplied spanner, locking the manifold and bottom track in place.



Note that the bolt is up-side-down with the nut on top. This allows the thread to be viewed and as such prevents the installer from loosening the bolt so much that the nut drops off. The bolt head is prevented from rotating by use of a nut lock, preventing the need to use a second

spanner.

2.3.5. Customising the Frame

The standard frame, low pitched roof frame and flat roof frame components can be used creatively to suit a range of different installation surfaces. Additional holes may be drilled in the frame as required, but ensure that frame structural integrity is not compromised (E.g., drilling holes too close together).
For examples of customized frame installations, please view the photo gallery on the Apricus website by visiting: http://www.apricus-solar.com/html/solar_collector_photo_gallery.htm

2.4 Flush Pitched Roof Installation (Standard Frame)

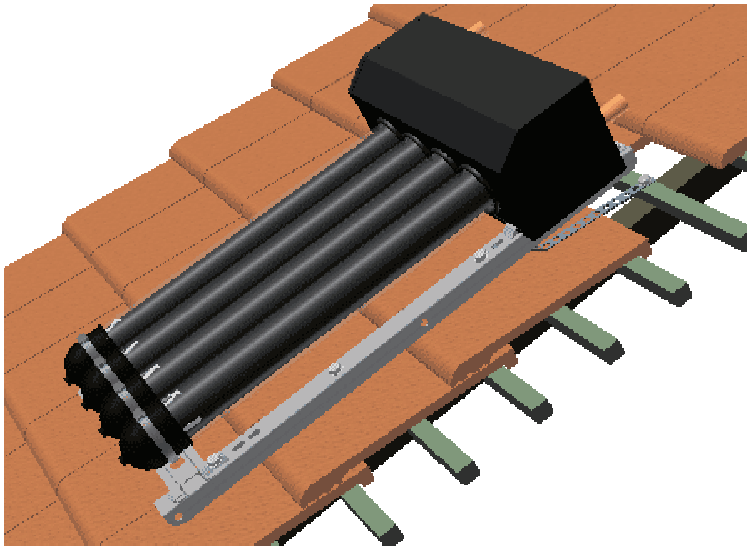
Refer to Appendix A for assembly diagram.

2.4.1. Installation Planning

In order to minimize the number of tiles that need to be removed (and returned into place), please carefully plan the location of the manifold, frame front tracks and plumbing pipes. Tiles may have holes cut to allow the roof straps or bolts passing through. Any holes must be covered and/or sealed with standard roofing materials to avoid leaks during rainfall.

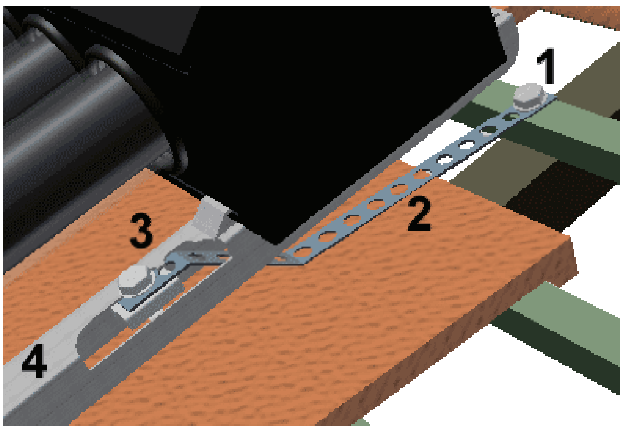
2.4.2. Positioning Manifold

The manifold and bottom track can slide left and right in relation to the frame front tracks, so there is some flexibility when selecting the location for the frame front tracks. Generally the frame front tracks should be located such that they lay flat and even on the roof (match the tiles) and also line up with the roof frame timbers. If possible try to locate them under the 2nd or 3rd tube from each end. By locating the front tracks directly under the evacuated tubes, the stainless steel frame will be hidden, improving the aesthetics of the installation.



2.4.3. Tiled Roof Attachment

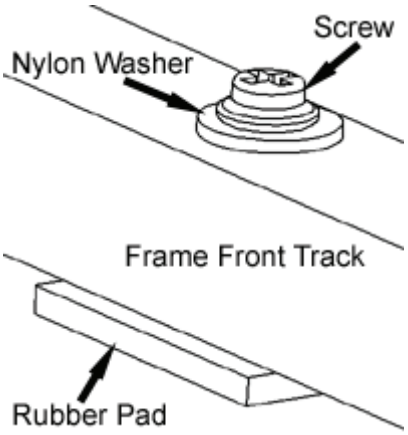
For tiled roofs, the 60cm / 2foot long roof attachment straps should be secured to the underside of the frame front tracks using the supplied M8-20 bolts and nut lock assemblies. The pictures above and below show a strap at the top of the front track. Another strap should also be attached lower down the front track to provide an additional attachment point. Attachment to the roof should be completed with M8 (8mm diameter) or thicker bolts or screws. Please ensure that roof-anchoring points are very sturdy. Once the upper straps are attached and tightened, adjust the bottom straps to ensure that they too are providing support to the frame.



