
# Apricus AP Solar Collector Installation and Operation Manual

USA Edition

(Revision 2.1 - May 2012)

# IMPORTANT INFORMATION

## READ CAREFULLY

**All components of the solar thermal system must be installed in accordance with those installation regulations required in the area the installation is to be completed. All regulations must be adhered to in all cases. Consultation with local authorities must be made before installation is commenced. Inspection by a plumbing inspector prior to final commissioning may also be required.**

**All installation work must be completed by licensed, suitably qualified and experienced installers. The installer of the solar collector system must have attended an Authorized Apricus Training Session and be registered with Apricus.**

**If you have NOT attended an Apricus training session, please contact your local Apricus supplier to organize training or contact Apricus:**
**Email: office-usa@apricus.com**
**Phone: 877 458 2634**

**The following terms are used through this document to bring attention to the presence of hazards of various risk levels or to important information concerning product operation.**

| ⚠ WARNING |
| --- |
| Indicates a potentially hazardous situation, which, if not avoided, could result in death, serious injury, or substantial property damage. |

| ⚠ NOTICE |
| --- |
| Important information that must be read and understood and adhered to where applicable. |

For installation of OG-300 listed systems please refer to:
Apricus OG-300 Solar Hot Water System Installation & Operation Guidelines

# Contents



# 1. Glossary & Conversions

## 1.1. Glossary of Terms

**Anti-scald Valve (Tempering Valve):** A valve used to limit the temperature of water being used.

**Closed Loop:** A system that, typically, has an anti-freeze, heat transfer fluid circulating through a closed, pressurized solar collector piping loop.

**Direct Flow:** A system that has potable water under the water main's pressure flowing directly through the solar loop piping into the collector and back down to the storage tank. Only used in warm climates.

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

**Return Line:** The plumbing line supplying hot water FROM the collector back to the storage tank or heat exchanger (compare to Supply Line, below).

**Insolation**: Solar radiation level, expressed in Btu/ft2/day (kWh/m2/day).Peak solar radiation is about 317 Btu/ft2 (1000 W/m2).

**Supply Line (Flow or Feed Line):** The plumbing line supplying water from the storage tank or heat exchanger TO the solar collector for heating (compare to Return Line, above).

## 1.2. Conversions

1 kWh = 3412 Btu = 859.8 kcal

1 kWh/$m^2$/day = 317.1 Btu/$ft^2$/day

1 kcal will heat 1 litre of water by 1$^{\circ}$ C

1Btu will heat 1 lb of water by 1$^{\circ}$ F

1 US Gallon of water = 8.34 lbs

# 2. Important Information

## ⚠ NOTICE

This manual pertains only to the installation and operation of the Apricus solar collector, pump stations, heat dissipator and controller. 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, valves and other plumbing components should be provided separately by their respective manufacturers.

This manual is primarily a reference document for installers, as the solar collector is only permitted to be installed by Authorized Persons. Under no circumstances should any Apricus product be installed by the homeowner.

## 2.1. Local Code

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

i) Canada the system must be installed in accordance with CSA F379.1 and the interim TIL MSE-45 document in addition to other relevant CSA standards cover the installation. Visit the following site for more details: http://www.cansia.ca/Default.aspx?pageId=156490

ii) In the US, also refer to the following reference documents:

ASHRAE 90003 Active Solar Heating Design Manual

ASHRAE 90342 Active Solar Heating Systems Installation Manual

## 2.2. Authorized Person(s)

a) The term “Authorized Person(s)” used throughout this document refers to a suitably qualified professional, who holds appropriate industry licenses or certificates required for the work completed during the installation process. This may also include solar specific certificates such as NABCEP (USA) or CANSIA (Canada). Any installer of the Apricus solar water heating system must have attended an accredited Apricus training session in order to verify that the installer has been provided key safety, design, installation and technical information related to the Apricus range of products.

b) Installations may only be completed by Authorized Persons.

c) Unless otherwise specified, no part of the Apricus solar collector, pump station, controller, heat dissipator or balance of system components may be inspected, repaired or maintained by anybody other than an Authorized Person(s).

d) At all times, the guidelines of this installation manual by be adhered to. If any guidelines contradict or fail to meet local local codes, regulations or standard practice, the installer must contact Apricus to discuss in order to ensure that the final method meets all relevant codes and regulations and will not void the warranty or cause any safety or operational issues with the Apricus products.

✖ *Failure to installed in accordance with the Authorized Persons requirements outlined above, will void the warranty.*

## 2.3. Safety (OSHA / CCOHS)

a) At all times, installers must adhere to operation safety and health guidelines as outlined by OSHA (USA) or CCOHS (Canada). For more information please visit www.osha.gov or www.ccohs.ca

b) The installer is responsible for his or her own safety while performing installations, at all times.

c) Those meeting the “Authorized Persons” requirements must also thoroughly READ and UNDERSTAND this installation manual prior to initiating installation of any Apricus solar water heating product(s).
For any queries contact you local Apricus representative or Apricus directly in North America:

Ph: +1 203 488 8215 Email: office-usa@apricus.com

d) **Evacuated Tubes:**

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

ii) Safety glasses MUST be worn at all times when handling evacuated tubes.

iii) 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. Protection should be implemented to prevent broken glass from causing injury or creating walking hazards to those below.

iv) The home owner should be made aware by the installer of 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.

e) **High Temperatures:**

i) When installed in the evacuated tube and in good sunlight, the heat pipe tip can reach temperatures in excess of 392˚F (200˚C). At this temperature, touching the heat pipe will result in serious burns. Thick leather gloves must be worn when handling hot tubes and heat pipes.

ii) In an operational system, if the pump stops during daylight hours the collector header and plumbing close to the manifold can reach temperatures in excess of 320°F (160°C). ALWAYS use caution when working near the collector and piping.

f) **Metal Components:**

i) ALWAYS use caution and wear appropriate personal protective equipment, including gloves, when working with any and all metal components, especially those with sharp edges.

g) **Electrical Connections:**

i) Any electrical installation work must be completed by a licensed electrician. Take special care when working in potential wet environments. Ensure all power outlets, cables and connectors are protected from water ingress, high humidity and condensation.

## 2.4. Collector Specifications


| | 10 tubes | 20 tubes | 30 tubes |
|---|---|---|---|
| **Overall Length** [1] | 80" (2005 mm) | | |
| **Overall Height** [2] | 6.14" (156 mm) manifold + standard frame | | |
| **Overall Width** [3] | 31.3" (796 mm) | 58.8" (1496 mm) | 86.4" (2196 mm) |
| **Absorber Area** | 8.6 $ft^2$ (0.8 $m^2$) | 17.2 $ft^2$ (1.6 $m^2$) | 25.8 $ft^2$ (2.4 $m^2$) |
| **Aperture Area** | 10.68 $ft^2$(0.99 $m^2$) | 21.36 $ft^2$ (1.98 $m^2$) | 32.05 $ft^2$ (2.98 $m^2$) |
| **Gross Area** | 14.46 $ft^2$ (1.34 $m^2$) | 31.86 $ft^2$ (2.96 $m^2$) | 44.76 $ft^2$ (4.15 $m^2$) |
| **Gross Dry Weight (Standard Frame)** | 77 lb (35 kg) | 140 lb (63.5 kg) | 209 lb (95 kg) |
| **Fluid Capacity** | 9.8 fl.oz (290 ml ) | 16.9 fl. oz (500 ml) | 24 fl. oz (710 ml) |

1. Length of standard frame channels;
2. Height of standard frame channels + manifold;
3. Width of manifold (not including inlet/outlet ports);

Please note that values are from SRCC and may differ from other reports slightly as each have different calculation methods.

| Manifold & Header | |
|---|---|
| **Copper Header Material** | >99.93% Copper<br>Reference Grades: T2, C11000, CDA110, C102, ECu-58 |
| **Brazing Rod Materials** | 45% Ag, 30% Cu, 25% Zn (BAg45CuZn)<br>& 93% Cu, 7% P (BCu93P) |
| **Recommended Flow Rate** | 0.026 Gallon/tube/minute = 0.26 Gallon/10 tubes/minute<br>(0.1 L/tube/minute = 1 L/10 tubes/minute) |
| **Max Flow Rate** | 3.9 gpm (15L/min) regardless of collector size |
| **Max Operating Pressure Rating** | 116 psi (800 kPa)<br>123 psi (850 kPa) Pressure Relief Valve acceptable |
| **Manifold Material** | 0.03” (0.8mm) Aluminum Grade 5005-H16<br>Anodized clear finish |
| **Glass Wool Insulation** | ~4.36 lb/ft$^3$(~70 kg/m$^3$)<br>R-value = 6.6 ft$^2$.$^o$F.h/Btu (1.16K.m$^2$/W)  K-value = 0.043 W/mK |
| **Acceptable Fluids** | Water, Solar Hi-temp, or 50/50% or weaker propylene glycol mix. |

| Mounting Frame | |
|---|---|
| **Frame Material** | 439 or 304 Stainless Steel |
| **SS Tube Clips** | 301 or 304 Stainless Steel |
| **Bolts, Washers and Nuts** | 304 Stainless Steel |

