Apricus Solar Collector Installation and Operation Manual

North American Edition

(Revision 1.2 - April 2008)

Contents

IMPORTANT INFORMATION IS PRESENTED IN YELLOW BOXES THROUGHOUT THIS DOCUMENT

PLEASE READ CAREFULLY

1. Important Information

1.1. Local Standards

a) Installation must be completed in accordance with relevant local standards and regulations.

1.2. Authorized Person(s)

a) The term “authorized person(s)” used throughout this document refers to a suitably qualified professional, who holds relevant industry licenses or certificates required for the work completed during the installation process.

b) Installation may only be completed by authorised persons.

c) Unless otherwise specified in section 3, no part of the Apricus solar collector may be inspected, repaired or maintained by anybody other than an authorized person(s).

1.3. Pressure and Temperature Control and Relief

a) For open loop systems, the normal operating pressure should be <500kPa / 72.5psi, if necessary via use of a pressure limiting (pressure reduction) valve on the mains cold supply line.

b) For open loop systems, it is acceptable for the system design to allow the solar collector to stagnate to prevent additional heating of the storage tank (i.e. pump stoppage once tank temperature reaches 80^{o}C / 177^{o}F). The pressure relief valve on the tank must be able to release the pressure increase that occurs when the manifold stagnates, and should be rated to meet the maximum possible heat output of the solar collector(s). Please see section 3.4 regarding insulation of piping for high temperatures, and section 2.2.3 regarding overheating.

c) For closed loop systems, the solar loop must operate at <500kPa / 72.5psi, and have an expansion vessel installed to control water expansion. The system design may allow stagnation of the collector as a standard form of controlling tank temperature, but only if the glycol is suitably rates for such high temperature exposure. If the glycol is not rated for high temperatures, stagnation should not be used as the standard high temperature protection control method.

d) Any system design must provide means for allowing pressure release at no more than 850kPa / 123psi, or as specified by local regulation. Also check the maximum pressure ratings for any components of the system and design for the weakest link.

1.4. Water Quality

a) Water in direct flow through the manifold header must firstly meet potable water requirements and, in addition, the following:

Total dissolved solids	< 600 p.p.m.	Total hardness	< 200 p.p.m.
Chloride	< 250 p.p.m.	Free Chlorine	< 5 ppm
Magnesium	< 10 p.p.m.		

b) In areas with “hard” water (>200ppm), lime scale may form inside the header pipe (where a direct flow format is used). 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.

1.5. Metallic Corrosion

a) Both copper & stainless steel are susceptible to corrosion when, amongst other factors, high concentrations of chloride are present. The solar collector may be used for heating of spa or pool water, but levels of free chlorine must not exceed 5ppm, otherwise the copper header could be corroded.

Apricus does not warrant the solar collector against corrosion related damage.

1.6. Freeze protection

Freeze protection must be implemented in any regions that experience freezing conditions at any time throughout the year.

a) For areas with temperature not falling below –5°C / 23°F, simple low temp controller based freeze protection may be used. (i.e. pump circulates if the manifold temperature approaches freezing). If possible, backup protection in the form of uninterrupted power supply (UPS) or drip valve should also be installed. Note: Drip valve opens to allow water to dribble from the supply line if power supply is cut. A check valve between tank and drip valve must be installed, to ensure flow is through the collector.

b) For areas with temperatures below –5°C / 23°F, a closed loop filled with an anti-freeze glycol-water mix should be used to provide freeze protection. Please refer to glycol manufacturer's specifications about the temperature ranges the liquid can withstand. See also 1.4 regarding water quality requirements.

c) 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.

Apricus does not warrant the solar collector against freeze related damage.

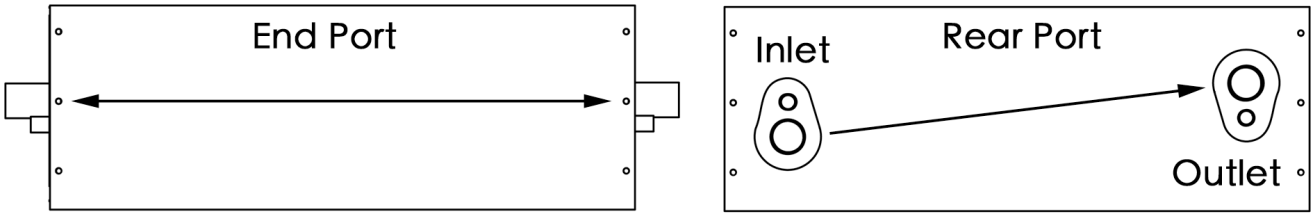
1.7. Collector Dimensions & Weights

Collector Size	10 tubes	20 tubes	30 tubes
Overall Length [1]	1980mm / 80"		
Overall Height [2]	156mm / 6.14" (manifold + standard frame)		
Overall Width [3]	796mm / 31.3"	1496mm / 58.8"	2196mm / 86.4"
Absorber Area [4]	0.8m^2 / 8.6ft^2	1.6m^2 / 17.2ft^2	2.4m^2 / 25.8ft^2
Aperture Area [5]	0.94m^2 / 10.1ft^2	1.88m^2 / 20.2ft^2	2.82m^2 / 30.3ft^2
Gross Area	1.57m^2 / 16.95ft^2	2.96m^2 / 31.8ft^2	4.35m^2 / 46.8ft^2
Gross Dry Weight (Standard Frame)	34.8kg / 76.5lb	63.5kg / 139.7lb	94.8kg / 208.5lb
Fluid Capacity	290ml / 9.8floz	520ml / 17.58floz	710ml / 24floz

1. Length of frame front track;
2. Height of frame front track + manifold;
3. Width of manifold (not including inlet/outlet ports);
4. Absorber = Outside diameter of inner tube x exposed tube length;
5. Aperture = Inner diameter of outer glass tube x exposed tube length

1.8. Manifold Formats (End or Rear)

a) There are two manifold formats, rear port and end port. For the end port manifolds, flow in either direction is acceptable, but for the rear port manifold, only one direction of flow is suitable. Please refer to the following diagram.



1.9. Wind Stress

a) When installing the collector, please consider the issue of wind loading, and the resultant stress on attachment points.

b) The standard frame, and frames kits are all designed to withstand wind speeds of up to 130mph / 208km/h without damage, which corresponds to the mid range of Category 2 cyclones (US Saffir-Simpson Scale). For higher wind speeds reinforcement of manifold and tube to frame attachment, and frame to roof attachment is required, and must be approved for use by both Apricus and a qualified engineer.

c) Refer to sections 2.3 - 2.7 for specific roof attachment details for various frame options.

d) Other mounting formats in high wind regions may require inspection and approval by an authorised engineer or the local building department. It is the responsibility of the installation officer to ensure that the frame mounting is of suitable strength.

ALWAYS SEEK ENGINEER APPROVAL FOR INSTALLATIONS IN HIGH WIND REGIONS.

1.10. Snow Load

a) In areas prone to heavy snow falls the solar collectors should ideally be installed at an angle of 50º or greater to help promote snow sliding off the tubes. In addition it is advisable to raise the front of the collector frame 15-20cm off the roof surface as this allows the collector to sit above moderate snow falls and also more easily blow away from under the collector. See the picture to the right. A front track extension (Part #: FR-FTRACK-EXT) can be used for this purpose.

b) Each tubes 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.

1.11. Storage Tanks

a) Glass lined storage tanks: Please note that if the water heater is left in an operating condition and not used for two weeks or more, a quantity of hydrogen (which is highly flammable) may accumulate in the top of the water cylinder. To dissipate this gas safely it is recommend that a hot water tap be turned on for several minutes at a sink, basin or bath but not a dishwasher, clothes washer or other appliance. During this process there must be no smoking or open flame or any other electrical appliance operating nearby. If hydrogen is discharged through the tap it will usually sound like air escaping.

b) Pressure Relief Valve: The storage tank's pressure and temperature relief valve and the drain outlet pipe must not be sealed or blocked. It is normal for the valve to release small amounts of water during heating cycles.

1.12. Hail Resistance

a) 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, and even larger when installed at angle of 40° 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.

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

c) If in the unlikely circumstance that a tube should become broken, it can be easily 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.
Please refer to section 3.3 for more details on tube replacement.

1.13. Scope of Manual

a) This manual pertains only to the installation and operation of the Apricus 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 manufacturers.

b) This manual is primarily a reference document for installation officers, as the solar collector is not permitted to be installed by non-authorized persons.

1.14. Terminology

The terminology used from region to region differs and so to avoid confusion please note the following terminology:

a) "supply", indicates the plumbing line running from the outlet of the collector back to the tank.

b) "return" indicates the plumbing line running from the tank (or heat exchanger) to the inlet of the collector. This line incorporates the circulation pump.

c) Insolation = solar radiation level, expressed in kWh/m^2/day or Btu/ft^2/day

2. Installation

2.1 Transport, Unpacking and Inspection

2.1.1. Transport

a) When possible transport the boxes of evacuated tubes standing upright, taking notice of the THIS WAY UP arrows. If the boxes can only be laid down, always place on a flat, firm surface such as a sheet of plyboard. If stacking the boxes, ideally do not exceed 3 layers and ensure they are strapped down in place to avoid movement. Straps should be padded with thick cardboard or similar at box corners to avoid cutting into the boxes.