Key:
1. Roof Attachment
2. Attachment Strap
3. Frame Attachment
4. Front Track

2.4.4. Corrugated Iron Roof

For installation on a corrugated iron roof, the rubber pad can be used to separate the frame from the roof and also to seal the hole. Use a standard corrugated iron roofing screw to secure the frame front track directly to the roof's wooden purlins (addition holes may need to be drilled in the frame front track). The roofing screw should have a rubber/nylon washer, which will prevent direct contact between the two metals, and also seal the hole. The rubber pad will form a tight seal against the roof, preventing any water ingress.
This mounting method is also suitable when attaching the roof tracks used in the low-pitched roof frame. (See section 2.5)



2.4.5. Asphalt Shingle Roof

For installation on an asphalt shingle roof, the front track may be screwed directly to the roof in a similar fashion to the diagram above. The rubber pads will help seal the hole in the asphalt shingle to prevent water ingress (silicone sealant may also be required).

2.4.6. Correctly Align Frame

Please make sure that the front tracks are both parallel and level. An uneven frame may result in damage to the system, in particular, the evacuated tubes.

2.4.7. Manifold and Bottom Track Attachment

Once the front tracks are secured, the manifold and bottom track may be attached, taking care to ensure they are correctly aligned. Both the manifold and bottom track will lock into the frame, secured from above with the attachment plates that are already in place.

2.5 Low Pitched Roof Installation (Low Pitched Roof Frame)

If the roof pitch is insufficient, the low-pitched roof frame kit can be used to increase the angle by between 9 and 27^{o}. This frame kit combines with the standard frame components. See Appendix B for assembly diagram.

Connection of the roof tracks should be completed in the same way as the front tracks, outlined in section 2.4. Additional holes in the roof tracks may need to be drilled onsite to match the location of roof purlins or other roof structural components.

2.5.1. Rear X Brace Adjustment

Unlike the flat roof frame, which has a set location for the rear legs and front tracks, the low-pitched roof frame is adjusted like the standard frame to match the tiles/corrugations/shingles. In addition, the angle chosen (as dictated by the length of the rear legs) will affect the required length of the rear x brace struts. The two struts per X brace must be cut to length, and 9mm / 0.35" holes drilled to suit. This is quite easy to do using a hacksaw/angle grinder and standard electric drill.

2.6 Flat Roof Installation (Flat Roof Frame)

The flat roof frame is appropriate for installations on flat surfaces and provides adjustment from 30-50°. The flat roof frame kit combines with the standard frame components to form the complete frame.
Refer to Appendix C for assembly diagram.

2.6.1. Number of Legs

10 and 20 tube collectors use 2 sets of front track and legs and one rear X brace. 22 and 30 tube collectors utilise three sets of front track and legs, as well as two sets of rear X braces. Additional sets of legs and front tracks can be added if required (extreme high wind areas).

2.6.2. Front Track Positioning

For flat roof frames, the position of each front track is fixed, as dictated by the rear X braces and front braces. If the location of the front tracks needs to be adjusted, these two components can have additional holes drilled and be cut to length. The standard location of the left and right front tracks is directly beneath the second tube from each end. For 22 or 30 tube collectors which have a third set of front track and rear leg, the central front track is located between the 11th and 12th, or 15th and 16th tubes respectively.

2.6.3. Frame Feet Anchoring

Frame feet should be bolted to the installation surface using M10 (10mm diameter) or larger bolts, or a similarly sturdy fastening method. Ensure the surface is solid and able to withstand the significant "pull" force that may be encountered during high winds.

2.6.4. Adjusting Frame Angle

The rear legs of the flat roof 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 30 and 50°. If an angle less than 30° is required the top rear leg may be cut short (the bottom leg is not used). In such cases the rear X brace components will need to be cut shorter, and additional holes may need to be drilled to ensure correct alignment.

2.7 Plumbing

2.7.1. Plumbing Connection

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

2.7.2. Choice of Piping Material

13mm OD, or 15mm OD copper piping is generally used for most solar collector installations. As the flow rate is slow, a large diameter pipe is unnecessary and will only increase system costs and heat loss. AP collectors come standard with two flexible SS pipes (not in all markets). They are designed for connection to the manifold as they are easy to bend and pass through the roof. The end of the flexible pipe is either 1/2” F or 3/4” F BSP thread, and so can accept standard male BSP thread fittings for connection to copper pipe.

2.7.3. Pressure Levels

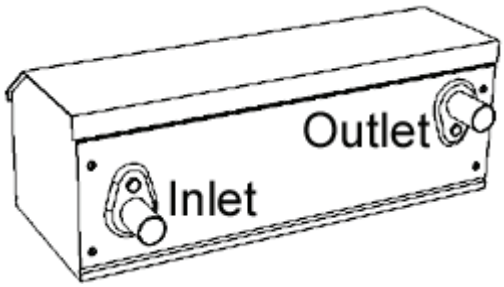
Regardless of the installation configuration, pressure release valves, expansion vessels and/or other pressure control devices must be installed. The solar loop should be designed to operate at no more than 800kPa (PRV may be 850kPa). (800kPa = 8 bar = 116psi) For installations where mains pressure water is used, the system should ideally be designed to operate at a pressure of <500kPa, achieved by use of a pressure limiting/reduction valve.