| Heat Pipes | |
|---|---|
| **Length** | 70.8” (1800 mm) |
| **Material** | ∅0.314” OD x 0.027” (∅8 mm OD x 0.7 mm) copper<br>Reference Grades: TU1, C10200, CDA102, C103, OF-Cu |
| **Heat Transfer Fluid** | Purified water (non-toxic) |
| **Maximum Working Temperature** | 577˚F (300˚C) |
| **Minimum Temperature** | Fluid in heat pipes will freeze, but will not damage the heat pipe:<br>No minimum operating temperature. |
| **Startup Temperature** | Startup < 86˚F (<30˚C) |
| **Vacuum** | ~P<5x10$^{-3}$ Pa |
| **Installation Angle from horizontal** | 20˚ minimum angle, 80˚ maximum |

| Rubber Components | |
|---|---|
| **Material** | HTV Silicone Rubber (UV stabilized) |
| **Density** | 1.15 g/cm$^3$ +/- 0.05 |
| **Durometer Hardness (Shore A)** | 50-70<br>(depends on component) |
| **Elongation** | 320% |
| **Rebound** | 54% |
| **Maximum Working Temperature** | 577˚F (300˚C) |
| **Tensile Strength** | 6.4 Mpa |
| **Tear Strength** | 12.5 KNM |

| Evacuated Tubes | |
|---|---|
| **Tube Length** | 70.8” (1800 mm)<br>Actual length to tip = 71.25”-72” (1810-1830 mm) |
| **Outer Tube Dimensions** | ∅2.28” x 0.07” (∅58 mm x 1.8 mm) |
| **Inner Tube Dimensions** | ∅1.85” x 0.07” (∅47 mm x 1.8 mm) |
| **Weight** | 4.4 lb (2 kg) |
| **Glass Material** | Borosilicate Glass 3.3 |
| **Absorber Material** | Graded-index coating Al-N on Al on glass |
| **Thermal Expansion** | 3.3x10-6 •C |
| **Absorptance (α)** | >92% (AM1.5) |
| **Emittance (ε)** | <8% (80•C) |
| **Vacuum** | P < 5 x10-3 Pa |
| **Stagnation Temperature** | >395° F (>200° C) |
| **Heat Loss** | <0.8W/ (m2 •C) |
| **Maximum Strength** | 120 psi (0.8 Mpa) |
| **Absorber Area per Tube**<br>**(for standard performance calculations)** | 0.86 ft2 (0.08 m2) |

| Thermal Efficiency | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Efficiency (gross area)*** | ηo (-) = 0.456, $a_1$ (W/m²K) = 1.3509, $a_2$ (W/m²K²) = 0.00381<br>Based on gross area of 4.158 m² / 44.76 ft² | | | | | | | | | |
| **Efficiency (aperture area)*** | ηo (-) = 0.634, $a_1$ (W/m²K) = 1.877, $a_2$ (W/m²K²) = 0.00529<br>Based on gross area of 2.99m² / 32.21ft² | | | | | | | | | |
| **IAM** | 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° |
| **Kθ (longitudinal)** | | | | | | 0.93 | | | | |
| **Kθ (transversal)** | 1.0 | 1.02 | 1.08 | 1.18 | 1.37 | 1.4 | 1.34 | 1.24 | 0.95 | 0.0 |

| Thousands of BTU Per Panel Per Day* | | | |
|---|---|---|---|
| **Category** | **Clear Day** | **Mildly Cloudy** | **Cloudy Day** |
| A (-9° F) | 46.1 | 34.8 | 23.5 |
| B (9° F) | 44.0 | 32.7 | 21.4 |
| C (36° F) | 40.6 | 29.3 | 18.0 |
| D (90° F) | 34.2 | 23.0 | 11.8 |
| E (144° F) | 27.1 | 16.8 | 6.2 |

*SRCC test data from report 2007033A - see Appendices 4-7 for complete certificate.

# 3. System Design

## ⚠ NOTICE

Apricus provides the system design information contained herein as a guide only and does not guarantee the accuracy of such information. In ALL cases the system design and installation must adhere to local codes, regulations and guidelines and the suitability and safety of the system design may need to certified by a licensed engineer, and finally inspected by a plumbing inspector. All systems must be installed by Authorized Persons.

### 3.1. Type of Systems

The three most common system formats for solar thermal hot water installations are described below:

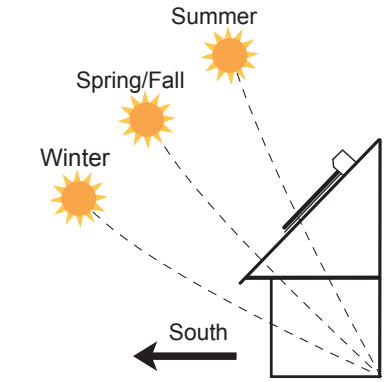
a) Direct Flow systems have potable water under the water main's pressure flowing directly through the solar loop piping into the collector and back down to the storage tank. These systems are suitable for areas that do not fall below 23˚F (–5˚C) at anytime throughout the year. Freeze tolerance limits are based upon assumed set of environmental conditions.

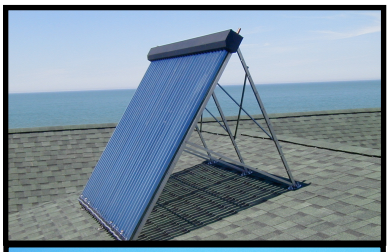
b) Closed loop installations are suitable for cold regions and use a non-toxic "anti-freeze" heat transfer fluid, instead of potable water. Heat exchangers separate the non-toxic fluid from the potable water.

c) Drainback installations are suitable for both cold and warm regions and when the pump shuts off, any fluid in the collector and solar loop piping drains back down into a reservoir tank located within a conditioned, interior space.

ci) Refer to Apricus OG-300 documentation and www.apricus.com for specific schematics.

### 3.2. Solar Collector & Storage Tank Location



3.2.1. Collector Direction

a) The collector should face as close to True South as possible. A deviation of up to 15˚ to the East or West is acceptable and will have minimal effect on collector performance. If a choice can be made, west is preferable over east as solar radiation levels are often highest early afternoon.

b) If the roof faces E-W rather than South, there are a few options:

i) The collector angle can be raised up to 60-70˚ and positioned near the peak of the roof so that both the front and back of the evacuated tubes can be exposed to light. See image to the right. In such a position wind loading must be carefully considered.

ii) Collectors may also be mounted on a pitched roof in line with the roof pitch as show to in the bottom right.

**Note:** In either of the above configurations wind loading must be carefully considered. For more information on wind loading refer to section 3.13.

3.2.2. 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 an pitched roof. See previous 3.2.1.b.ii.

b) The collector must not be installed up-side-down (tubes pointing upwards) or with tubes lying horizontally.

3.2.3. Collector Angle

a) The solar collector should be installed at an angle between 20-80˚ In areas prone to hail, a minimum angle of 45˚ is advisable (see section 3.16). In areas prone to snow, 45˚ or higher is advisable (see section 3.14) Even with snow sitting on the bottom of tubes, the heat pipes will work effectively to produce heat.

c) Under no circumstances should the collector be oriented more than 90˚ (East or West) from True South.

3.2.4. Avoid Shade

a) Collectors should be located so that shading does not occur between 9 am - 3 pm, which are the peak solar hours. Use of a solar shading analysis tool is recommended.

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

c) If installing multiple rows of collectors, ensure there is enough space to avoid shading between rows. Visit www.apricus.com for a shading calculator.

3.2.5. Proximity

a) The collector should be positioned as close as possible to the storage tank to avoid long pipe runs. This will improve system performance and minimize pressure drop through the piping.

## 3.3. System Sizing

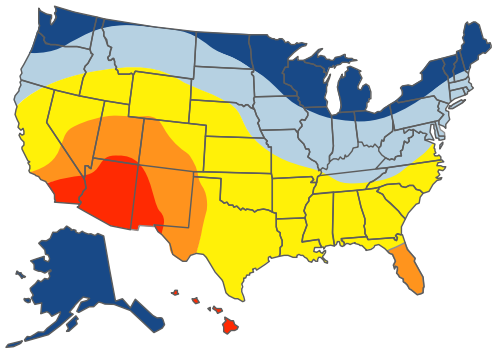
For space heating or commercial domestic water heating, system sizing is more complicated. Calculations of load (energy requirements) and solar radiation levels need to be thoroughly analyzed before a system design can be developed.

3.3.1. Commercial System Sizing

Commercial Systems require more detailed sizing and modeling. For help sizing commercial systems please contact your local Apricus representative or download the Apricus commercial sizing guide from www.apricus.com

3.3.1. Residential Hot Water System Sizing

The following chart can be used to estimate the number of collectors required based on location and household size.



1. Sizing is based on providing >90% of domestic hot water in the summer time. An electric or gas backup system is required to guarantee hot water year round.
2. Based on a true south installation at an angle of 10° or greater than the latitude of the location.
3. Additional components required include pumps, valves, controls and in certain areas, heat exchangers and propylene glycol antifreeze.

| Climate | Size of Household | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 3 People | | 4 People | | 5 People | | 6 People | |
| | Tank (gal) | Collectors | Tank (gal) | Collectors | Tank (gal) | Collectors | Tank (gal) | Collectors |
| | 80 | 1 x AP-20 | 80 | 1 x AP-20 | 80 | 1 x AP-30 | 120 | 2 x AP-20 |
| | 80 | 1 x AP-20 | 80 | 1 x AP-30 | 120 | 1 x AP-30 | 120 | 2 x AP-20 |
| | 80 | 1 x AP-20 | 80 | 1 x AP-30 | 120 | 1 x AP-30 | 120 | 2 x AP-30 |
| | 80 | 1 x AP-30 | 80 | 1 x AP-30 | 120 | 2 x AP-20 | 120 | 2 x AP-30 |
| | 80 | 1 x AP-30 | 80 | 2 x AP-30 | 120 | 2 x AP-30 | 120 | 2 x AP-30 |

## 3.4. Pipe Type & Size

3.4.1. Pipe Material

a) Due to potential high collector temperatures, only copper or stainless steel piping should be used.

b) Dielectric unions must be used to connect any other types of material to the collector piping.