2.1.2. Component List

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

2.1.2. Tube & Heat Pipe Inspection

a) Open the tube box(es), which contain the evacuated tubes with heat pipes inserted. Check to make sure the evacuated tubes are all intact, and the bottom of each tube is still silver colored. If a tube has a white or clear bottom, it is damaged and should be replaced. The heat pipe should be removed from the damaged tube and inserted into a replacement tube. Apricus dealers/installers should ALWAYS carry spare tubes when travelling to an installation.

b) 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.

e) Heat pipes are bright and shiny when newly manufactured, but will dull and may form dark-grey surface discoloration over time. This is due to mild surface oxidation (when exposed to air) and is perfectly normal and does not affect the integrity of the heat pipe.

d) Do not remove and/or expose the tubes to sunlight until ready to install, otherwise the heat pipe tip will become very hot, sufficient to cause serious skin burns. The outer glass surface will not become hot.

WEAR SAFETY GLASSES AND LEATHER GLOVES AT ALL TIMES WHEN HANDLING EVACUATED TUBES & HEAT PIPES

NEVER TOUCH THE INSIDE OF EVACUATED TUBES OR THE HEAT PIPE TIP AFTER EXPOSURE TO SUNLIGHT.

Apricus does not warrant the tube or heat pipes against failure as a result of damage incurred during transport or installation.

2.1.3. Frame

a) Unpack the standard frame that is provided together with the manifold. If a frame kit is being used, those components will be packed separately from the manifold. See Appendix A for standard frame diagram.

b) Depending on the roof surface, rubber pads, roof attachment straps or round feet may be used to attach the standard frame to the roof. These components are supplied separately from the standard frame.

2.2 System Design

2.2.1. System Design

a) 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.

APRICUS SOLAR COLLECTORS MUST ONLY BE INSTALLED BY AUTHORIZED INSTALLERS.

Apricus does not provide warranty coverage and will not be held liable for any damage to person or property that results from solar collectors that are installed by unauthorized persons.

2.2.2. Delta-T Controller Settings

a) Usually a Delta-T ON value of 10°C / 18°F and Delta-T OFF value of 3°C / 5°F is appropriate. These settings may need to be altered slightly according to the location and system design. Refer to the instruction manual provided with the chosen solar controller for appropriate settings.

2.2.3. Stagnation and Overheating

a) 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.

b) If the system is designed to allow stagnation as a means of preventing tank overheating, the collector and plumbing in close proximity may reach temperatures of >200°C / 395°F; therefore components that may be exposed to the high temperatures such as valves, plumbing or insulation, should be suitably rated.

c) If the system is designed to allow stagnation of the collector when the tank reaches a set maximum level, steam may form in the header (depending on the system pressure). In such a system, a temperature relief valve or auto air vent should NOT be installed on the collector outlet, as they may not be able to withstand the high temperatures and will not allow stable stagnation of the collector (may dump hot water). The PTRV on the tank may open to release pressure or as required, especially at the point when steam forms in the header. Under such conditions the

collector manifold will normally reach a maximum temperature of around 160°C / 320°F. Any heat returning from the collector is generally not enough to cause a continued increase in tank temperatures (i.e. Heat input is less than tank heat losses), and therefore is able to meet requirements in force in some regions regarding limiting tank hot water dumping. A crackling noise may be heard down the supply line when hot water is used, as the pressure in the system drops and steam forms, this is normal.

2.2.4. Correct System Sizing to Avoid Overheating

a) 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, an Apricus Heat Dissipator unit, or alternative cooling/dissipation system should be installed.

2.2.5. Solar for Central Heating – Preventing Overheating

a) If a system has been designed to provide contribution to space 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 hot-tub/jacuzzi or pool that can use the heat in the summer period, a large storage tank or underground thermal store, or an Apricus Heat Dissipater unit(s) should be installed. See also the following point (2.2.6), regarding reduction of summer heat output.

2.2.6. Adjusting Collector Angle to Ease Overheating

a) 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° above the latitude angle. This angle corresponds closely to angle of the sun in the sky during the winter months, 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, in effect reducing overall heat production considerably (by about 20-25%). This option is ideal for installations where solar thermal is being used for space heating.

2.2.7. Collector Direction

a) The collector should face as close as possible to due South. A deviation of up to 10° from due South is acceptable, and will have minimal effect on heat output. 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. If a choice can be made, west is preferable over east as solar radiation levels are often highest early afternoon.

2.2.8. Collector Plane

a) The collector manifold is normally installed on the flat horizontal plane, but may be installed at an angle such as when installed sideways on a pitched roof.

b) The collector must not be installed up-side-down (tubes pointing upwards) or with tubes lying horizontally, as the heat pipes will not function.

2.2.9. Collector Angle

a) It is common for collectors to be installed at an angle that corresponds to the latitude of the location. While adhering to this guideline, an angle of latitude +/- 5° is acceptable, and will not greatly reduce solar output. See also point 2.2.6.

b) The solar collector should be installed at an angle of between 20-80° to ensure optimal heat pipe operation.

2.2.10. Avoid Shade

a) Collectors should be located so that shading does not occur for at least the 3 hours either side of midday.

b) Partial shading due to small objects such antennas and small flues, is not of great concern.

2.2.11. Location

a) The collector should be positioned as close as possible to the storage cylinder to avoid long pipe runs. In new installations, storage cylinder positioning should therefore consider the location requirements of the solar collector.

b) The storage cylinder should be located as close as possible to the most frequent draw off points in the building.

2.2.12. Expansion Vessel – Minimising water wastage

a) 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 controlled, as it cannot be compressed like air.

b) In mains pressure open loop systems that have a check valve/non-return valve on the cold mains, this expanded water is released via the pressure relief valve, which is mounted on the tank or solar collector loop. In order to prevent this wasteful dumping of water, it is recommended that an expansion vessel be installed.

c) Closed loop systems should always be installed with an expansion vessel. The volume of the vessel usually equates to 2-3% of the volume of the water in the system. Refer to the expansion vessel manufacturers' guidelines regarding correct sizing.

d) In un-pressurized open vented systems no pressure vessel is required.

2.2.13. Lightning Protection

a) It is advisable to earth/ground the copper circulation loop of the collector to avoid lightning related damage, or electrical safety issues.

2.2.14. Pipe Connections & Pipe Size

a) Apricus solar collectors are provided as standard with 3/4" copper pipe inlet and outlet pipe (starting April 2008, prior to April, 22mm OD is provided which is slightly smaller than standard 3/4" Nth American pipe).

b) For domestic heating applications with 1 or 2 collectors, nominal 1/2" piping is suitable.

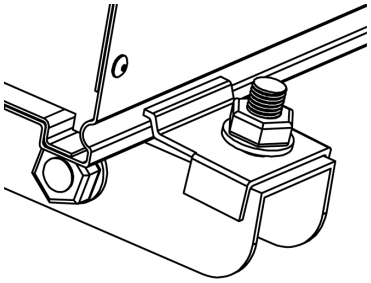
c) For applications using 2 or more solar collectors in series, it is advisable to use a nominal 3/4" piping.

d) For connection of banks of collectors, larger pipe sizes should be used as required for the given application, with consideration made to flow rates, pressure drop and pump sizing.

e) The material used for the solar loop must be able to withstand the operating temperatures and pressures to which the system may be exposed, due to both normal and extraordinary conditions (eg. Pump failure, or power outage). Copper pipe is the most widely used piping material for solar applications. Synthetic piping should not be used for the solar loop, unless specifically rated for high temperatures (>250^{o}C / 482^{o}F).

2.2.15. Connection of Multiple Collectors

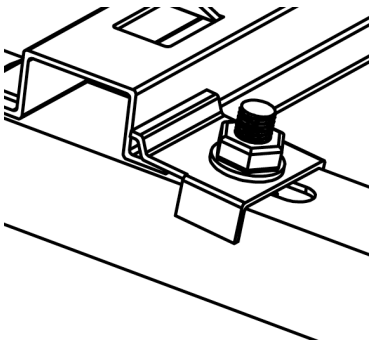
a) When connecting collectors in series that have end manifold connections (as opposed to rear), flexible connections should be used between each collector in order to allow for the expansion and contraction of the copper header with temperature changes. Failure to use flexible connections between consecutive collectors may result in damage to the header if the system stagnates. The simplest flexible connection is a U shaped copper pipe that should be commercially available from plumbing suppliers.



Apricus does not warrant the collector against damage resulting from poorly managed header expansion and contraction.

2.2.16. Heat Transfer Liquid

a) In regions where freeze protection is not a concern, water is the most appropriate heat transfer fluid.



b) If the system is direct flow, meaning that potable water is flowing through the collector, any components used in the system must meet potable water requirements.

c) When using a direct flow system is used in an area with hard water (high mineral content), scale may gradually form in the solar collector loop, gradually reducing performance, increasing pressure drop, and ultimately rendering the system inoperable (due to flow restriction). In such regions, a water treatment system should be installed, which either removes the scale forming minerals, or prevents formation of a scale layer.

d) In regions where freeze protection is required, it is advisable to use a closed loop system with a non-toxic grade polypropylene glycol used as the heat transfer liquid. This liquid should be used directly, or mixed with water as per the manufactures instructions. Periodic inspection of the glycol should be completed (annually), and replaced if necessary. Please refer to the guidelines provided by the glycol manufacturer regarding replacement times.

e) In order to meet health and safety regulations, when using a single wall heat exchanger non-toxic (GRAS - generally regarded as safe) polypropylene glycol should be used. Other grades of glycol may be used ONLY if a

double wall heat exchanger is used.