2.7.4. Tempering valve.

It is recommended, and may be required by regulations, that a temperature control device (tempering valve) be fitted into the hot water pipe between the water heater and bathrooms and en-suites to reduce the risk of scalding. This is achieved by controlling the water temperature to below 50°C / 122°F (temperature may be adjustable).

2.7.5. Inlet and Outlet Connections

For REAR port manifolds, when viewing the manifold from the rear, the inlet is the left hand (lower) port (marked with red ring). END port manifolds can use either end as the inlet. Both the inlet and outlet of end and rear port models have temperature sensor ports. Generally the outlet should be used for temperature sensing; using the inlet port can result in the pump cycling to frequently.



2.7.8. Temperature Sensor Insertion

The solar controller's temperature sensor should be coated with a thick layer of thermal paste and inserted into the sensor port to the full depth. If the fit is too loose, slide a piece of copper plate or wire in beside the sensor. Seal the sensor port opening with silicone sealant to prevent water ingress. Ensure that sensors used on the collector are high temperature rated (up to 250^{o}C / 486^{o}F), in particular the cable.

2.7.9. No Brazing Permitted

Do not braze copper pipe directly onto the manifold ports. The rubber seal and glass wool may be damaged. Only use the supplied brass compression fittings (or locally available equivalent). Always use two opposing spanners when tightening the compression fittings. DO NOT twist the copper pipe as the header may be damaged.

2.7.10. Air Purge

Once the inlet and outlet are connected to the plumbing system, the collector loop should be purged of air. If a direct mains pressure system is being used, opening up the hot water taps in the house and operating the pump at full speed should elimination all air from the system. For non mains pressure installations, the pump should be run at the highest speed settings, forcing air out of the manifold and back into the tank. If air is not fully eliminated from the collector manifold, it may be necessary to loosen the connection to the header outlet to allow air to be released (auto-air vent may be used to vent air from collector manifold)

2.7.11 Plumbing Check

Once plumbing is confirmed as leak free and with all air having been purged, the heat pipes and evacuated tubes may be installed.

2.7.12. Insulation (Lagging)

Heavily insulate all piping running to and from the manifold with a high quality closed cell insulation (at least 15mm/0.6" thick).

Ensure the insulation is tight against the manifold casing, thus minimising 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 between the manifold casing and the insulation material. Insulation foam that is exposed to direct sunlight should have a wrap of a metallic foil applied to protect against UV degradation.

Piping should have a minimum insulation thickness of 13mm, thicker in cold climates.

For systems designed without a PRTV close to the manifold, high temperature rated insulation (Eg. glass wool or mineral wool) should be used for the first 1m/3 feet from the inlet & outlet as high temperatures will be encountered during periods of stagnation. Glass wool insulation may come with an external foil wrap, but any cuts made during installation should be sealed with a foil style layer.

2.7.13. Pump Size

Sizing the pump is not always an easy task. The pump should provide enough pressure to enable circulation through the header, but preferably only at a slow rate (0.1L/tube / 0.026G/tube). Apart from wasting electricity, a fast flow rate will cause turbulent mixing of the water in the storage tank, disturbing temperature stratification, which is not desirable.

If the water pressure used in the solar loop is sufficient to fill the header passively, then the pump is simply required to circulate the water. The key consideration is therefore the pressure drop throughout the pipeline. Elbows, Ts, and bends in piping all contribute to pressure drop. For this reason the flow path

should be kept as simple and unrestricted as possible.

Please refer to the Apricus pressure drop model to allow accurate calculation of pressure drops through the collector header(s).

For single storey houses where the pipe run to and from the collector is no more than about 8m / 27feet, a small 25-30Watt pump with low head pressure (~50kPa / 7psi) may be sufficient. 2 or 3 storey houses where the pump run is longer, a 60-70Watt pump may be required. The use of a 3 speed pump is ideal, as an appropriate speed setting can easily be chosen (Eg. 40, 60 & 90Watt settings).

In order to determine if the pump chosen is suitable, a flow meter can be temporarily installed on the return flow line, thus providing a visual indication of flow rates. Alternatively, if a solar controller with LCD temperature display is used, the solar collector and tank temperatures may be monitored. Under normal operation, with correct flow speed, the manifold temperature should gradually increase (speed will depend on solar radiation levels). In good sun it should only take 3-5min for the manifold to increase by the Delta-T ON level (~7-10^{o}C / 12-18^{o}F). Once the pump turns on, the header temperature should initially increase by 2-3 degrees as the hot water in the header passes by the sensor. Over a subsequent period of 30-60seconds the header temperature should gradually drop back down, the pump turning off once the Delta-T OFF level is reached.

If the manifold temperature does not gradually decrease once the pump turns on, then it may indicate insufficient circulation. If the temperature drops too quickly, the circulation speed may be too fast, wasting electricity, and causing unnecessary turbulence on return to the storage tank (if applicable). The best option, if possible, is always to use an appropriately sized pump. An experienced solar installer is the best person to provide advice regarding pump sizing.

Always use hot water rated pumps, as temperatures close to boiling can be experienced. The pump should always be installed on the TO COLLECTOR line, thus reducing exposure to high temperatures.