3.4.2. Pipe Size

a) **Pipe Selection:** The pipe size should be selected to minimize fluid velocity in the pipes. The ideal flow rate for an Apricus systems is: # of tubes * 0.026 gpm/tube

b) **Pipe Diameter:** See table below for basic pipe sizing:

| Number of Tubes | Pipe Size |
|---|---|
| 10-20 | 1/2” |
| 30-90 | 3/4” |
| 90-240 | 1” |

3.4.3. Pipe Location

Depending on the construction of the building, the route of the pipe run to the collector could be inside, outside or even underground. Always consider the following factors:

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

b) **Inside:** Extra care must be taken to any piping leaks inside the building. Avoid joints in attic or overhead spaces that could cause significant property damage if they were to leak.

c) **Outside:** Ideally, run insulated pipe within PVC conduit or similar material, which will protect the insulation from UV degradation and also provide a clean, unobtrusive appearance.

d) **Underground:** Burying pipes underground may be required, if the collectors are mounted away from the mechanical room.

i) When running pipes underground, ALWAYS call in the appropriate “locates” before digging, according to local requirements.

ii) When running pipes underground, always use a conduit such as PVC to prevent water ingress.

iii) Always bury piping to the appropriate depth, as required by code. Buried pipes may require a municipal inspection prior to “cover.” Also, consider potential for the pipes to be crushed, if vehicles drove over the area. Reinforce as required.

iv) Put markers along the path of the piping to warn anybody who may dig up the ground in that area.

v) Consider the frost depth of the soil in cold regions. Burying below the frost depth will provide better insulation.

3.4.4. Noisy Pipes

a) **Water Hammer:** When water is traveling through a pipe and suddenly a tap is turned off it stops with considerable force, which can lead to a loud noise commonly referred to as “water hammer”. Hammer arresters are commercially available to eliminate this issue.

b) **Steam Noise:** In direct flow system that is stagnating under pressure, the water can be very hot without forming steam (above 212˚F or 100˚C). When a hot water tap is opened, the pressure in the system drops, which allows steam to rapidly form and then condense repeatedly in the solar collector causing a popping or banging sound similar to water hammer. This problem is most common when the cold water inlet pressure is less than 50 psi (350 kPa). A solution is to install a closed loop system. The loop can be filled with

potable water, but because the pressure is independent of the water main pressure, fluctuations in pressure will not occur.

Refer also to 3.6.2 for more information about pressure and water boiling.

## 3.5. Pump Selection & Flow Rates

a) **Pump Size:** The pump selected must be able to provide adequate flow. This is dependent on the number of collectors installed and length of the run. Calculate the pressure drop in the line and match against the pump curve to ensure the pump can provide enough flow. Below is a list of Apricus pump stations and the number of collectors they can service

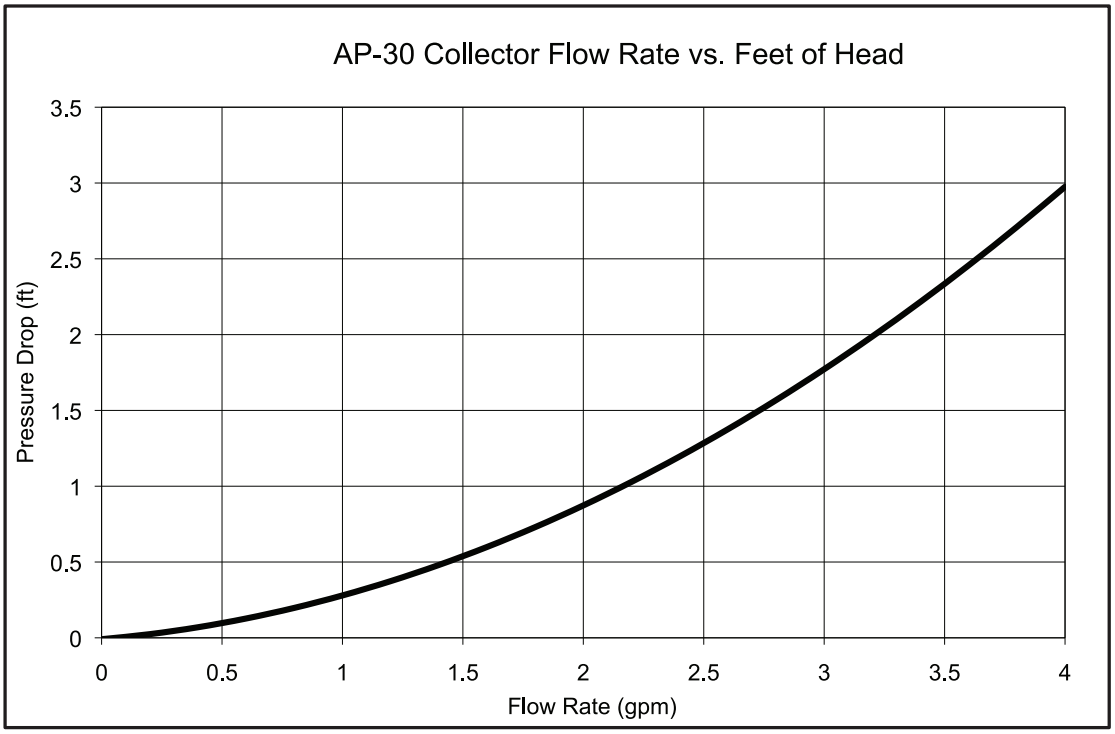
| Product | Maximum Number of Collectors * |
|---|---|
| Apricus Closed Loop Pump Station | 3 AP-30 |
| Apricus Direct Flow Pump Station | 3 AP-30 |
| Apricus Commercial Pump Station | 10 AP-30 |

* Number of collectors based on a pipe run of less than 125 ft.

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

c) **Pump Body Material:** Cast iron pumps may ONLY be used for closed loop or systems; they will rust and fail if used with potable water. Pumps in direct flow systems must be made from a material safe for use with potable water and be certified as such.

d) **Pressure Drop Curve:** The Apricus 30 tube solar collector header has the following pressure drop curve. The pressure curve will be slightly less for Apricus 10 and 20 tube collectors.



e) **Use a Flow Meter:** A flow meter with the ability to adjust flow rate should be installed on the solar system. A flow meter is included in all Apricus pump stations.

f) **Stratification and Flow:** A high flow rate in a direct flow or external heat exchange system may cause turbulence in the solar storage tank and disturb stratification, which can lower the entire tank temp during low solar production periods. A variable speed pump control will ensure that the flow rate matches the heat output and limit tank de-stratification.

g) **Correct Pump Choice:** Any pump used for solar loop circulation must be able to handle continuous use to 232˚F (110˚C) and higher, if required by system design. The solar pump should always be installed on the Supply Line (pumping to the collector and away from the heat exchanger or tank) thus limiting exposure to high temperatures. All systems except drainback must have a check valve installed after the pump. All Apricus pump stations incorporate a flow meter, pump and check valve.

h) **Flow Rate:** The flow rate through the collectors should be determined under the following considerations:

i) Idea flow rate is 0.026 gallons per minute per tube.

iii) Flow rate should not exceed 4 gpm through any collector.

iv) Flow rates exceeding 4 gpm will increase pressure drop and could cause damage to the collectors.

iv) The following table provides estimated temperature rises at various flow rates:

| Flow Rate per 30 tubes | Temp Rise @ 150Btu/ ft$^2$(Clear Winter Day) | Temp Rise @ 320Btu/ ft$^2$(Clear Summer Day) |
|---|---|---|
| 0.2 gpm (0.75 Lpm) | 30˚F (16.4˚C) | 85˚F (35˚C) |
| 0.4 gpm (1.5 Lpm) | 15˚F (8.2˚C) | 42˚F (17.5˚C) |
| 0.6 gpm (2.3 Lpm) | 10˚F (5.5˚C) | 28˚F (11.7˚C) |
| 0.8 gpm (3 Lpm) | 7˚F (4.1˚C) | 21˚F (8.7˚C) |
| 1 gpm (3.8 Lpm) | 6˚F (3.3˚C) | 17˚F (7˚C) |

v) As a general rule the ideal flow rate for Apricus evacuated tube solar collectors is:

**0.026gallons/tube/min AP-10 = 0.25gpm AP-20 = 0.5gpm AP-30 = 0.8gpm.**

## 3.6. Overheating & Pressure

3.6.1. What is Stagnation?

a) **Stagnation:** Stagnation refers to the condition that occurs whenever the pump stops running. This could be due to pump failure, power outage or most commonly, as the result of a max tank temperature protection feature setting on the controller. During stagnation, the collector, unable to actively dump heat, will continue to rise in temperature until the heat loss from the collector and piping equals the heat being absorbed. In strong sunlight with high ambient temperatures, the collector will reach a peak stagnation temperatures of about 428˚F (220˚C), if dry (decommissioned system or drainback), and a lower level of 320˚F (160ºC), if the piping and collectors contain fluid (as in pressurized systems).

b) **Consider High Temperatures:** Components that may be exposed to the high temperatures such as valves, plumbing or insulation should be suitably rated.