2.3 Mounting Frame

Apricus solar collectors are supplied with a standard frame, which is suitable for flush mounting on a suitably pitched roof. For installation on low-pitched roofs, flat roofs or off walls, additional frame kits are available. Depending on the roof surface, the standard frame may be attached to the roof with rubber pads (corrugated steel, asphalt), roof attachment brackets (tiled roof), or round feet (asphalt).

WEAR LEATHER GLOVES AT ALL TIMES WHEN HANDLING FRAME COMPONENTS

2.3.1. Frame Material

a) All frame components are made of 1.5mm / 0.06" thick 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.

2.3.2. Galvanic Reaction between SS and Zinc Galvanized Iron

a) Zinc galvanized iron roofing material should NOT be allowed to in direct contact with stainless iron, as galvanic reaction between the two metals can cause premature oxidation of the zinc coating and the metal underneath.

b) If the roof surface is galvanized steel, refer to section 2.4.4 for installation guidelines.

c) Only use stainless steel components.

2.3.3. Roof Installation

Three types of roof installations are outlined in this guide:

1. Flush installation on a suitable 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
4. Installing on a wall. Section 2.7

2.3.4. Manifold and Bottom Track Attachment

a) 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.

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

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

d) Note that the some bolts are 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, removing the need to use a second spanner/wrench.

e) Spring washers are supplied to ensure the stainless steel bolts do not loosen over time. Stainless steel bolts are not as hard as hardened steel bolts, and therefore care should be taken not to over-tighten the nuts, as this can damage the thread making it difficult to undo.

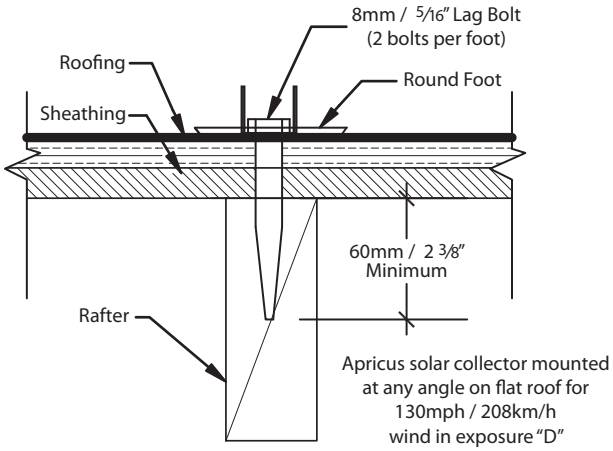
2.3.5. Customizing the Frame

a) The standard frame, low, mid, high and fixed angle roof frame components can be used creatively to suit a range of different installation surfaces. Additional holes (no larger than ⌀10mm / 6/16" diameter) may be drilled in the frame as required, but the frame structural integrity must not be compromised (Do not drill holes closer than 30mm / 1 1/4" centre to centre).

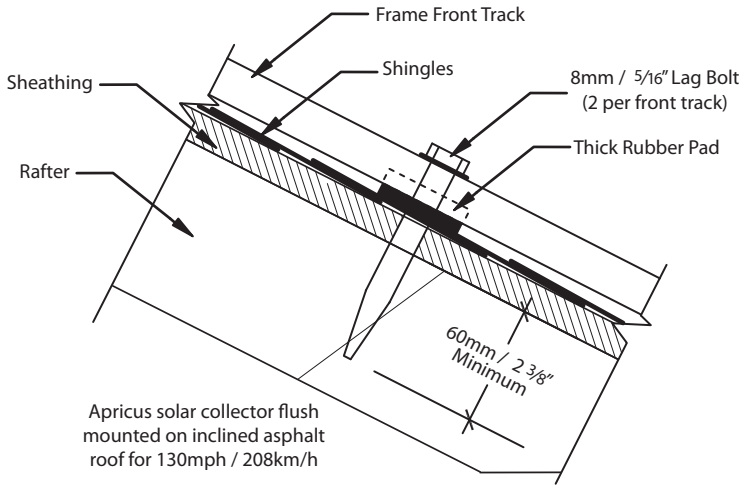
2.3.6. Roof Attachment

a) In order to meet strength requirements in areas with winds up to 130mph / 208km/h and category "D" exposure, the following attachment format should be followed. Any other installation format should be approved by a local engineer.

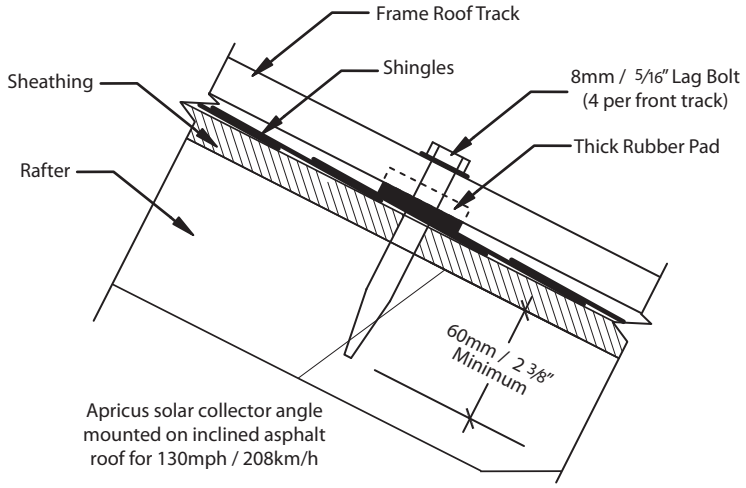
Mount on Flat Roof using Round Feet



Flush Mount on Pitched Asphalt Shingle Roof



Angle Mount on Pitched Asphalt Shingle Roof



2.4 Flush Pitched Roof Installation (Standard Frame)

Refer to Appendix A for assembly diagram.

2.4.1. Installation Planning

a) Carefully plan the location of the collector frame and plumbing pipes in order to align with the roof rafters, and allow the shortest pipe run possible to the storage tanks. Any penetrations in the roof must be sealed with standard roofing materials to avoid leaks.

2.4.2. Positioning Manifold

a) 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. The frame front tracks should be located such that they lay flat and even on the roof aligned with the roof rafters. If the frame cannot be aligned with the roof rafters, additional wood may need to be added to the framework, such as a horizontal beams secured beneath the rafters, with long stainless steel bolts used to secure the frame in place. Consult with an engineer to ensure custom roof designs meet strength requirements.

b) If possible try to locate front tracks 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. For collectors with three front tracks (30tube), the middle front track should be positioned roughly centrally, again ideally behind a tube. The horizontal brace (Part #: FR-HBRACE) provided with the standard frame kit provides an indication of the standard location of the front tracks. In North America, holes are spaced at 8” centers to match 16” or 24” centered rafters. Additional holes may be drilled in the horizontal brace to meet different front track locations. See also 2.3.5.

2.4.3. Corrugated Iron Roof

a) For installation on a corrugated iron roof, the standard thickness rubber pad (#FR-SRPAD) can be used to separate the frame from the roof and also to seal the hole. The rubber pad will form a tight seal against the roof, preventing any water ingress. Addition of some silicone sealant beneath the pad and inside the hole is required. Attach the front track to the roof using the same format as outlined for an asphalt roof, shows in 2.3.6.

d) This mounting method is also suitable when attaching the roof tracks used in the low or mid angle roof frame when using the roof track option, however FOUR attachment points per front track, rather than TWO are required in order to withstand the additional wind loads. (See also section 2.5)

2.4.4. Asphalt Shingle Roof

a) For installation on an asphalt shingle roof, refer to the diagram in 2.3.6. The extra thick rubber pad (#FR-TRPAD) should be used to compensate for the pad sinking into the asphalt.

2.4.5. Manifold and Bottom Track Attachment

a) Once the front tracks are secured in place, 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. See also 2.3.4 for guidelines.

2.5 Low Pitched Roof Installation (Low or Mid Angle Frame)

Refer to Appendix B & C for assembly diagrams.

If the roof pitch is insufficient, a low or mid angle roof frame kit can be used to increase the angle by 12^{o} or 27^{o} respectively. Low or mid angle frame kits combine with the standard frame components to form a complete frame assembly.

2.5.1. Frame Options

Two frame options are available, round feet or roof tracks.

a) Round Feet are suitable for attachment to concrete or asphalt shingle roofs on which the round foot twin bolt attachment is preferred. Round feet allow some front and back movement of the rear legs, thus slightly adjusting the install angle. Refer to 2.3.4 for installation guidelines.

b) Roof tracks are ideal when rubber pads are the preferred attachment method and provide a fixed install angle. Roof tracks are attached to the roof in the same method as the standard front track. Refer to 2.3.6 for installation guidelines - please note that 4 lag bolts per roof track must be used. Also refer appendix diagrams B, C & E.

c) In cases where either option is viable, round feet provide the most cost effective solution.

2.5.2. Rear X Brace Adjustment

a) The rear X brace components have a series of elongated holes to allow adjustment of the location of the legs. If further adjustment is needed, additional ∅9mm / ∅0.35" holes may be drilled to suit.

2.6 Flat Roof Installation (High Angle Frame)

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

2.6.1. Frame Feet Anchoring

a) Frame feet should be bolted to the installation surface using 8mm / 5/16" diameter bolts, or a similarly sturdy fastening method. Only stainless steel bolts should be used.