2.8 Evacuated tube & Heat Pipe Installation

The AP collector is a simple “plug in” system. The heat pipes and evacuated tubes just need to be plugged into the manifold. The contact between the heat pipe condenser and heat pipe port 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, even if replacing a damaged evacuated tube.

DO NOT INSTALL THE HEAT PIPES AND EVACUATED TUBES UNTIL SYSTEM PLUMBING IS COMPLETED AND PUMP AND CONTROLLER ARE OPERATIONAL.

Please follow the instructions below for assembly and installation:

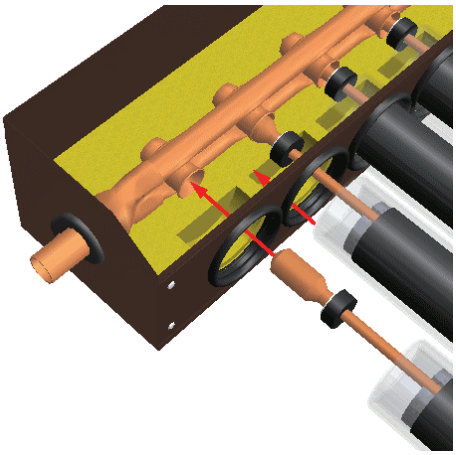
2.8.1. Unpacking

The heat pipes and evacuated tubes are packed in the same box, but for reasons of safety (against breakage) the heat pipes are not inserted into the evacuated tubes. The heat pipes must be inserted into the evacuated tubes prior to insertion into the manifold.

a) Ensure the heat pipe is relatively straight prior to insertion into the evacuated tube. Slight curves are acceptable as the copper is soft and able to "straighten" when inserted.

b) Place a rubber caps onto the bottom of the evacuated tube.

2.8.2. Heat Pipe and Evacuated tube Insertion



a) Insert the heat pipe into the evacuated tube, guiding the heat pipe down between the evacuated tube and heat transfer fin (in the groove provided). A certain amount of resistance will be experienced when inserting the heat pipe due to friction with the heat transfer fin. This is normal. The evacuated tube is very strong and will not be damaged when installing the heat pipe. A twisting action can be used to facilitate smooth insertion.

b) Insert the heat pipe until approximately 10cm / 4" of the heat pipe remains protruding from the evacuated tube. Make sure the metal disc and rubber ring are pushed up to a position just below the condenser.

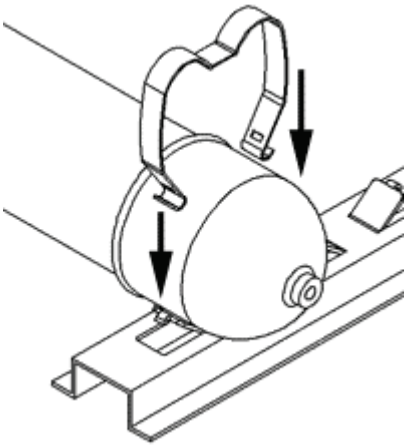
c) Coat the sides of the heat pipe condenser with a thin layer of heat transfer paste, or alternatively, apply to the inside of each of the heat pipe ports (header). Lubricate the top outer surface of the evacuated tube with a small amount of lubricating solution (mild dish washing liquid & water mix). This facilitates easy insertion past the manifold rubber ring seal. As small pump spray bottle is the best method for carrying and applying the lubricating solution.

DO NOT ALLOW ANY WATER TO ENTER THE EVACUATED TUBE.

d) Whilst firmly holding the evacuated tube, guide the heat pipe tip in past the manifold rubber seal, and into the heat pipe port. As it is a tight fit, it may not insert fully – see next step.

e) Using a slight left and right twisting action, push the evacuated tube up into the manifold. If the evacuated tube seems to stick to the rubber ring, apply some lubricating solution to the ring. The neck of the evacuated tube will push against the rubber ring at the base of the heat pipe condenser, pushing it fully into the port. The heat pipe and evacuated tube are fully inserted once the black coating of the evacuated tube has disappeared up into the manifold (no clear glass visible) and the bottom of the tube sits correctly in the bottom track.

f) After all the tubes are inserted fully, secure the tube to the bottom track using the stainless steel clips as follows.



Step 1) Line up the clip with the hook on the bottom track and push down over the rubber cap while favouring one side until a "click" sound is heard.

Step 2) While **centralizing** the clip over the top of the rubber cap, push down the other side until it too "clicks" into position.

Step 3) Check to ensure both sides are correctly clipped over the hooks.

The clip can be removed by using a small screwdriver or needle nosed pliers to pull each side of the clip down and outward.

2.8.3. Post Installation Cleaning

Clean each evacuated tube with a liquid glass cleaner and cloth/paper.

2.9 Post Installation

2.9.1. Collector Operation

After installing all the tubes, and given good sunlight, the solar collector will begin to produce heat after a 5-10min “warm up” period. Check the Delta-T controller and pump for correct operation and adjust settings as required.

2.10 Precautions

2.10.1. Metallic Components

Always wear gloves when handling the various solar collector components. All efforts have been made to make the metal components safe to handle, but there may still be some sharp edges.

2.10.2. Evacuated tubes

Be careful when handling the evacuated tubes, as they will break if knocked heavily or dropped. Wear gloves if handling any broken glass.