3.6.2. System Pressure & Boiling Temperature

a) **Boiling Temperatures:** The boiling temperature of water (or other fluid) is directly related to the pressure of the system. Water will boil at a higher temperature, the more pressure it under. This is a very important concept, as the pressure of the system can greatly influence the operation and reliability. Generally, a higher pressure is better (within reasonable limits).

The table below provides pressures and corresponding boiling temperatures for water. These will be slightly higher for 50/50% glycol mixes, which on average have a boiling point of 220˚F (104˚C) at sea level (i.e.1 atmosphere of pressure) versus pure water at 212°F (100°C).

| PRESSURE and $H_2O$ BOILING POINT | | | |
|---|---|---|---|
| **PSI** | **°F** | **kPa** | **°C** |
| 14.5 | 212 | 101 | 100 |
| 28 | 247 | 203 | 120 |
| 43.5 | 271 | 304 | 133 |
| 58 | 289 | 405 | 143 |
| 72.5 | 304 | 507 | 151 |
| 87 | 317 | 608 | 158 |

b) **Different Fluids:** Heat transfer fluids for closed loop systems will have different properties. Refer to the manufactures specification for more information.

c) **System Pressure:** The fluid in any system will lose about 0.5 psi per foot of vertical height. To calculate the proper system pressure divide the height from the pressure gauge by 2 and add 20 psi. A typical residential system will be set to 40 psi.

d) **Flash Point:** The flash point of a fluid is the lowest temperature at which vaporization can occur to form a mixture in air that can be ignited. Propylene glycol has no measurable flash point in concentrations less than 80%. Always ensure that the flash point of the heat transfer fluid is below the maximum stagnation temperature of the system.

3.6.3. Correct System Sizing to Avoid Overheating

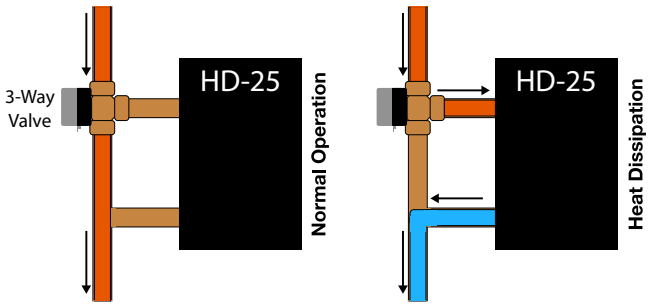
a) **Avoid Excessive Heat Output:** The system should be sized so that overheating of the tank is difficult to achieve in a single day, even during hot, sunny periods. If the system is over-sized, so that stagnation occurs often during summer months, the system must be able to stagnate repeatedly without damage or heat transfer fluid degradation. Repeated stagnation in a closed loop system is not recommended.

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

3.6.4. Heat Dissipation

Closed loop systems with excess output should use heat dissipation.

a) **Fluid to Air:** A finned fluid-to-air unit can be used to dissipate heat from the system, once the tank has reached the maximum temperature. Apricus offers the HD-25 for this purpose. The heat transfer fluid circulates through the copper pipe transferring heat to a set of large aluminum fins, which in turn dissipate heat to the surrounding air. Each HD-25 can dissipate up to 5100 Btu/hr (1.5kW) or greater with active air flow. The HD-25 is for exterior installation only. If greater heat dissipation is required a hydronic fan coil can be used.




b) **Underground Heat Dump Piping:** An underground pipe run in copper or suitably temperature rated plastic pipe can be completed. Any piping must be rated for direct burial in your area. Always call for appropriate locations prior to digging. If using copper, 100 ft of 1/2” pipe is required per 30 tube collector, or 150 ft, if using synthetic pipe which has poorer heat transfer properties. If using a larger diameter pipe, a shorter length can be used. Measures must be taken to avoid Legionella within the loop during inactive

periods if using a direct flow system.

If possible bury the pipe at a depth that is normally moist as the water content of the soil will help to improve heat dissipation.

c) **Alternative Heat Uses:** During the summer, heat can also be dumped into a hot-tub, jacuzzi, pool, large storage tank or underground thermal store.

See also the following point (3.6.5), regarding reduction of summer heat output.

3.6.5. Adjusting Collector Angle to Reduce Overheating

a) **Increase Angle to Reduce Summer Output:** Increasing the installation angle will help decreased the average daily output of the collector during the summer time.

## 3.7. Multiple Collector Connection

3.7.1. Connection of Multiple Collectors

a) **Connecting Collectors in Series:** The flow rate through any given collector in a system should no exceed 4 gpm. Based on the ideal flow rate this equates to a maximum of 150 tubes in series.

i) Excessive high flow rates can “scrub” the walls of the copper header, wearing it away.

ii) High flow rates greatly increase the pressure drop, requiring a much larger circulation pump, wasting electricity.

iii) Thermal expansion of more collectors in series could cause buckling of the copper header during periods of stagnation.

As described earlier in section 3.5, the use of a variable speed pump control is highly recommended.

✖ *Damage to collectors due to excessive flow rates is not eligible for warranty claims.*

b) **Isolation and Drain Valves**: Each bank of collectors (up to 5 in series) should have an isolation valve at each end and a drain valve. If the collector bank needs to be isolated for maintenance work the drain valve must immediately be opened to avoid dangerous pressure and temperature buildup.

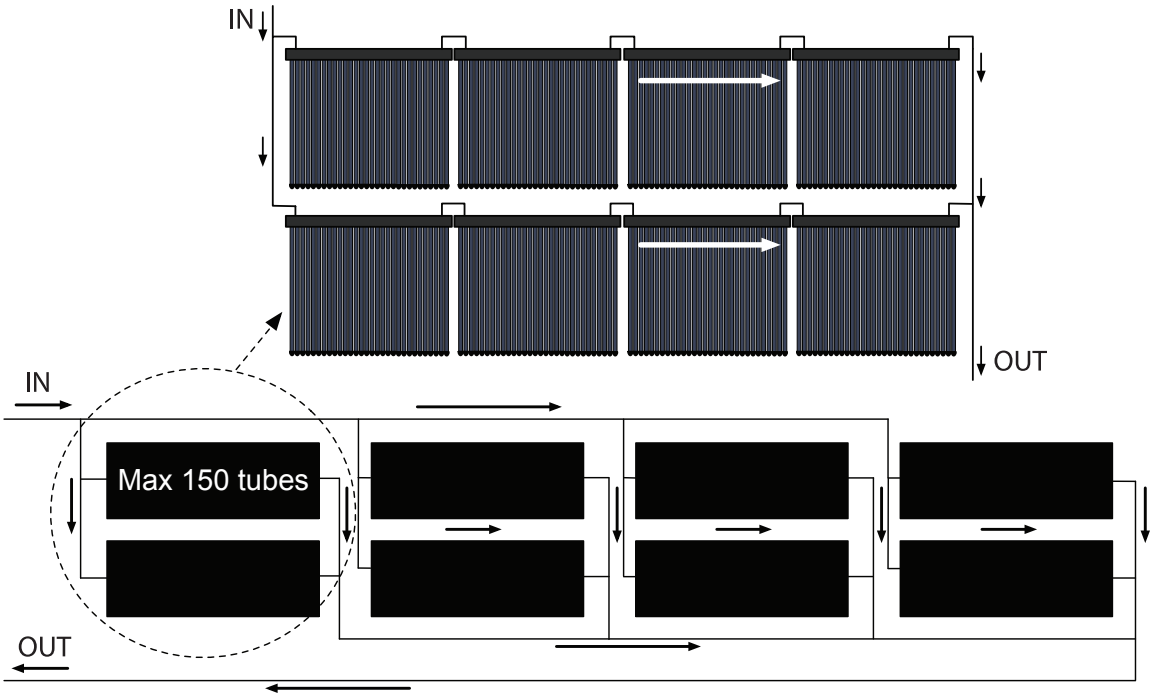
**⚠ WARNING**

If any solar collectors are isolated, a drain valve located between the two points of isolation must immediately be opened, otherwise a rapid pressure build up may occur potentially resulting in component rupture releasing superheated water or steam.

3.7.2. Balanced Flow

a) **Balancing Flow Through Collectors:** All collectors must see equal flow in a system. On systems with multiple banks of collectors this can be achieved through reverse return or with balancing valves.

b) **Reverse Return** or “first in - last out” is an effective piping configuration that helps to ensure balanced flow. The major disadvantages are less precise flow balancing, and increased cost and heat loses due to extra piping length. Below is a diagram of reverse return piping.




c) **Balancing Valves:** A more precise method of ensuring equal flow is using manual or automatic balancing valves. Not only can the flow on each bank be measured and directly adjusted, but this may be more cost effective than reverse return as it eliminates the additional pipe run length and associated increased cost and heat loss.

## 3.8. Auxiliary Heating

There are multiple ways to configure a solar thermal system. The two common types are:

**Pre Heat:** A dedicated storage tank feeds a traditional or existing water heater.

**Single Tank:** The solar and back up tank are combined into one unit.

Below are some notes on different system configurations. Refer to Apricus schematics for more details.