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

2.6.2. Adjusting Frame Angle

a) 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 30° and 50°.

b) Each pair of legs (top and bottom) must always be attached together by 2 bolts (two sets of holes).

c) If an angle less than 30° is required a low angle frame kit should be sourced. Rather than making adjustments to the high angle frame, it is much easier to directly use a low or mid angle frame kits. See Appendix B & C.

d) If an angle greater than 50° is required the mounting points of the rear feet may be raised. Raising the angle greatly increases the horizontal force during high winds, and as such should be considered. Consult a building engineer for design requirements.

2.7 Wall Mounting (using Low, Mid, High or Fixed Angle Frames)

Refer to Appendix F for assembly diagram.

2.7.1. Wall Frame Options

a) If mounting on a wall, low, mid, high or fixed angle frames may be used, with the legs reversed, so attached to the bottom of the front tracks rather than the top.

2.7.2. Attachment Methods

a) The method used for attachment to the wall will depend on the wall material. For brick or concrete walls, the round feet can be used, secured with stainless steel expansion bolts.

b) For wood or synthetic boarding, stainless steel screws that can penetrate into the wall framework may be suitable. If the strength of such screw attachment is of concern it is advisable to use bolts that run directly through the wood, with a large washer or metal plate positioned before the nut.

c) Always consider the weight of the collector and the structural integrity of the wall. Consult a building engineer for design requirements.

d) Ideally do not install the collector beyond an angle of 80°, otherwise heat pipe performance may be reduced. Installing vertically is permitted and will not void the warranty, but perform will be reduced.

e) When installing on a wall, consider the possible shading from eves, particularly in the summer. This in fact may be a part of the system design, in order to minimize summer heat output. Another advantage of installing under an eve overhang is to minimize snow buildup on the collector in areas with regular snowfall. Even with snow sitting on the bottom of tubes, the heat pipes will work effectively to conduct heat, as the inner tube temperature becomes fairly even for the full length due to heat transfer by the aluminum fins.

f) If using round feet at the top of the front tracks to bolt to the wall, the rear corners of the manifold attachment plates will need to be ground slightly to allow for the round foot.

g) If installing on a wall such that the collector is above a walkway, please consider the danger associated with broken glass that could fall 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 such falling materials.

2.8 Connection to Plumbing

2.8.1. Plumbing Connection

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

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

2.8.2. Temperature Sensor Insertion

a) The temperature sensor port is located beside the inlet and outlet ports. Generally the temperature should be sensed at the outlet of the manifold.

b) The solar controller's temperature sensor should be coated with a thin 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 or stainless steel plate/wire in beside the sensor.

c) Ensure that the insulation tightly covers the opening to prevent water ingress. Use a silicone sealant if required to ensure a watertight seal against the manifold.

d) Ensure that sensors used on the collector are high temperature rated (up to 200^{o}C / 395^{o}F), in particular the cable.

2.8.3. Header connection

a) The header may be connected by sweating/soldering or a flared fitting. If soldering, care must be taken to avoid exposing the manifold casing to the torch flame. Ideally place a wet cotton cloth around the base of the header pipe to reduce the temperature of the copper pipe in contact with the silicone rubber seal.

2.8.4. Air Purge

a) Once the inlet and outlet are connected to the plumbing system, the collector loop should be purged of air (see also 2.8.3).

b) Mains Pressure Open Loop – for a system without an auto-air vent installed, a drain valve on the supply line should be fitting along with a ball valve on the tank side. With the ball valve closed the drain valve can be opened to allow air to escape as the mains pressure water forces through the collector and line. Be careful as the water may be hot, with even some steam being released if the collector is hot. Once the drain valve is no longer releasing air it can be closed and the ball valve opened so that normal operation can begin. If an auto-air vent is installed on the outlet of the collector, air will be automatically eliminated from the solar line. If using a manual air vent this should be opened until all air is eliminated. AIR VENTS SHOULD BE CLOSED AFTER COMISSIONING AND REMOVED IF NOT HIGH TEMPERATURE RATED.

c) Low Pressure Open Loop – run the pump at the highest speed setting, forcing air out of the manifold and back into the tank. If an auto-air vent is installed on the outlet of the collector, air will be automatically eliminated from the solar line. If using a manual air vent this should be opened until all air is eliminated. AIR VENTS SHOULD BE CLOSED AFTER COMISSIONING AND REMOVED IF NOT HIGH TEMPERATURE RATED.

d) Closed Loop – the solar loop should be filled with glycol/water mix, vented and pressurized. The exact process will depend on the design of the loop and components used – refer to relevant instructions specific to the pump station/heat exchanger used.

2.8.5. Plumbing Check

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

2.8.6. Insulation

a) Heavily insulate all piping running to and from the manifold with a high quality insulation of at least 15mm/0.6" thickness, and double the thickness in cold climates. Heat loss from the piping can be significant, and so particular attention should be taken to insulate any possible points of heat loss.

b) 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.

c) Insulation foam that is exposed to direct sunlight should be protected against UV related degradation by wrapping/covering with a suitable material such as adhesive back aluminum foil, PVC conduit or similar.

d) For systems designed to allow stagnation, high temperature rated insulation such as glass wool or mineral wool should be used on piping close to the collector (~2m / 6'). Glass wool insulation may come with an external foil wrap, but any cuts made during installation should be sealed with watertight and UV stabilized material such as adhesive backed aluminum foil.

e) Circulation pumps can be a source of significant heat loss and should be insulated. Some pumps come standard with a molded foam casing which has good insulation properties. If the pump does not have any insulation, the same foam style insulation used on the plumbing pipe can be used to cover the pump, secured in place with good quality nylon cable ties or adhesive tape. ***Note:*** **Certain pumps are not designed to be insulated, please contact the pump manufacturer if in doubt.**

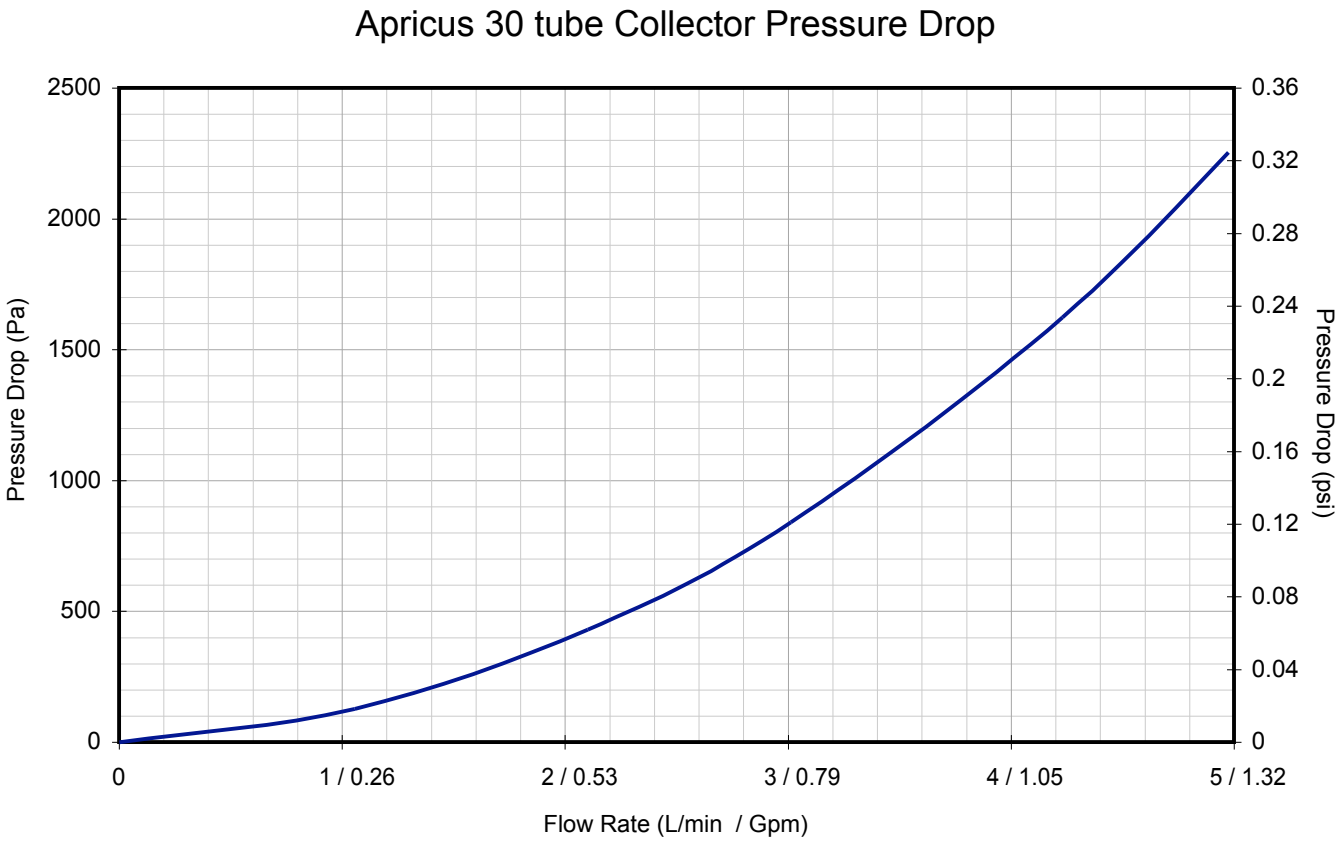
f) All internal piping as well as external should be insulated. This includes at least the 1m / 3" closest to the hot water outlet of the tank, as this copper pipe is a significant point of passive heat loss.