2.10.3. High Temperatures

With the heat pipe installed in the evacuated tube, and good sunlight, the heat pipe condenser can reach temperatures in excess of 200^{o}C / 392^{o}F. At this temperature touching the heat pipe will result in serious burns, so please take care when “experimenting” with, or “demonstrating” the evacuated tube and heat pipes.

In an installed, fully plumbed system, if the pump is stopped during good sunlight, the collector header and plumbing pipe close to the manifold can reach temperatures of 160^{o}C / 320^{o}F, and therefore caution should be taken when touching such components.

3. Maintenance

Maintenance of the system is very easy and includes the following tasks:

3.1. Cleaning

Regular rain should keep the evacuated tubes clean, but if particularly dirty they may be washed with a soft cloth and warm, soapy water or glass cleaning solution. If the tubes are not easily and safely accessible, high pressure water spray is also effective.

3.2. Leaves

During autumn, leaves may accumulate between or beneath the tubes. Please remove these leaves regularly to ensure optimal performance and to prevent a fire hazard. (The solar collector will not cause the ignition of flammable materials)

3.3. Broken Tube

If a tube is broken it should be replaced as soon as possible to maintain maximum collector performance. The system will still operate normally even with a tube broken. Any broken glass should be cleared away to prevent injury.

To replace a tube:

a) Remove the tube clip(s), slide broken tube out and carefully pick up any glass pieces. Please wear protective gloves when handling the broken glass. When removing the tube, the rubber ring in the manifold casing may pop out. Just return this ring into place before inserting the new tube.

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

c) The new tube(s) should already have heat transfer fins inserted, so slide the new tube into place taking care to guide the heat pipe into the slot between the fin and glass wall. Normally the heat pipe does not need to be removed from the manifold.

3.4. Insulation

The plumbing pipes running to and from the collector should be heavily insulated. This insulation foam should be checked annually for damage. For any insulation that is exposed to sunlight, UV stabilised foam (or metallic wrap) should be used, otherwise rapid deterioration may occur.

3.5. Draining the Collector

Draining of the manifold may be required if maintaining the system, moving the collector, or in preparation for extremely cold conditions (extended snow cover).

To drain the collector of fresh water (direct flow system):

Step 1. Turn off the mains water supply to the solar storage tank.

Step 2. If the storage tank or other system components are being concurrently drained, refer to their instruction manuals for details. If storage tank is not being drained, isolate piping to and from the solar collector (isolation valves should already be installed), and open drain cocks on both lines (or undo fittings).

Step 3. Open an air vent or drain cock, or undo a fitting on the manifold outlet to allow air to enter the system, permitting the solar loop to drain of liquid.

Step 4. Allow the manifold to sit in a vented state for 5-10min to allow the manifold to boil dry (may need longer in poor weather).

Step 5. Close the air vent or drain cock, or re-fasten fitting.

3.6. Other Components

Other parts of the system such as the pump and storage tank (electric or gas water heater) should be serviced/inspected according to their manufacturer's own maintenance guidelines.

4. Troubleshooting

Only those inspection items with an (**H**) in front may be safely completed by the home-owner. Any other system troubleshooting, system adjustments or repairs must be completed by a qualified tradesperson.

4.1. No Hot Water

If there is no hot water, it will generally be related to the gas or electric heating system, and not the collector. The collector pre-heats water, with final boosting completed by the electric element or gas booster system. Please contact the manufacturer/installer of your gas/electric water heater.

4.2. Reduced Solar Contribution

Solar contribution to your heating is directly related to the amount of solar radiation and the volume of hot water used. During the winter, and periods of rainy, or particularly overcast weather, the amount of energy produced by the solar collector will be greatly reduced.

As a general rule, the solar collector will have been sized to provide close to 100% of your summer hot water needs, which, depending on your location and hot water usage patterns, may result in between 40% - 70% of your annual hot water energy needs. During the winter, increased cloud cover and reduced solar radiation levels may result in solar contribution as low as 20%. This is normal.

If, given similar environmental conditions, you feel that the solar contribution (as indicated by energy savings) has considerably reduced; there may be a problem with your solar heating system. This may be due to an incorrectly configured controller, pump malfunction or problem with the boosting system. In such cases please contact your local Apricus agent or the tradesperson who completed the installation.

The home owner may safely investigate the following (then notify installer):

Investigation
(H) 1. Does the circulation pump appear to be operating? In good sunny weather the circulation pump should come on for 1-2 minutes once every 5 to 10 minutes. The pump may run very quietly, and so you may need to touch the pump or piping running to and from with a solid object to feel for motor operation (slight vibration). ***Do not use fingers as it may be hot!!***

(H) 2. Are all the tubes intact? If a tube has been damaged (broken) it will reduce the system performance and should be replaced. If a tube is damaged, do not attempt to remove it, seek professional assistance.

(H) 3. Are there any apparent leaks in the pluming to and from the collector? Any water trails down the roof, or around the storage tank?

4.3. Regular Water Dumping

If during normal daily hot water use, the temperature release valve on the tank or collector is regularly dumping hot water, it indicates a problem with the system.

Possible Causes:
1. The system has been sized incorrectly (oversized). This will be most apparent in the summer months, when solar radiation levels are high.
2. The pump has failed, or electrical supply to the controller and pump has been compromised.