### 3.8.1. Electric & Bottom Fired Gas Tanks

a) **Retrofits:** Solar thermal may be retrofitted to an electric back up tank or a dedicated solar pre-heat can be installed that feeds the existing electric boosted tank

b) **Heating Elements:**

i) **Single Tank:** The electric tank should not have an element in the portion of the tank heated by solar. An aquastat or control should be installed to ensure the top half is always hot. Note that this can not be accomplished with most standard gas water heaters thus single tank systems using traditional bottom fired gas tanks is not recommended.

ii) **Pre Heat:** If using an electric tank to hold solar water, the electric elements should not be connected. The elements in the second or auxiliary tank should be connected normally. It is important to make sure that the second tank does not have a high temperature limit that could be activated by solar. If the second tank does have a high limit install a mixing valve between the two tanks.

**⚠ WARNING**

Any modification to the electrical wiring of the storage tank must be completed by an authorized electrician and meet relevant regulations. Power supply must be turned OFF and locked (to avoid accidental connection) while any electrical work is being completed. Take extreme care when working in wet areas to avoid potential contact with energized wiring.

3.8.2. Instant/Tankless Gas Boosting

a) **Operation:** The heater chosen must be able to accept water pre-heated up to 160˚F (70˚C) from the solar tank. The water exiting the tankless water heater must be tempered down to 122˚F (50˚C) by an anti-scald valve. Always consult equipment manufacturers instructions and guidelines before installation.

**⚠ WARNING**

Suitable tankless gas water heaters will allow solar heated water to pass straight through if above the set temperature. To avoid excessively hot water from reaching the household taps and potentially causing serious burns, an Anti-Scald Valve MUST be installed after the tankless gas booster to bring the water down to a safe temperature.

3.8.3. Boiler Boosting

a) **Pre Heat:** The solar pre heat can feed a standard indirect water heater.

b) **Single Tank:** Tanks with an upper coiler for a boiler and the bottom for solar exist.

## 3.9. Pipe Isolation

a) **Direct Flow:** Piping must allow the collectors to be isolated from the water heating system and allow the collector loop to be drained without affecting the operation of the water heating system. A pressure relief valve must be installed between the isolation valves and the collector to prevent dangerous build up of pressure.

b) **Closed Loop:** Piping must allow the collectors to be isolated from the water heating system. A pressure relief valve must be installed between the isolation valves and the collector to prevent dangerous build up of pressure.

**⚠ WARNING**

When isolating any section of pipe it is essential that pressure be released by opening a drain valve or loosening a fitting. Failure to release pressure on an isolated section of pipe, especially if that includes a solar collector, could result in dangerously high pressures and temperatures.

## 3.10. Operating Limits

a) **High Temperature Limits:** Components within 18” of the collector may see temperature in excess of 320°F. All components placed near the collector must be suitably rated.

b) **Operating Limits:** All components in the solar thermal system should be rated to a minimum of 225°F.

c) **High Temperature Controller Setting:** The control must be set up to lock the circulator to prevent downstream components from being exposed to high temperatures.

d) **Low Temperature Limits:** Any components exposed to outdoor conditions must be rated and suitable for use in these conditions.

e) **Ultraviolet (UV) degradation:** Any components installed outside must be able to withstand UV radiation

without significant degradation. Color fading is common, but cracking, peeling and other severe degradation should not occur during the design-life of any component in the system.

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

- Wind loading refer to section 3.13.
- Snow loading refer to section 3.14.
- Hail refer to section 3.16.

## 3.11. Fluid Expansion & Steam Formation

a) **Thermal Expansion:** Fluids expand as they are heated up. Proper control of this expansion is critical to the operation of a solar thermal system. An expansion tank must be sized to accept the total possible expansion of the system.

b) **Potable Water Expansion:** Systems with back flow prevention or check valves on the cold water inlet must have an appropriately sized expansion vessel installed. This vessel must be sized to accept the full expansion of the system without causing an unsafe build up in pressure. A solar thermal system may have more expansion than a traditional water heating system due to higher operating temperatures.

c) **Closed Loop Expansion:** An expansion vessel that can handle the full expansion of the heat transfer fluid must be installed to prevent unsafe build up in pressure and be rated for the operating temperatures and conditions.

d) **Steam Formation:** There is a potential during stagnation for steam to form in the collectors. Steam expands and occupies a much larger volume than water. This must be taken into consideration when sizing an expansion tank. Failure to do so can cause a build up in pressure which may cause the pressure relief valve to open.

## 3.12. Heat Exchangers

### 3.12.1. Internal Coil Heat Exchangers

a) **Coil Design:** Due to heat transfer characteristics Apricus recommends that a tank be used with the smallest possible coil diameter to improve system efficiency.

b) **Closed Loop Fluid Volume:** When calculating the closed loop fluid volume, remember to include the volume in the coil, which should be listed on the tank's product specification sheet. In Canada, CSA requires that the fluid volume of the solar system not exceed 10% of the volume of the storage tank.

c) **Single vs Dual Wall:** If the local area requires a dual wall heat exchanger Apricus recommends avoiding the use of a coil heat exchanger as the efficiency will be lower than desirable. Choose a dual wall brazed plate heat exchanger instead (see 3.12.2). When using a single wall heat exchanger the solar loop pressure should be less than the potable water pressure.

3.12.2. Brazed Plate Heat Exchangers

a) **Advantages:** Brazed plate heat exchangers (BPHE) are a compact and efficient heat transfer unit ideal for use in solar thermal systems. They are superior to coil heat exchangers because they allow the solar collector to run at a lower, more efficient temperature, while transferring the same amount heat energy to the tank.

b) **Disadvantages:** BPHE require an additional pump to facilitate circulation on the potable (end-use) side of the plates. In areas with hard water, limescale can build up restricting flow and requiring periodic flushing.

c) **Single vs Dual Wall:** BPHE are available both in single wall and dual wall models. Dual wall models are required in some areas and generally need to have positive leak detection, so fluid will leak out the sides if either of the plates rupture. When using a single wall heat exchanger the solar loop pressure should be less than the potable water pressure, according to local code.

**⚠ WARNING**

Selecting the proper heat exchanger is important for the safety of the system. You may only use a single wall heat exchanger (internal or external) if the heat transfer fluid being used is Generally Regarded As Safe. This information can be found in the Material Data Safety Sheet of the fluid.

## 3.13. Wind Loading

a) Collector wind loading must be considered and the resulting stress on attachment points thoroughly examined. The attachment method may need the stamp of a professional engineer, depending on local regulation.

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

c) Refer to Section 5 for specific roof attachment details.

d) Other mounting methods in high wind regions may require inspection and approval by a licensed engineer or the local building department. It is the responsibility of the installer to ensure that the frame mounting is of suitable strength.

e) The table below provides an overview of the forces on and AP-30 at 130 mph winds.

| Round Foot | Peak Vertical Pull Load @ 30° / 45° / 60° angle | Peak Shear Load @ 30° / 45° / 60° angle |
|---|---|---|
| Front Middle | 49 lbs / 18 lbs / 88 lbs | **130 lbs / 220 lbs / 397 lbs** |
| Front Left/Right | 34 lbs / 29lbs / 95lbs | 70.5 lbs / 163 lbs / 220 lbs |
| Rear Middle | **84 lbs / 187 lbs / 269 lbs** | 40 lbs / 68 lbs / 146 lbs |
| Rear Left/Right | 71 lbs / 172 lbs / 251 lbs | 38 lbs / 53 lbs / 128 lbs |
| Combined Load | 343 lbs / 607 lbs / 1076 lbs | 278.5 lbs / 720 lbs / 1782 lbs |

f) Based on the figures provided in the table above, the weight of individual concrete blocks or the strength of fixation points requirements can be determined. A safety factory of at least 1.2 should be used or as

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

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

**⚠ WARNING**

Failure to implement suitable collector mounting methods to withstand wind loading may result in damage to the solar collector, extreme damage to property and even death.

### 3.14. Snow Load

a) In areas prone to heavy snow falls, the solar collectors can be installed at an angle of 50° or greater to promote snow sliding off the tubes. In addition, it is advisable to raise the front of the collector frame 6-8" off the roof surface as this allows the collector to sit above moderate snow falls and allow snow to blow away from under the collector. A front track extension (Part #: FR-FTRACK-EXT) can be used for this purpose. See the picture to the right.

b) Each tube is strong enough to withstand >110lb loading, but roof attachment points may need to be reinforced. Please refer to local regulations regarding snow loading precautions.

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

### 3.15. Storage Tanks

a) **Glass-lined storage tanks:** NOTE: If no hot water is used for 2 weeks at a time or more and the water heater is left in an operating condition, a quantity of highly flammable hydrogen gas may accumulate in the top of the hot water tank. 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. THIS STATEMENT IS INCLUDED AS A REQUIREMENT OF CERTAIN COUNTY/STATE REGULATIONS.

b) **Pressure and Temperature Relief Valve (T/P Valve):** The storage tank's pressure and temperature relief valve must be piped to an approved drainage location. No relief valve or port or the drain outlet should be sealed, blocked or used for other purposes.