2.8.7. Pump Selection

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

b) 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, tees, and bends in piping all contribute to pressure drop. For this reason the flow path should be kept as simple and unrestricted as possible. A larger pipe size will also provide less pressure drop, so may be an option if the pump is slightly undersized.

c) Pressure drop through an Apricus 30 tube header with cold water at 3L/min / 0.79gpm is only 900Pa / 0.13psi. See graph on following page for pressure drops at flow rates up to 5L/m / 1.32gpm.



d) For single storey/floor houses where the pipe run to and from the collector is no more than 8m / 27feet, a small 25-30Watt pump with low head pressure (~50kPa / 7psi) may be sufficient. Two 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 recommended, as an appropriate speed setting can easily be chosen (e.g. 40, 60 & 90Watt multi-speed pump).

e) To determine if the pump chosen is suitable the following methods can be used:

i). If a flow meter is installed on the supply line, a visual indication of flow rates can be provided.

ii). If a flow meter is NOT installed, observing pump operation can reveal if sufficient flow is being achieved. Under normal conditions with sunny weather the pump should cycle on and off. If the pump is cycling more than once every 2-3minutes, or indeed running continuously the flow rate may be insufficient. A faster than required flow rate might be indicated by a very short pump operation time of less than 20seconds.

iii). If a solar controller with LCD temperature display is used, the solar collector and tank temperatures may be monitored. Under normal operation, 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 to 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 faster than required, wasting electricity, and causing unnecessary turbulence on return to the storage tank (if applicable).

iv). If the system does not seem to be flowing properly, check for air locks in the lines.

f) Always use hot water rated pumps (up to 110^{o}C / 232^{o}F), as high temperatures can be experienced. The pump should always be installed on return line, thus preventing exposure to extreme temperatures. In addition a check valve should always be installed after the pump to prevent back flow, and possibly thermosiphoning at night.

2.9 Evacuated tube & Heat Pipe Installation

The Apricus solar collector is a simple “plug in” system. The heat pipe and evacuated tube assembly just needs to be plugged 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, 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, UNLESS THE SYSTEM (IN PARTICULAR INSULATION) IS DESIGNED TO WITHSTAND HIGH TEMPERATURE STAGNATION, OR THE TUBES ARE COVERED.

Please follow the instructions below for assembly and installation:

2.9.1. Unpacking

a) The heat pipes and evacuated tubes are packed in the same box, with heat pipes already inserted into the evacuated tubes.

b) Open the bottom of the box to expose the ends of the tubes, placing a rubber caps on each tube. This protects the tubes from accidental damage.

c) Do not expose tubes to sunlight until ready to install, otherwise the heat pipes will become extremely hot, and could cause serious burns if touched.

WEAR SAFETY GLASSES AND LEATHER GLOVES AT ALL TIMES WHEN HANDLING EVACUATED TUBES & HEAT PIPES

e) Heat pipes contain a small amount of copper powder which aids in heat transfer and provides protection against freeze related damage to the heat pipe. 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 (heat pipes down), return upright (heat pipe at top) and then shaken up and down a few times to ensure the powder has all returned to the bottom.

2.9.2. Heat Pipe and Evacuated Tube Insertion

a) The heat pipe will already be inserted fully into the evacuated tube.

b) If an evacuated tube is damaged for any reason (e.g. knocked heavily or dropped), it will need to be replaced. Either use another tube with heat pipe already inserted, or if a plain evacuated tube spare is being used, carefully remove the heat pipe from the broken tube and insert into the new tube. This should be done with care, holding the heat transfer fins in place with one hand while inserting the heat pipe by making a short push and twisting action. Never throw heat pipes away, as they are very sturdy and will not be damaged even if the tube has been. They can be kept as spares, or inserted into plain spare evacuated tubes.

c) While holding the spring plate in place, pull the heat pipe out of the evacuated tube by about 8cm / 3”. Using the heat transfer paste, form a thin layer over the heat pipe head (not the top round end).

Note: The powder content of the thermal paste may have settled during storage and freight – in order to ensure optimal thermal conductivity, it is advisable to sit the tube (cap downward) in a glass of warm water (particularly in cool weather) to allow the powder to mix through. This will also allow the paste to become thinner, making application and heat pipe insertion easier.

d) 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**

e) Whilst ensuring the metal spring plate is sitting in the mouth of the evacuated tube, firmly hold the evacuated tube, guiding the heat pipe tip in past the manifold rubber seal and into the heat pipe port. Ensure the heat pipes are at the TOP of the evacuated tube, and therefore aligned correctly with the heat pipe port.

f) Using a slight (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.

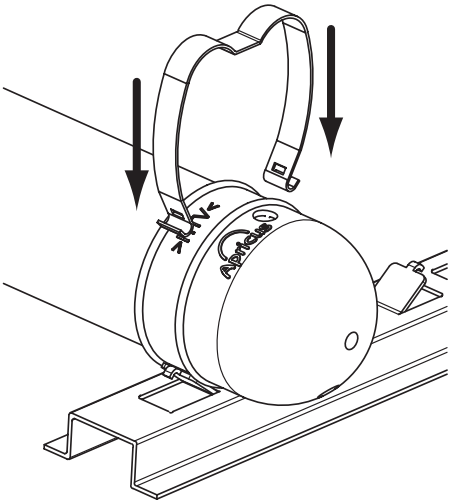
g) The heat pipe and evacuated tube are fully inserted once the black coating of the evacuated tube has disappeared up into the manifold (no clear glass visible) and the bottom of the tube sits correctly in the bottom track.

h) As each tube is inserted, or alternatively once all tubes have been inserted, secure the tubes 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.



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

j) As the distance between consecutive tubes is minimal, it may be necessary to push a consecutive tube slightly off to the side while attaching the clip to allow enough room to operate.

2.9.3. Post Installation Cleaning

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

2.10.2. Take Photograph

a) Always take several digital photographs of the solar collector on the house roof. These serve an important record if you ever receive a phone call from the home owner about the installation.

b) Send a copy of ALL installation photos to your local Apricus Dealer/Distributor as a record of the installation, and for possible use on their websites and in promotional material.

c) Complete an installation record form in triplicate, with the original left with the owner, a copy retained by the installer, and the 3rd copy faxed or mailed to the local Apricus distributor.

2.10 Post Installation

2.10.1. Collector Operation

a) 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.

3. Maintenance

Under normal conditions the solar collector is maintenance free. Other system components such as the pump, glycol liquid (if used) may require periodic inspection and changing/maintenance. Please refer to the documentation provided by the manufacturer of these other components.

APART FROM THOSE MAINTENANCE ITEMS OUTLINED BELOW, ANY SYSTEM INSPECTION, MAINTENANCE OR REPAIR SHOULD ONLY BE COMPLETED BY AUTHORIZED PERSONS. THE SOLAR COLLECTOR WARRANTY COVERAGE MAY BE VOID IF NON-AUTHORIZED PERSONS ATTEMPT TO MAINTAIN OR REPAIR THE SOLAR COLLECTOR OR ASSOCIATED COMPONENTS.

The following basic maintenance may be completed by the HOME OWNER

3.1. Cleaning

a) 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 but ONLY if the solar collector is located in a position which does require climbing onto the roof, use of step-ladder or otherwise potentially dangerous location. If the tubes are not easily and safely accessible, high-pressure water spray is also effective.

b) If cleaning is required and the above outlined methods are not suitable, the company that supplied and installed the solar collector should be contacted to complete such cleaning.

3.2. Leaves

a) 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). Such cleaning may only be completed by the homeowner if the tubes are easily and safely accessible (refer also to 3.1 for safety considerations)

The following maintenance may ONLY be completed by AUTHORIZED PERSONS

3.3. Broken Tube

a) If a tube is broken it should be replaced as soon as possible to maintain maximum collector performance.

b) The system will still operate normally and safely even with a tube broken.

c) Any broken glass should be cleared away to prevent injury.

d) To replace a tube:

i) Remove the tube clip(s), slide broken tube out and carefully pick up any glass pieces. Protective gloves must be worn when handling broken glass.

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

iv) If the heat pipe is not easily removed (commonly the case), it can be left in place and a new evacuated tube inserted, guiding the heat pipe down the groove between the evacuated tube inner wall and heat transfer fin. - If the heat pipe is easily removed, the easiest option is to replace the heat pipe and evacuated completely.

3.4. Insulation

a) The plumbing pipes running to and from the collector should be heavily insulated. This insulation foam should be checked periodically (at least once every 3 years) for damage.

b) For any insulation that is exposed to sunlight, ensure any protective cover/wrap/foil is in good condition, replacing as required.

3.5. Draining the Collector

a) Draining of the manifold may be required if maintaining the system or in preparation for extremely cold conditions (extended snow cover). In order 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 immediately open drain valves on both lines (or undo fittings). Never leave the isolation valves in the off position while the collector is full of water and exposed to sunlight as the water will heat cause a pressure increase which may rupture of fittings/connections. **In good weather the water may be hot or have built up pressure, so take care when opening the drain valve.**

Step 3. 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 4. Always leave one drain valve or fitting open, otherwise the system may build up pressure when it heats.

b) For draining of other types of systems, please refer to specific instructions for the system used.

3.6. Other Components

a) 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.

3.7. Other Components

a) 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.