3. A problem exists with the electric heating thermostat (Electric boosting only).

Investigation
(H) To test the system, run the hot water tap in the bathroom or kitchen for 5 minutes to release some heat from the system (the water will be hot, so be careful). If after this period, the collector is still regularly venting hot water it indicates a definite problem. Please contact your installer to organize an inspection.

4.4. Safety Precautions

For any problems that involve plumbing or electrical connections the services of a qualified professional must be employed.

5. Warranty

Apricus Solar Co., Ltd does not provide a warranty directly to the end user. Any warranty for this product must be provided by the company responsible for the distribution of the Apricus range of products in your location market. If no warranty document has been provided with this system please immediately contact your local Apricus distributor, or the company from whom this collector was purchased.

All warranty claims should be made to the local company through which the collector was purchased.

6. Disclaimer

Apricus Solar Co., Ltd withholds the right to change dimensions and the characteristics of the product without any forewarning, and rejects any kind of responsibility for misprints.

This booklet is only a guide and as such Apricus Solar Co., Ltd will not be held responsible for any damage to person or property that results during the installation or subsequent use of this solar collector and related system components. Any claims for liability shall be directed towards the local distributor of the Apricus range of products.

7. Installation Checklist

The following list is a guide only. Specific items will depend on the nature of the installation.

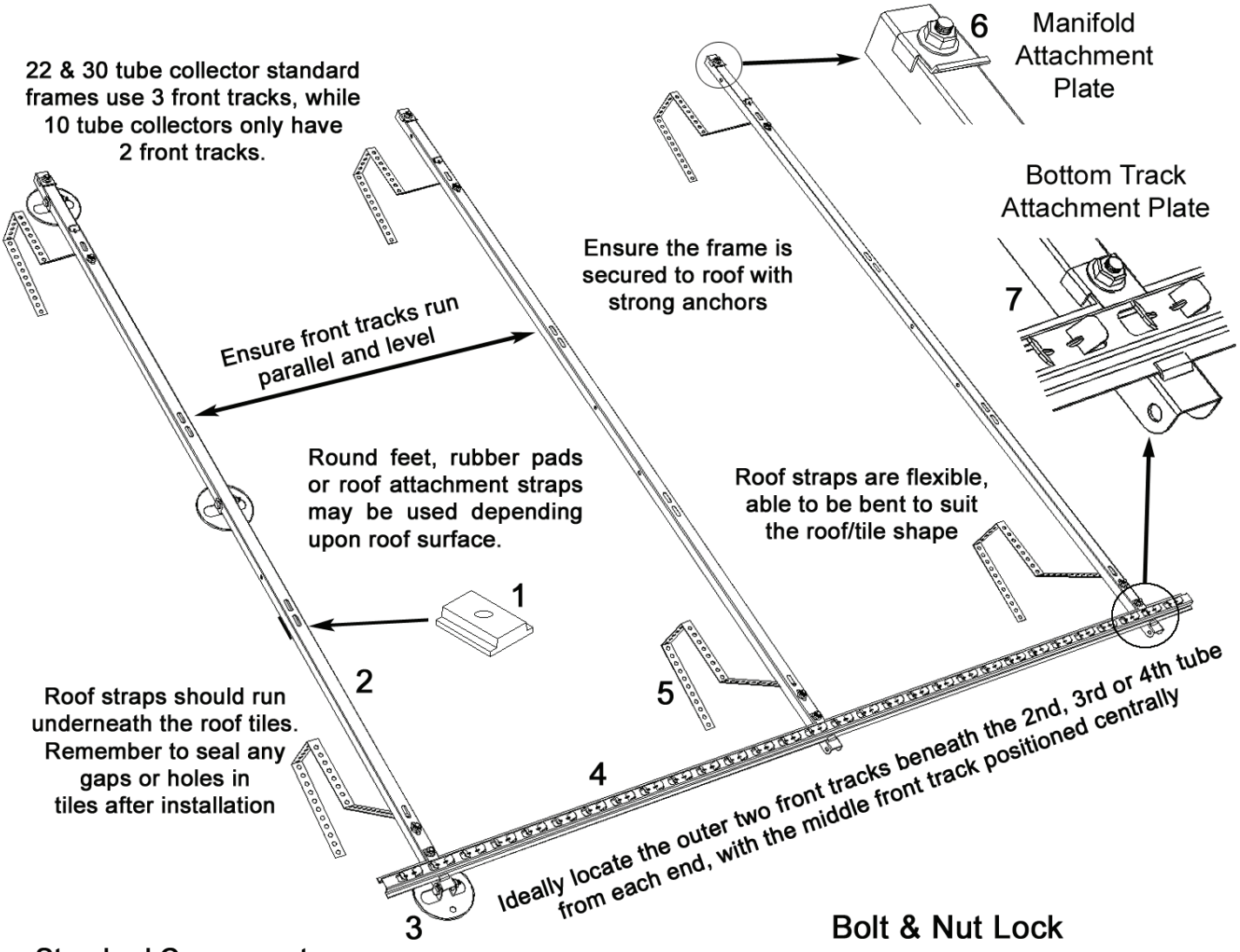
1	Collector faces as close as possible to due North/South.	□Y	□N
2	Manifold is not significantly shaded throughout the day.	□Y	□N
3	Manifold is not likely to be struck by falling objects such as branches, falling fruit, or other nearby objects	□Y	□N
4	Collector is installed at an angle of between 20^o – 70^o, preferably at latitude angle.	□Y	□N
5	In areas prone to large hail (>∅20mm / ∅3/4”), collector is installed at an angle of 40^o or greater.	□Y	□N
6	Frame is secured to structurally sound roof framing	□Y	□N
7	Plumbing is leak free	□Y	□N
8	Plumbing pipe runs are well insulated	□Y	□N
9	Insulation above roof level is protected with foil wrap or equivalent.	□Y	□N
10	Controller is configured correctly with freeze setting on (if required)	□Y	□N
11	System is fitted with PTRV on the collector outlet and/or storage tank.	□Y	□N
12	PTRV will dump only onto high temperature resistant material and will not pose a danger of scolding people.	□Y	□N
13	Pump, controller and all electrical connections are protected from water ingress	□Y	□N
14	Evacuated tubes have been cleaned	□Y	□N
15	Warranty document has been given to customer and basic operation explained	□Y	□N
16	Functional checks for controller and pump have been completed	□Y	□N
17	Water quality has been checked	□Y	□N