**⚠ WARNING**

Blockage of temperature and/or pressure relief valves can cause serious injury, death and substantial property damage.

c) **Insulation:** Tanks must be well insulated and meet minimum daily heat loss requirements stipulated by relevant codes, regulations etc. Heat losses are particularly high if there are exposed metal ports, pipes etc. Any exposed metal on the outside of the tank should be covered with insulation material.

d) **Drip Pans (Trays):** For tanks installed indoors, a drip pan must be installed under the tank to collect any water that may accumulate due to leaks. The tray should ideally have a pipe that runs to a suitable drainage point. Follow local codes, in regards to when and where drip pans are necessary and how they can be piped and terminated

e) Refer to the manufacturer's storage tank installation manual for more specific installation, operation, maintenance and safety information.

**⚠ WARNING**

Always follow tank manufacturers guidelines when installation a storage tank. Do not set controls in any way that can exceed the tanks set limits (temperature, pressure, etc.). Failure to do so can cause unsafe operating conditions.

### 3.16. Hail Resistance

a) Installed glass evacuated tubes are able to handle significant impact stresses once. Testing and impact stress modelling shows that the tubes are able to withstand impact from hail up to 1" (25 mm) in diameter, and even larger when installed at angle of 45˚ or greater. The ability of the evacuated tubes to withstand impact from hail is greatly influenced by the angle of impact. Installing the collectors at low angles does reduce their impact resistance.

b) In areas prone to hail over ∅3/4" (∅20 mm), it is recommended that the solar collector be installed at an angle of 45˚ or greater to provide optimum impact resistance. Due to collector performance at many latitudes prone to hail, this is generally a common installation angle already.

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

Refer to section 11.3 for more details on tube replacement.

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

### 3.17. Lightning Protection

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

### 3.18. Thermosyphoning

Thermosyphoning (convection) can occur if the solar loop pump is off and a low outside air temp makes the collector manifold colder than the fluid or water in the mechanical room. Thermo-siphoning occurs when hot fluid rises up the Return Lines toward the cooler collector and external piping. After it dissipates its heat and cools, it falls back down the Supply (Feed) Line. and cooling the tank. This can occur with direct flow systems or closed loops with a coil heat exchanger inside the tank. Thermo-siphoning only occurs when the collector is cooler than the tank, so normally at night. If not controlled it can cause considerable heat loss.

The following methods can be employed to stop thermo-siphoning:

i) A check valve should be installed on the discharge side of the circulator.

ii) If the issue persists a heat trap can be piped in by coming off the tank and coming down 8" before going to the pump station and/or collectors.

### 3.19. Pressure and Temperature Control and Relief

a) **Direct Flow Max Incoming Pressure:** For direct flow systems, the normal operating pressure should be no greater than 72.5 psi (500 kPa), if necessary a pressure limiting (pressure reduction) valve should be installed on the main cold feed line.

b) **Closed Loop Max Pressure:** For closed loop systems with single wall heat exchangers the solar loop should not be set higher than the potable water pressure. All closed loop systems must have a properly sized expansion tank and pressure relief valve. .

c) **Maximum Allowable Pressure:** The maximum allowable operating pressure for the solar collector in any system configuration (domestic or commercial) is 116 psi (800 kPa) with pressure relief valve discharge rating at no more than 123 psi (850 kPa) or lower as specified by local codes and regulations. Also, check

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

d) **Stagnation:** For direct flow systems and closed loop systems with suitable heat transfer fluid, it is acceptable for the system design to allow the solar collector to stagnate (i.e. stop the pump) to prevent overheating of the storage tank above ~177˚F (~80˚C). An expansion tank must be properly sized and installed to accept the increase in fluid volume due to thermal expansion and potential steam formation, in order to minimize or prevent release of fluid from the pressure relief valve.

e) **Heat Transfer Fluid:** In a closed loop system, it is important to use a heat transfer fluid that is rated to at least 320˚F (160˚C) to minimize fluid degradation during periods of stagnation (see above). Depending on the pressure of the closed loop the fluid may vaporize (boil) during stagnation causing some degradation of the the fluid. If stagnation happens on a regular basis due to excessive heat production (heat supply > demand) or power outages, an inspection of the fluid should be completed. Contact the manufacturer for more information on how to check the fluid. Refer to Section 3.31 for heat transfer fluid information.

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

**⚠ WARNING**

Failure to safely control system pressure levels could result in the dangerous rupture or explosion of system components. This may cause serious scalding injury and damage.

## 3.20. Water Quality & Inspection

a) In direct flow systems, the water flowing through the manifold header must qualify as potable water and meet the following requirements:

| | | | |
|---|---|---|---|
| Total dissolved solids | < 600 p.p.m. | Total hardness | < 200 p.p.m. |
| Chloride | < 250 p.p.m. | Free Chlorine | < 5 p.p.m |
| Magnesium | < 10 p.p.m. | Sodium | < 150 p.p.m |
| pH | 6.5 - 8.5 | Electrical conductivity | < 850 µS/cm |

b) In areas with “hard” water (>200ppm), lime scale may form inside the header pipe (direct flow), or inside the storage tanks/heat exchanger (closed loop). In such regions, it is advisable to install a water softening or anti-scale device to ensure the long term efficient operation of the solar water heating system.

✖ *Failure to install and maintain a water softening device in an area with “hard” water may void warranties.*

c) Any heat transfer fluid MUST be GRAS (Generally Recognized As Safe by the FDA) or a dual wall heat exchanger with leak detection must be used. Such liquids should be checked on a periodic basis, ideally once annually, but no less than once every 3 years, or as determined appropriate given experience in that climate and as may be specified by the manufacturer. Refer to 3.31 for more information on heat transfer fluids. As a general rule the following tests should be completed (see also sections 11.5 & 11.9).

i) Check for cloudiness or “sludging” that would indicate indicate fluid breakdown

ii) Check pH. It should be within the range specified by the manufacturer

iii) Use a hydrometer to check freeze protection level

✖ *Performance losses due to scale formation is not eligible for warranty claims.*

✖ *Performance losses or any component failure related to fluid degradation are not eligible for warranty claims.*

## 3.21. Metallic Corrosion

a) **Chloride:** Copper is susceptible to corrosion, especially if 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 5 ppm, otherwise the copper header may corrode.

b) **Copper Corrosion:** On rare occasions, corrosion of copper pipe may occur causing blue staining at the point of hot water usage. This corrosion is generally due to either poor water quality or electrical current on

the copper pipe due to poor grounding or contact with some electrical appliance or electrical source causing galvanic reactions.

c) **Air Pollutants:** Air pollutants such as acid rain, emissions from industrial exhausts and various chemicals in the air may cause corrosion of the collector casing and frame. A site inspection should be completed to identify any potential pollutants prior to installing system.

d) **Coastal Regions:** The 439, 301 and 304 grade stainless steels used for Apricus solar collector frames, clips and fasteners are corrosion resistant to salt water.Installation near the sea is not normally a problem. In some coastal regions, the combination of salt spray and living sea microbes can result in rapid corrosion of the stainless steel. In such cases, the frame needs to cleaned thoroughly and sprayed with an enamel paint to provide protection (zinc based paint is NOT suitable).

e) Refer also to water quality requirements above in section 3.20.

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

### 3.22. Freeze protection

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

a) For areas with temperature not falling below 23° F (–5˚C), 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 a power outage drain valve should also be installed. Note: Power outage drain valve in installed on the return line (back from collector to tank) and opens to allow water to slowly run through the collector if power supply is cut. A check valve between the tank and drain valve must be installed, to ensure flow is through the collector. The Apricus direct flow pump station uses this kind of valve. See section 8 for details

b) For areas with temperatures below 23° F (–5˚C), a closed loop filled with a freeze resistant heat transfer fluid should be used. Please refer to heat transfer manufacturer's specifications about the temperature ranges the fluid can withstand. The pH and freeze level of the fluid should be tested every year before cold weather occurs. Always follow the manufacturers guidelines when testing the pH and freeze protection of the heat transfer fluid. Refer to sections 11.5,11.9, 3.31 & Appendices 11-18 for more information.

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.

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

**⚠ WARNING**

Failure to implement effective freeze protection may result in rupture of piping and can cause substantial property damage.

**⚠ WARNING**

Extended periods of cold weather at temperatures below the design limitations of the system's freeze protection method may cause freezing and damage to exposed parts of the system. It is the owner's responsibility to protect the system in accordance with the Installer's instructions, if weather is anticipated to approach or exceed the specified freeze tolerance limit.

### 3.23. Electrical Supply

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

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

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

## 3.24. Labeling

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

## 3.25. Back-flow Prevention

Certain areas require back flow prevention on solar thermal systems.

## 3.26. Anti-Scald / Tempering Valves

A certified anti-scald valve must be installed on the hot supply to the building taps to reduce the hot water supply to a safe temperature of no more than 120˚F.

## 3.27. Building Considerations

a) **Penetration Through Fire-Rated Assemblies:** Any piping that needs to penetrate fire-rated assemblies needs to be prepared/finished in line with any relevant regulations.

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

c) **Direct Flow Systems:** Main's pressure direct flow systems using the pump circulation for freeze protection must not terminate insulation at the flashing and begin again in the roof space. The exposed pipe at the flashing may freeze during a power outage in cold conditions. The insulation should pass through the flashing and be sealed appropriately. If there is concern of water-tightness between the insulation and flashing, a PVC pipe with an elbow facing down the roof pitch can be used, with the insulated pipe passing through the PVC pipe. Ensure that the method used meets local code. The Apricus direct flow pump station has a power outage valve that opens to allow water flow through the manifold to provide extra freeze protection.

d) **Structural Supports:**

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

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

e) **Applicable Codes:** All roof penetrations must meet applicable codes and practices put forth by the National Roofing Contractors Association. All members penetrated by solar system components must meet relevant codes.

f) **Adjacent Materials:** Materials adjacent to the solar system components should not be exposed to elevated temperatures.