3.8. Freezing

a) During extended sub-zero periods with concurrent pump/controller failure or power outage, a direct flow (water) system may suffer from freeze related damage, indicated by no pump flow due to pipe blockage, or in most cases leaking due to a split pipe.

b) The most likely area of freeze damage is exposed copper piping, particularly near elbows or connections. One the system thaws, leaks will indicate any areas of damage which require replacement.

c) To repair, isolate flow to the collector or drain the system and repair/replace any damaged piping, then re-commission the system.

d) If freezing is a regular occurrence, consider installing a battery power backup system to ensure continued operation of the pump and controller during a power outage. To provide complete protection the system may need to be upgraded to a closed loop glycol system.

4. Troubleshooting

Those inspection items with an (**H**) in front may be completed by the home-owner, but only if such investigation is clearly both SAFE and EASY. Any information obtained during an investigation can then be relayed onto the company who supplied and installed the system. Any other system troubleshooting, system adjustments, or repairs may only be completed by authorized persons.

4.1. No Hot Water

a) If there is no hot water, it will generally be related to the gas or electric heating system, and not the solar collector. The collector simply pre-heats water, with final boosting completed by the electric element or gas booster system. For a retrofitted solar system, please contact the manufacturer/installer of your gas/electric water heater. For a new solar water heating system, please contact the company that supplied and installed the system.

4.2. Reduced Solar Contribution

a) 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.

b) 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.

c) 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 the company who supplied and installed the system.

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 3-5 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 evacuated tubes intact? If a tube has been damaged or discolored it will reduce the system performance and should be replaced. If a tube is damaged, do not attempt to remove it; contact the company who supplied and installed the system.

(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

a) During normal daily hot water use, if the temperature relief valve on the tank or collector is regularly dumping hot water (more than just a dribble), it may indicate 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. 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 tank or collector is still regularly dumping hot water it indicates a problem. Please contact the company who supplied and installed the system to organize a service call.

THE FOLLOWING IS A SUMMARY OF KEY SAFETY PRECAUTIONS. PLEASE READ CAREFULLY

5. Safety Precautions

5.1. Metallic Components

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

5.2. Evacuated tubes

a) Be careful when handling the evacuated tubes, as they will break if knocked heavily or dropped.

b) If exposed to sunlight and therefore hot (have internal pressure built up), the tubes make explode rather than implode if knocked and broken. This is a rare occurrence, but nevertheless safety precautions should be taken.

c) If the evacuated tubes are struck by a hard object with sufficient force (ie. branch falling on roof), they may break. During installation consideration should be taken as to the possible path any broken glass may take. Where possible protection should be implemented to prevent broken glass from reaching ground level where somebody could walk on it (ie. Guttering on roof).

d) The home owner should be made aware by the Installation Officer the location of the solar collector and the possible vicinity of broken glass in the event of an extreme storm or object falling on the collector.

5.3. High Temperatures

a) With the heat pipe installed in the evacuated tube, and good sunlight, the heat pipe tip 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 thick leather gloves must be worn when handling hot tubes and heat pipes.

b) 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 easily reach temperatures in excess of 160^{o}C / 320^{o}F, and therefore caution should be taken when handling such components.

5.4. Health & Safety

a) Always wear safety glasses when handling evacuated tubes

b) Wear leather gloves when handling metal components

c) Wear thick leather gloves if handling hot heat pipes

d) Adhere to safety regulations regarding working on roofs (or at a height)

e) Always obtain engineer approval for installations in high wind regions.

6. Warranty

For any solar collector related problems and warranty claims, please contact the company that supplied and installed the solar collector. They will help you to process the warranty claim and ensure your system is repaired and operating normally.

7. 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.

8. 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 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	Roof mounting guidelines have been adhered to, and if required an engineer approval has been obtained.	Y	N
5	Collector is installed at an angle of between 20^o – 80^o, preferably at latitude angle.	Y	N
6	In areas prone to large hail (>∅20mm / ∅3/4”), collector is installed at an angle of 40^o or greater.	Y	N
7	Frame is secured to structurally sound roof/wall.	Y	N
8	Plumbing is leak free.	Y	N
9	Plumbing pipe runs are well insulated.	Y	N
10	Insulation above roof level is protected against sunlight with foil wrap or equivalent.	Y	N
11	Controller is configured correctly with freeze setting on (if required).	Y	N
12	System is fitted with pressure relief valve on the collector outlet and/or storage tank.	Y	N
13	Pressure relief valve will dump only onto high temperature resistant material and will not pose a danger of scolding people.	Y	N
14	Pump, controller and all electrical connections are protected from water ingress.	Y	N
15	Evacuated tubes have been cleaned.	Y	N
16	Installation record form has been given to customer and basic operation explained.	Y	N
17	Functional checks for controller and pump have been completed.	Y	N
18	Water quality has been checked (if applicable).	Y	N

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

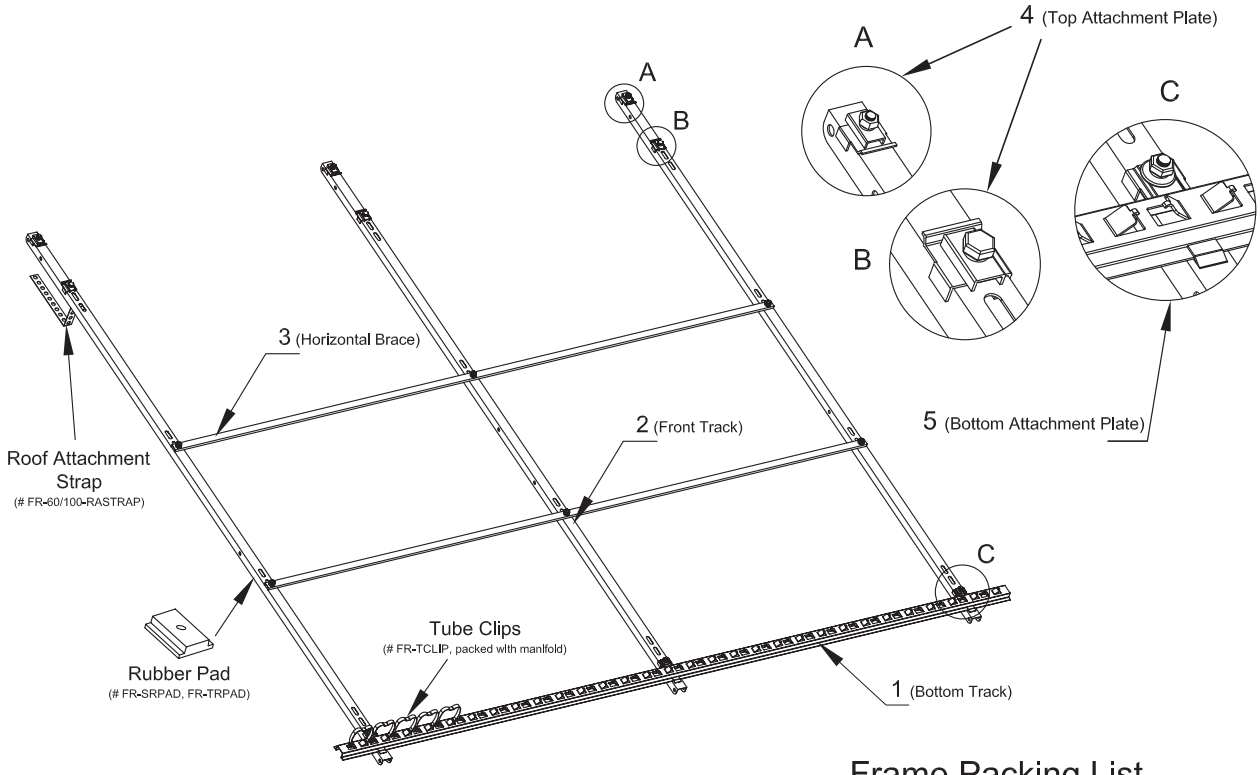
9. Appendices

Appendix A (Standard Frame Kit Assembly Diagram)

Apricus Solar Collector Standard Frame Kit

Part #: FR-XX-STANDARD

This frame is suitable for flush installation on a pitched roof. If installing on a low pitched roof, or flat roof, an additional frame kit is required which will complement the components already contained in this standard frame kit.



Frame Packing List

Part #	Component Quantities	
	10 & 20 Tube	22 & 30 Tube
1. FR-BTRACK-XX	1	1
2. FR-FTRACK-XX	2	3
3. FR-HBRACE	2	2
4. FR-TOP APLATE	4	6
5. FR-BOTTOM APLATE	2	3
6. FR-BOLT-M8x20	*6*	*9*
7. FR-BOLT-M8x30	*4*	*6*
8. FR-NUT-M8	*10*	*15*
9. FR-WASH-B	*4*	*6*
10.FR-SWASH	*10*	*15*
11. FR-WASH-S	*4*	*6*
12. FR-NLOCK	*14*	*21*

Nuts and bolts are already attached to the appropriate components.