All items should be ticked **Y** for the installation to be considered completed and satisfactory.

For more information on Apricus products please visit **www.apricus-solar.com**

Appendix A

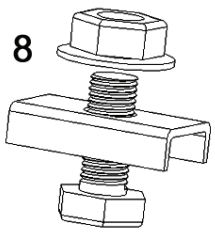
Standard Frame Assembly



Standard Components

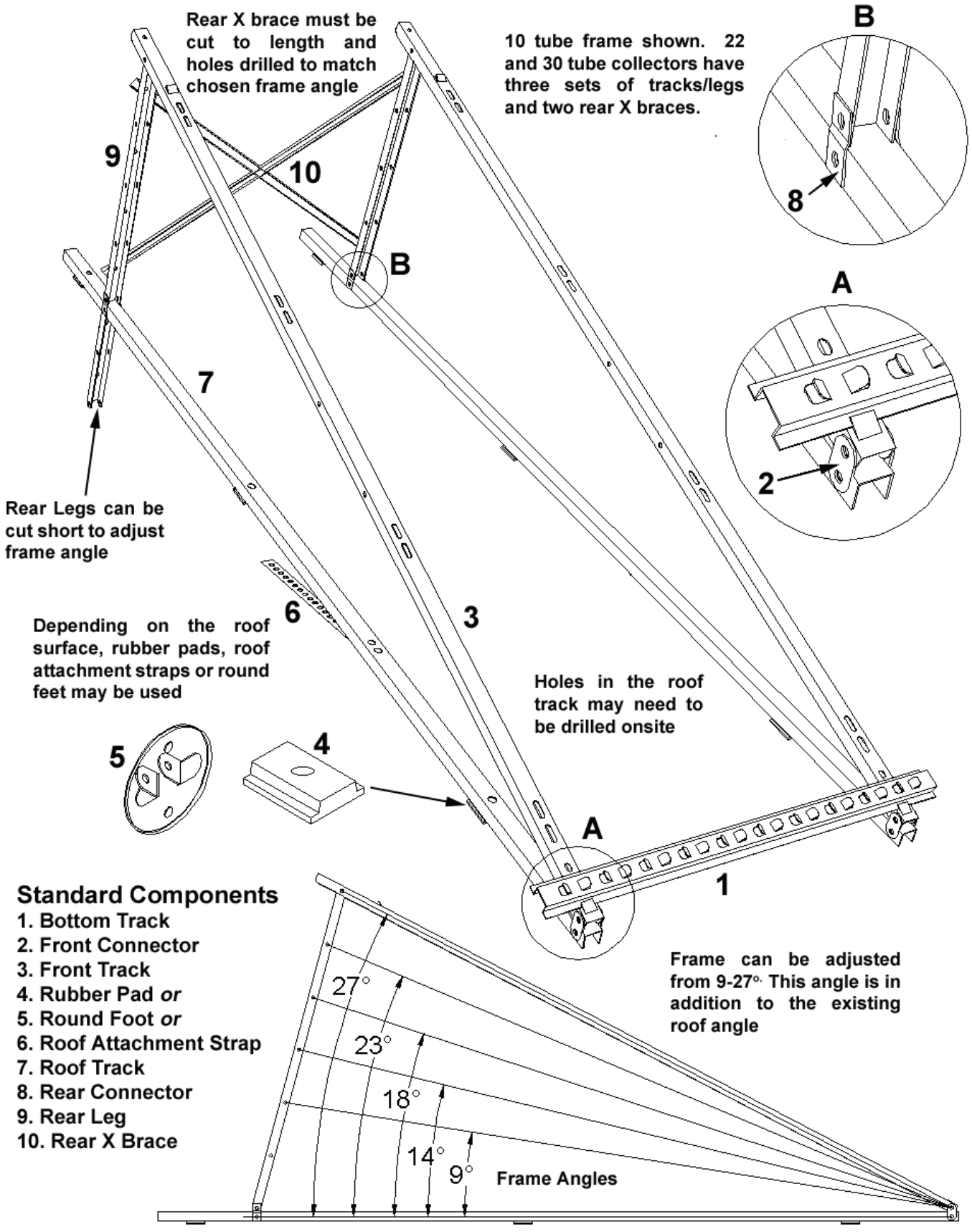
1. Rubber Pad
2. Front Track
3. Round Foot
4. Bottom Track
5. Roof Strap
6. Manifold Attachment Plate
7. Bottom Track Attachment Plate
8. Bolt & Nut Lock Assembly