## 3.28. Pressure & Temperature Relief Valve (PTRV)

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

## 3.29. Vacuum Breaker

A vacuum breaker may need to be installed at the highest point of the cold water inlet to the storage tank to

prevent damage to the tank in case of negative system pressure. Check with your local authorities to see if this is a requirement.

### 3.30. Sediment Buildup (Hard Water / Limescale)

a) If in areas prone to limescale formation the storage tank should be flushed by the home owner or Authorized Person as outlined in the tank manufacturer's operation manual. This should be completed as often as once every 6 month in areas with particularly hard water, and annual in most areas.

b) If installed in a direct flow system or closed loop using a brazed plate heat exchanger (BPHE) an inline strainer should be fitted before the pump to catch any sediment and allow periodic clean out.

### 3.31. Supporting Pipe and System Components

Pipe hangers use to support system components should be able to support the components and maintain the proper pitch. Any hangers used should not compress insulation used.

### 3.32. Heat Transfer Fluids

a) In cold regions, a closed loop system using a heat transfer fluid should be installed.

b) There are several types of heat transfer fluids commercially available, each with different properties. The following table provides a summary of key features of common fluids with water as base comparison. Please refer to detailed data files offered by each manufacturer. Apricus makes no claims on the performance of the products listed below and the names and types are only used as examples.

| | **Plain Water** | **Whitlam** Solar Hi-Temp | **Clariant** Antifrogen SOL HT | **Dow** Dowfrost | **Dow** Dowfrost HD |
|---|---|---|---|---|---|
| **Type of Fluid** | Water | Glycerine base | Higher Glycols with Inhibitors | Propylene Glycol with Inhibitors | Propylene Glycol with Inhibitors |
| **High Temp Stability** | Excellent | Excellent | Excellent | Poor | Moderate |
| **Viscosity at Freezing Temperatures** | Excellent | Poor | Moderate | Moderate | Moderate |
| **Pressure Drop at Freezing Temps** | Low | High | Moderate | Moderate | Moderate |
| **Specific Heat** | High | Poor | Moderate | Moderate | Moderate |
| **Thermal Conductivity** | High | Moderate | Low | Low | Moderate |
| **Non-toxic*** | Yes | Yes | Yes | Yes | Yes |
| **FDA GRAS Rating** | Yes | Yes | No | Yes | No |

*Fluids that are not rated FDA Generally Recognized As Safe require a dual wall heat exchanger, and may also need leak detection. In order to be used with a single wall heat exchanger the heat transfer fluid must be Generally Recognized As Safe. Always check the MSDS of the heat transfer fluid to ensure that the right type of heat exchanger is being used.

c) When diluting a heat transfer fluid for use in a closed loop solar system always follow manufacturers guidelines.

# 4. Installation Preparation

## 4.1. Product Transport & Delivery

4.1.1. Solar Collector Transport

a) **Safe Transport:** When possible transport the boxes of evacuated tubes standing upright, NOTE 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 ply-board. If stacking the boxes, do not place more than 3 boxes high 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.

b) **Freight Companies:** Apricus DOES NOT recommend sending single systems using freight companies, unless very well packed on a wooden pallet with the tubes standing upright. Always ensure spare tubes are provided.

4.1.2. Tank Transport

a) Always adhere to packing guidelines on tanks, especially for glass lined tanks, which can be damaged if transported lying down.

b) Take extra care when transporting heavy tanks especially if moving up and down stairs etc.

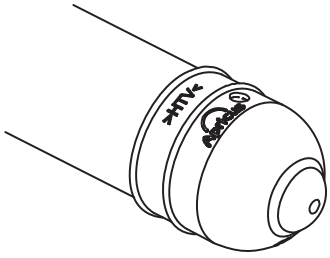
4.1.3. Carry Spares

a) Always carry spares of commonly used and easily lost or damaged components to avoid the “$100 ball valve”, driving 1 hour to buy a $4 component because you didn’t carry any spares!

For example:

- Brass fittings
- Evacuated tube caps and clips
- Heat transfer paste
- Evacuated tubes & heat pipes
- Frame fasteners
- Sensor cables
- Ball valves, drain valves

## 4.2. Unpacking and Inspection



4.2.1. Evacuated Tube & Heat Pipe Inspection

a) **Stock Inspection:** Open the evacuated tubes boxes. Check to make sure the evacuated tubes are all intact and the bottom of each tube is still silver colored. You may need to remove the rubber caps to do this. 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 installers should ALWAYS carry spare tubes when traveling to an installation.

b) **Protect Tubes:** As soon as the evacuated tubes are removed from the box, put on the rubber tube caps, if they are not already on the tubes they will be located in the manifold box. These caps protect the bottom tip of the glass tube from being broken if knocked.

c) **Copper Heat Pipe Color:** 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 and is perfectly normal and does not affect the integrity of the heat pipe or performance.

d) **Shield from Sunlight:** Do not remove the tubes from the box and/or expose the tubes to sunlight until ready to install,otherwise the heat pipe tip will become hot enough to cause serious skin burns. The outer glass surface should not become hot. If it does feel hot, the tube has lost vacuum and should be replaced.

**⚠ WARNING**

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

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

4.2.2. Frame

a) **Unpack Manifold:** 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 and standard frame kit. See Appendix 1 for standard frame diagram.

b) **Attachment Roof Mounts:** Depending on the roof surface and attachment method, rubber pads, track feet, U-feet or round feet may be used to attach the standard frame to the roof. These components are supplied separately from the standard frame.

c) **Assemble Frame:** Assembly of frame is best completed on the ground on a clear flat area. Assembling on the roof is both dangerous and makes it easy to loose bolts and nuts that may roll away. The collector frames are relatively light and can easily be carried onto the roof once assembled.

4.2.3. Balance of System Components

a) In addition to the solar collector, storage tank, pump/pump station and controller you may also need the following components:

- Expansion tank (for cold water inlet and/or closed loop systems)
- Copper pipe (straight and/or soft rolled)
- An automatic air vent solar loop high point
- Pipe InsulationHeat transfer fluid
- Closed loop pressurizing kit
- Anti-scald valve
- Various plumbing fittings, ball valves, drain valves, etc.
- Scissor lift, cherry picker and/or ladders and harness equipment for roof work
- Labels and permanent marker to label system components and flow paths.

**⚠ NOTICE**

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

## 4.3. Equipment Location

a) Mechanical Room: Position solar storage tank into room and fine-tune placement plan for pump station and solar loop piping route, all other piping and components, including any 3-way valves control wires and power wires.

b) If there is a possible for flooding, the tank should be raised off the ground on a concrete paver/slab.

c) Confirm the chosen collector location is suitable. Refer to points in section 3.2.

d) Consider accessibility to the pump station and other components

e) Consider accessibility to other equipment in the equipment room such as the boiler, which may be serviced from time to time.

**Do this BEFORE starting any actual installation work.**

## 4.4. Before Beginning Each Installation

a) **Safety:**

i) Do you have safety glasses, gloves and other required personal protective equipment?

ii) Do you have a well-maintained, properly-fitted safety harness, lanyard, rope and appropriate anchor for working on the roof? Also, do you have a harness attachment plan that ensures you aware of the safe working area with your particular harness setup?

iii) Do you know First Aid? Do have a first aid kit in case you injure yourself?

iv) Have you considered on-site risks? Slippery roof, exposed nails, hot plumbing, sunburn, high winds?

v) Are you up-to-date with relevant OSHA regulations?

b) **Weather:** It is important to consider the weather conditions when planning an installation.

i) Keep the evacuated tubes out of the sun until 2-3 minutes prior to installation. If you install the solar collector in direct sunlight, the heat pipes will become hot very quickly. Try to install the collector earlier or later in the day. DO NOT install the collector at night.

ii) Safety on the roof is always an important consideration. Avoid roof work if it is raining and ensure that the inside of the manifold does not get wet. Do not let rain enter the evacuated tubes.

c) **Staff:** At least 2 people are required to complete an installation. Do not attempt to complete an installation without a qualified and experienced installation team. Roof work should not be performed without a second installer on-site. Each person performing work on the roof needs to have their own harness, rope, lanyard and anchor, in accordance with OSHA regulations.

d) **Customer Service:** When dealing with the customer, always communicate clearly what the installation process will involve, where you will be going (in the basement, on the roof), what noises to expect, how long it will take, how long until they will have hot water, etc. Make them feel comfortable that you know what you are doing and answer any questions they may have.

If they are particularly interested in the system details, refer them to this manual, which they can download or you can provide in electronic format. Given the length of this document please save paper and avoid printing.

# 5. Collector Installation

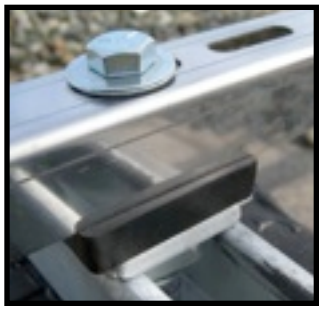
## 5.1. Collector Mounting

Apricus solar collectors are come with a standard frame, which is suitable for flush mounting in cases where the roof is suitably pitched. See Appendices 1-3 for frame diagrams. For installation on low-pitched roofs, flat roofs or for wall mounts, an additional adjustable frame kit is available. Depending on the roofing material, the standard frame may be attached to the roof with flashed bracketing solutions (corrugated steel, asphalt), roof attachment straps (tiled roof) or round feet (asphalt). An adjustable frame kit designed and provided by Apricus is capable of turning the standard frame into a rack, in order to position the manifold and tubes at the ideal azimuth and tilt for almost any location.