Roof Attachment Options (Components Supplied Seperately)
Tiled Roof - *Roof Attachment Straps*
Corrugated Iron Roof - *Standard Rubber Pads*
Asphalt Shingle Roof - *Extra Thick Rubber Pads*
or
Low, Mid, High or Fixed Angle Frame Kit

SAFETY CONSIDERATIONS

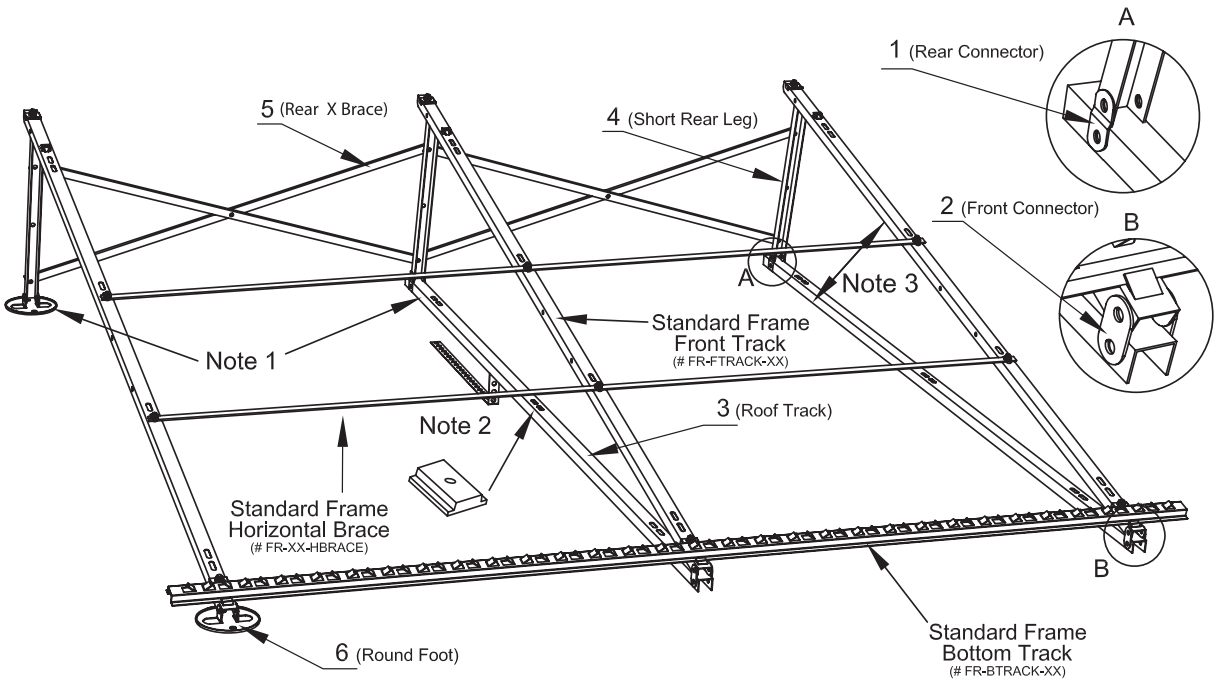
- Wear gloves when handling frame components
- If installing on corrugated iron roofs, always use rubber pads, thus preventing direct contact between galvanised iron and stainless steel frame.
- Ensure roof attachment points are structurally sound
- Follow relevant safety regulations regarding working on roofs

Appendix B (Low Angle Frame Kit Assembly Diagram)

Apricus Solar Collector Low Angle Frame Kit

Part #: FR-XX-LOW-RFOOT/RTRACK

The components contained in this package combine with the standard frame to form the complete frame assembly shown below.



Notes:
1. There are two mounting options, ROUND FEET or ROOF TRACKS.
2. When using the Roof Tracks, attachment to roof may be via roof attachment straps (# FR-60/100-RASTRAP) or rubber pads (# FR-SRPAD, FR-TRPAD) depending on roof surface.
3. ROUND FEET provide adjustable angle of 11-13deg. ROOF TRACKS provide a set angle of 12deg.

Nuts and bolts are already attached to the appropriate components.

Frame Packing List

Part #	Component Quantities			
	10 & 20 Tube		22 & 30 Tube	
	FEET	R.TRACK	FEET	R.TRACK
1. FR-RCON	4		6	
2. FR-FCON	4		6	
3. FR-RTRACK	-	2	-	3
4. FR-SRLEG	2		3	
5. FR-RXB-MID-XX	2		4	
6. FR-RFOOT	4	-	6	-
7. FR-BOLT-M8x50	*6*	*10*	*9*	*15*
8. FR-BOLT-M8x40	*1*		*4*	
9. FR-BOLT-M8x20	*4*	*4*	*4*	*4*
10. FR-NUT-M8	*11*	*15*	*17*	*23*
11. FR-SWASH	*11*	*15*	*17*	*23*
12. FR-WASH-S	*17*	*25*	*26*	*38*
13. FR-WASH-B	*4*	-	*6*	-
14. FR-NLOCK	*5*	*5*	*8*	*8*
15. FR-SPAN-12/14	1			

SAFETY CONSIDERATIONS

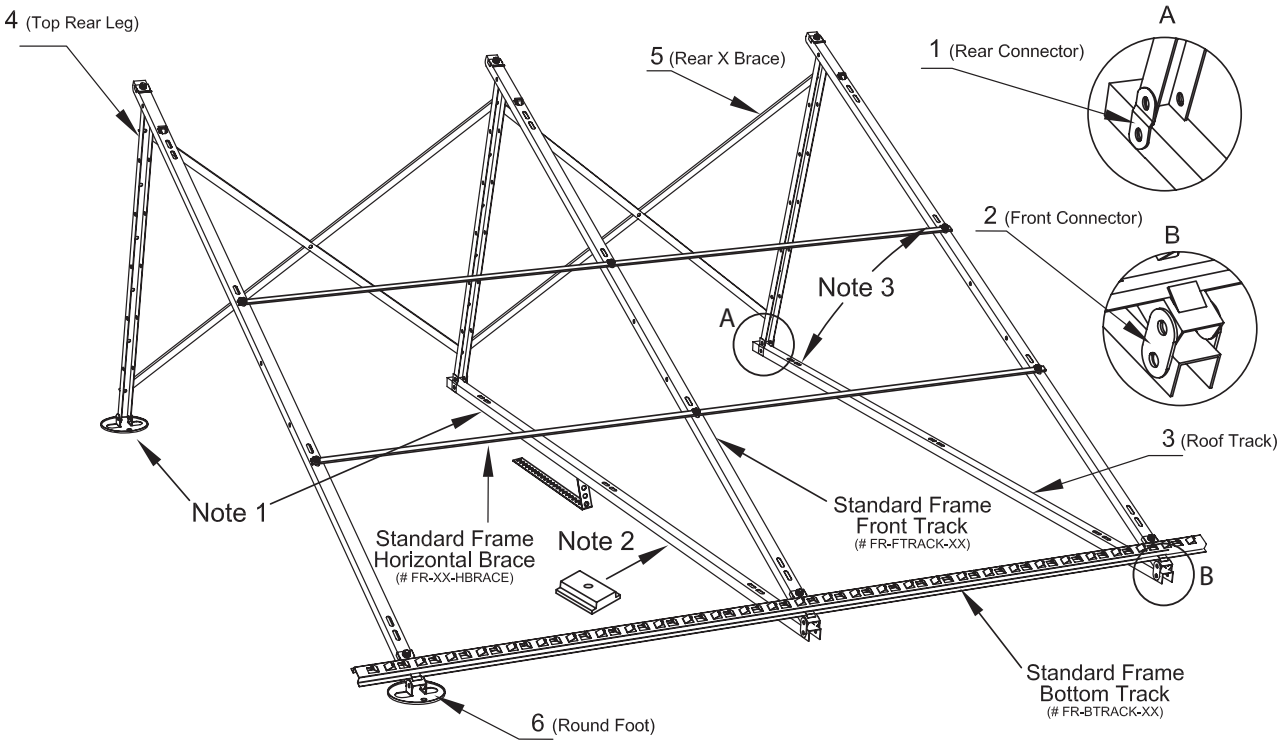
- Wear gloves when handling frame components
- If installing on galvanised iron roofs, always use rubber pads or rubber feet covers to preventing direct contact between galvanised iron and stainless steel frame.
- Ensure roof attachment points are structurally sound
- Follow relevant safety regulations regarding working on roofs

Appendix C (Mid Angle Frame Kit Assembly Diagram)

Apricus Solar Collector Mid Angle Frame Kit

Part #: FR-XX-MID-RFOOT/RTRACK

The components contained in this package combine with the standard frame to form the complete frame assembly shown below.



Notes:
1. There are two mounting options, ROUND FEET or ROOF TRACKS.
2. When using the Roof Tracks, attachment to roof may be via roof attachment straps (# FR-60/100-RASTRAP) or rubber pads (# FR-SRPAD, FR-TRPAD) depending on roof surface.
3. ROUND FEET provide an adjustable angle of 21-28deg. ROOF TRACKS provide a set angle of 27deg.

Nuts and bolts are already attached to the appropriate components.