Bolt & Nut Lock Assembly



Appendix B

Low Pitched Roof Frame Assembly

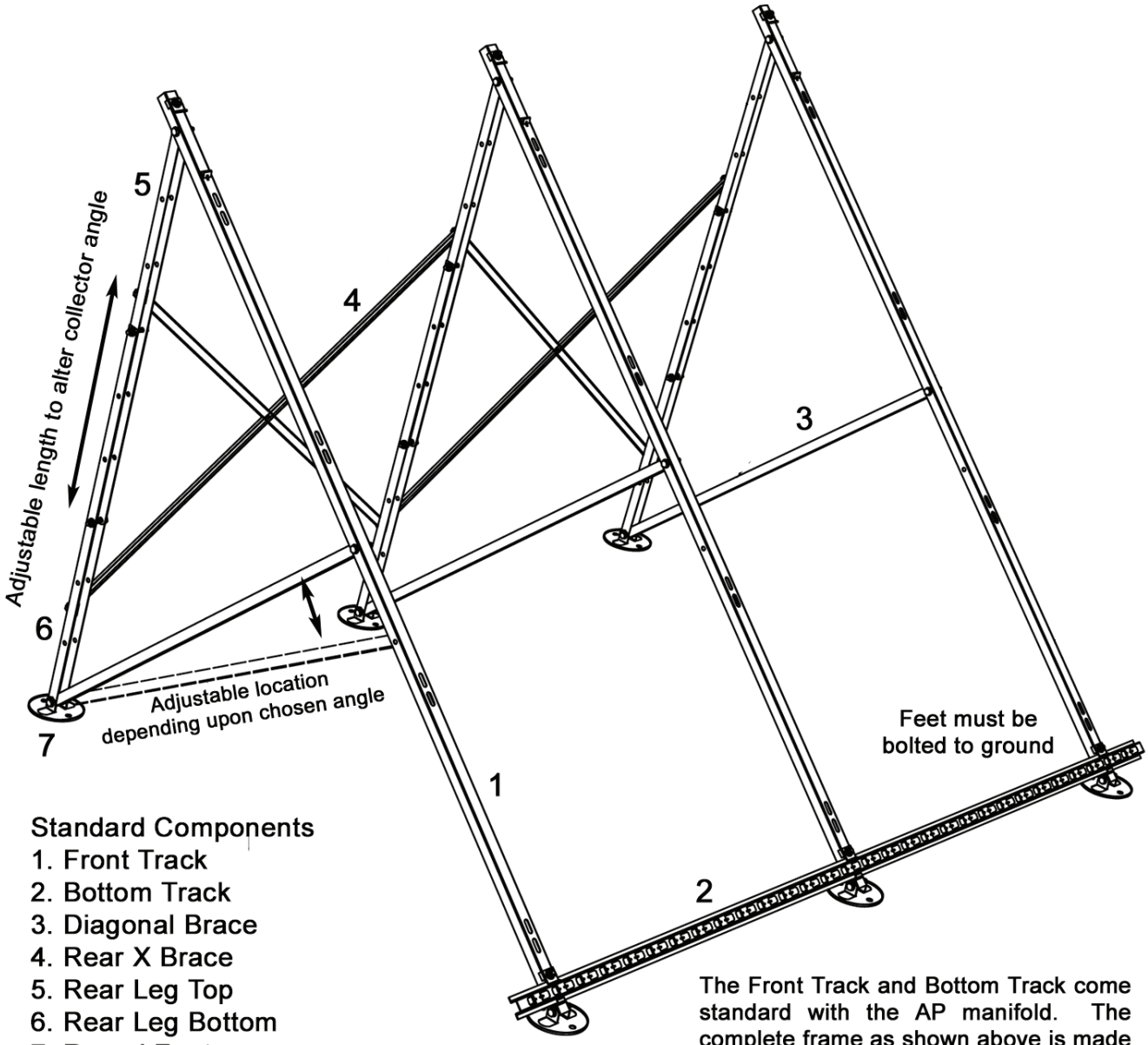


Appendix C

Flat Roof Frame Assembly

22 & 30 tube collector A-frames use:
- 3 sets of front track, rear legs and diagonal brace
- 2 sets of rear X brace assembly

10 tube collector A-frames use:
- 2 sets of front track, rear legs and diagonal brace
- 1 set of rear X brace assembly



Standard Components
1. Front Track
2. Bottom Track
3. Diagonal Brace
4. Rear X Brace
5. Rear Leg Top
6. Rear Leg Bottom
7. Round Foot

The Front Track and Bottom Track come standard with the AP manifold. The complete frame as shown above is made by combining the Standard Frame with a Flat Roof Frame kit.