Frame Packing List

Part #	Component Quantities			
	10 & 20 Tube		22 & 30 Tube	
	FEET	R.TRACK	FEET	R.TRACK
1. FR-RCON	4		6	
2. FR-FCON	4		6	
3. FR-RTRACK	-	2	-	3
4. FR-TRLEG	2		3	
5. FR-RXB-MID-XX	2		4	
6. FR-RFOOT	4	-	6	-
7. FR-BOLT-M8x50	6	10	9	15
8. FR-BOLT-M8x40	1		4	
9. FR-BOLT-M8x20	4	4	4	4
10. FR-NUT-M8	11	15	17	23
11. FR-SWASH	11	15	17	23
12. FR-WASH-S	17	25	26	38
13. FR-WASH-B	4	-	6	-
14. FR-NLOCK	5	5	8	8
15. FR-SPAN-12/14	1			

SAFETY CONSIDERATIONS

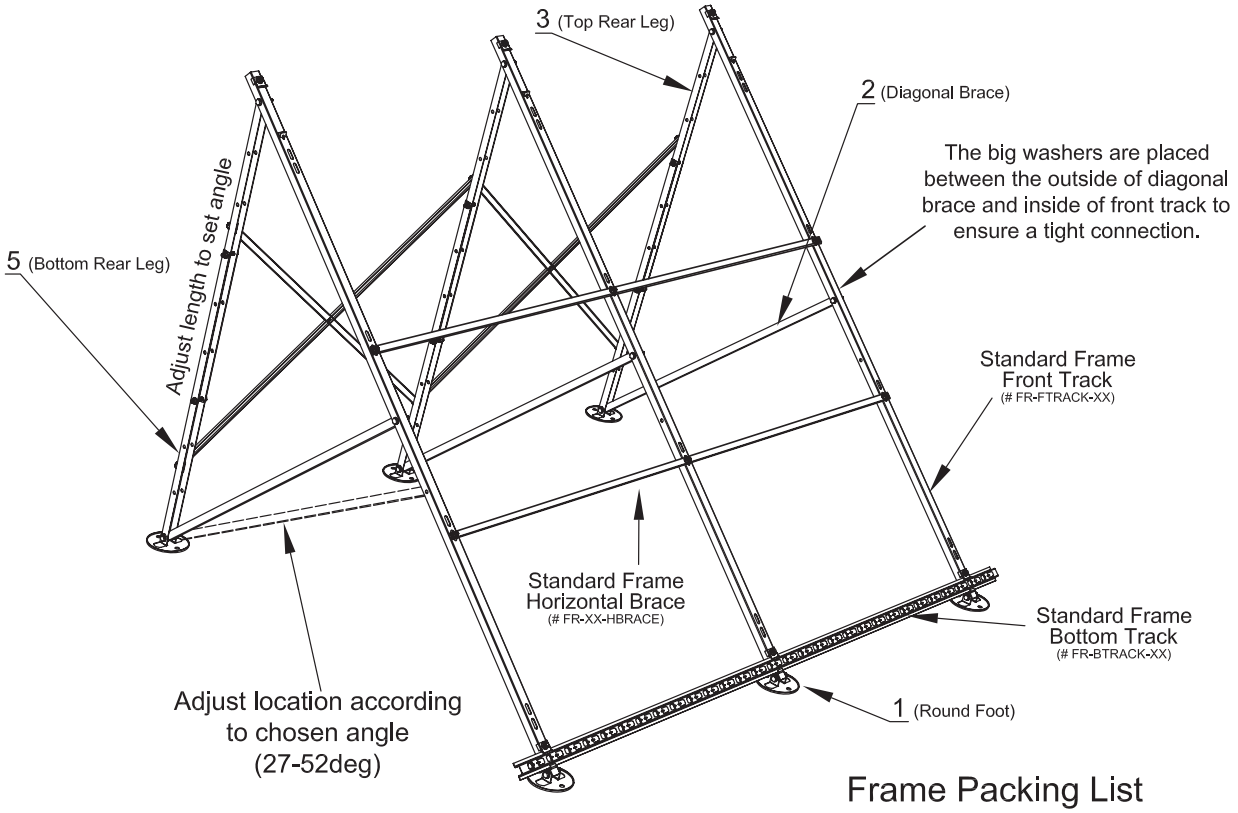
- Wear gloves when handling frame components
- Feet must be bolted to ground
- Ensure attachment points are structurally sound
- Follow relevant safety regulations regarding working on roofs

Appendix D (Round Foot High Angle Frame Kit Assembly Diagram)

Apricus Solar Collector High Angle Frame Kit

Part #: FR-XX-HIGH-RFOOT

The components contained in this package combine with the standard frame to form the complete frame assembly shown below.



Frame Packing List

Part #	Component Quantities	
	10 & 20 Tube	22 & 30 Tube
1. FR-RFOOT	4	6
2. FR-DBRACE	2	3
3. FR-TRLEG	2	3
4. FR-RXB-HIGH-XX	2	4
5. FR-BRLEG	2	3
6. FR-BOLT-M8x50	*12*	*18*
7. FR-BOLT-M8x40	*1*	*4*
8. FR-BOLT-M8x20	*4*	*4*
9. FR-NUT-M8	*17*	*26*
10. FR-SWASH	*17*	*26*
11. FR-WASH-S	*29*	*44*
12. FR-WASH-B	*8*	*12*
13. FR-NLOCK	*5*	*8*
14. FR-SPAN-12/14	1	

Nuts and bolts are already attached to the appropriate components

SAFETY CONSIDERATIONS

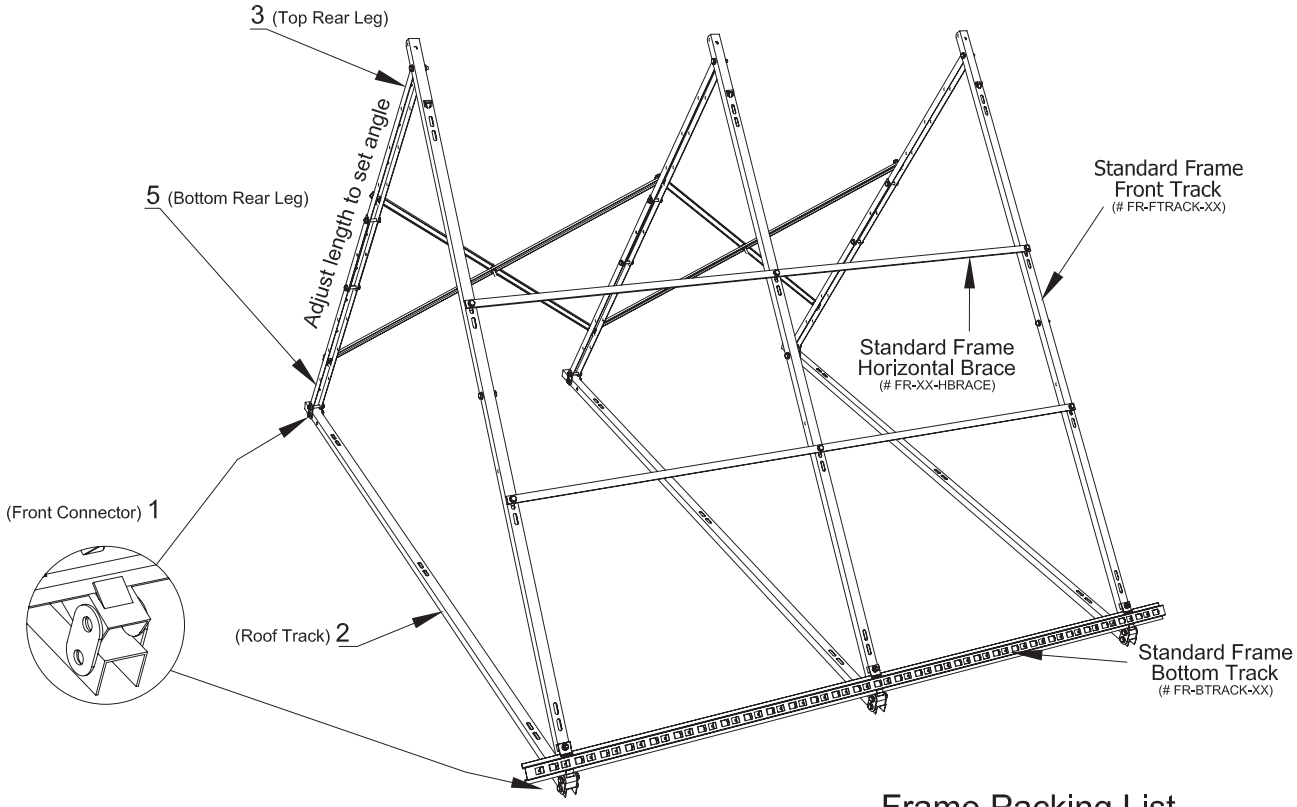
- Wear gloves when handling frame components
- Feet must be bolted to ground
- Ensure attachment points are structurally sound
- Follow relevant safety regulations regarding working on roofs

Appendix E (Roof Track High Angle Frame Kit Assembly Diagram)

Apricus Solar Collector High Angle Frame Kit

Part #: FR-XX-HIGH-RTRACK

The components contained in this package combine with the standard frame to form the complete frame assembly shown below.



Frame Packing List

Part #	Component Quantities	
	10 & 20 Tube	22 & 30 Tube
1. FR-FCON	8	12
2. FR-ROOFTRACK	2	3
3. FR-TRLEG	2	3
4. FR-RXB-HIGH-XX	2	4
5. FR-BRLEG	2	3
6. FR-BOLT-M8x50	*14*	*21*
7. FR-BOLT-M8x40	*1*	*4*
8. FR-BOLT-M8x20	*4*	*4*
9. FR-NUT-M8	*19*	*29*
10. FR-SWASH	*19*	*29*
11. FR-WASH-S	*33*	*50*
12. FR-WASH-B	-	-
13. FR-NLOCK	*5*	*8*
14. FR-SPAN-12/14	1	

Nuts and bolts are already attached to the appropriate components

SAFETY CONSIDERATIONS

- Wear gloves when handling frame components
- Feet must be bolted to ground
- Ensure attachment points are structurally sound
- Follow relevant safety regulations regarding working on roofs

Appendix F (Wall Mounting Diagram)

Apricus Solar Collector Wall Mounting Diagram