### 5.1.1. Frame Material

a) All frame components are made of 439 or 304 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.

* The level of corrosion resistance will depend on environmental conditions.



### 5.1.2. Galvanic Reaction between SS and Zinc Galvanized Steel

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

b) **Fasteners:** Use stainless steel fasteners, if possible. If using galvanized steel bolts, separate dissimilar metals using a nylon, high density EPDM or Silicone rubber washer.

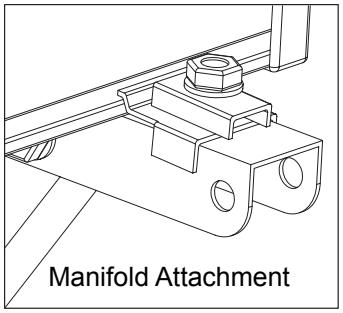
### 5.1.3. Roof Installation

Four types of roof installations are outlined in this manual:

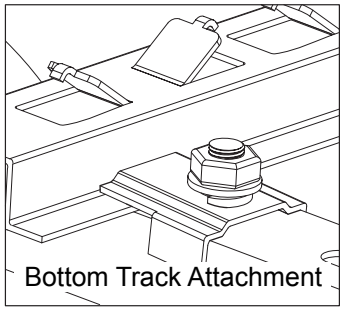
1. Flush installation on a suitable pitch roof. See section 5.2
2. Installing on a roof with insufficient pitch. See section 5.3
3. Installing on a flat surface. See section 5.4
4. Installing on a wall. See section 5.5

### 5.1.4. Manifold and Bottom Track Attachment

a) **Attachment Plates:** The Manifold and Bottom Track are secured to the standard frame channels using special attachment plates (see diagrams right). These plates are attached to the frame channels before they leave the factory They only need to be LOOSENED in order to allow enough movement to fit the Manifold and Bottom Track in place. The plates are designed so that while somewhat loose, they enable the Manifold and Bottom Track to slide left and right for positioning and allow the standard frame channels to be easily adjusted side to side to suit the roof framing layout.


Manifold Attachment

b) **Tightening Nuts:** Once correctly located, the nuts should be hand tightened ONLY using the supplied wrench, locking the Manifold and Bottom Track in place. DO NOT use a power tool or longer hand tool to tighten the nuts as stainless steel is prone to galling (cold welding), if excessive friction or over-torquing occurs. In other words, the nuts can lock to the shaft before they are completely seated, if they are over-tightened. It is also a good idea to use some lubricant on the threads, such as WD-40 which will help to prevent issues.


Bottom Track Attachment

Split washers are supplied to ensure the stainless steel bolts do not loosen over time. In areas with high temperature swings from winter to summer, it may also be worth using thread lock glue.

c) **Upside-down Bolts:** NOTE: Some bolts are upside-down with the nut on top. This so you can see the threads and helps prevent you from loosening the bolt so much that the nut drops off. The bolt head is prevented from rotating by use of nut locks (the rectangular C channel washers), removing the need to use a second wrench underneath the frame.

### 5.1.5. Customizing the Frame

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

**⚠ WARNING**

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

### 5.1.6. Roof Attachment

a) Attachment to the roof must consider 2 key factors:

i) **Strength:** Attachment points must be strong enough to withstand the forces that the collector will be exposed to, the main one being wind. This becomes very important when the collector is installed at an angle as the exposed wind load surface area is increased. Download force during wind, or due to snow loading must also be considered and the weight bearing strength of the roof or structure considered. Always select mounting methods which have suitable strength and meet local building guidelines. If in doubt consult a licensed engineer for design approval. Refer also to section 3.13 for estimated wind loading values.

ii) **Waterproofing:** The mount must not compromise the waterproof integrity of the roof.

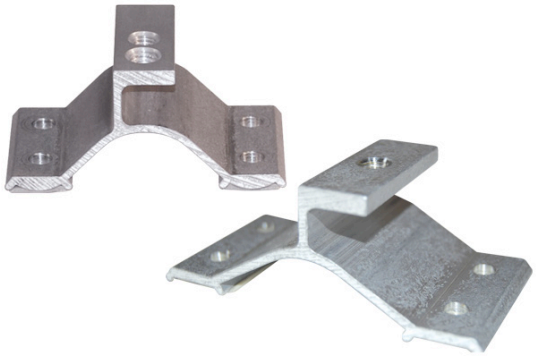
**⚠ WARNING**

Ensure the frame attachment points and the structure to which the collector is attached are of suitable strength. Refer to local building guidelines and consult a licensed engineer for design approval. Failure to meet strength requirements could lead to product and property damage and serious injury or death.

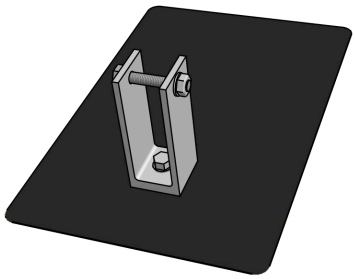
b) Refer to the following sections for more information on roof mounting options.

### 5.1.7. Steel Roof Mounting

a) Commercially available mounting brackets are available to mount on metal seam or corrugated iron roofing. Apricus recommends S-5. For more information visit http://www.S-5.com



5.1.8. Asphalt Shingle Roof Mounting



Apricus recommends EcoFasten Solar flashings that can easily be slipped under 3 tab composition roofing and secured to the roof framing member. The frame front tracks can be attached to the flashing bracket with a U-foot (available from Apricus).

For more information visit http://www.ecofastensolar.com

5.1.9. Tiled Roof Mounting

For tiled roofs, use a flashing designed for solar mounting such as the one shown to the right from QuickMount PV. This style can be molded to the shape of the tiles and forms a strong and watertight flashing.

For more information visit http://www.quickmountpv.com

## 5.2. Mounting on Suitable Angle Pitched Roof (Standard Frame)

Refer to Appendix 1 for assembly diagram.

5.2.1. Installation Planning

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

5.2.2. Positioning Manifold

a) **Securing to Roof:** The manifold and bottom track can slide left and right in relation to the standard frame channels, so there is some flexibility when selecting the location. The standard frame channels should be located so that they lay flat, are parallel with one another and, if possible, aligned with the roof rafters. If the frame cannot be aligned with the roof rafters, a rafter upgrade may need to be perform by adding additional wood to the framework. Consult an engineer to ensure roof designs and rafter upgrades meet structural requirements.

b) **Manifold and Bottom Track Alignment:** Ultimately, each Evacuated Tube will be installed with the Heat Pipe snugly engaged within the Header, the opening of the glass tube inside the Manifold receptacle and the bottom of the tube, protected by the Rubber Cap, will reside in the low spot between each set of tines on the Bottom Track, where it will be held in place by the Bottom Track Clip.

Each tube receptacle in the Manifold needs to line up with the corresponding “cradle” on the Bottom Track, otherwise the tubes will not engage properly with the Header and/or Bottom Track Clips will not fit snugly. Make sure to line the center point of the receptacle in the Manifold with the center point in the “cradle” on the Bottom Track and that the Manifold and Bottom Track are square with the standard frame channels.

Try to locate standard frame channels under the 2nd or 3rd tube from each end. By locating the standard frame channels directly under the evacuated tubes, the stainless steel frame will be hidden, improving the aesthetics of the installation. For collectors with three standard frame channels (30 tubes), the middle standard frame channels should be positioned roughly centrally, again ideally behind a tube (it is more important for this piece to be over a roof framing member, than that it is out of sight).

The horizontal brace (Part #: FR-HBRACE) provided with the standard frame kit gives an indication of the standard location of the standard frame channels. 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 standard frame

channel locations, however the component is NOT structural and is simply to help with alignment, so it can be removed if not convenient. If NOT using the horizontal brace, a string can be used to check the diagonals corners of the frame to determine if it is square; if the dimension from one set of opposite corners (top-left to bottom-right or top-right to bottom left) is different than the other set, then the frame is out of square and should be corrected before proceeding.

If installing a drainback system, the frame must be rotated slightly to achieve a 1/4" per foot slope toward whichever header port will be the collector outlet (hot), to promote complete drainage.

5.2.6. Manifold and Bottom Track Attachment

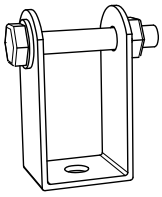
Once the standard frame channels are secured in place, the manifold and bottom track may be attached, taking care to ensure they are correctly aligned (see 5.2.2). The manifold and bottom track will lock into the frame, secured from above and below with the attachment plates that are already in place. See also 5.1.4.

## 5.3. Mounting on Insufficient Pitched Roof (Angled Frame)

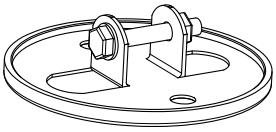
If the roof pitch is insufficient, an adjustable angle roof frame kit can be used to increase the angle by 27° to 57°. Adjustable frame kits combine with the standard frame components to form a complete frame assembly.
Refer to Appendix 2 for frame assembly diagram.

5.3.1. Frame Options

Three frame options are available:

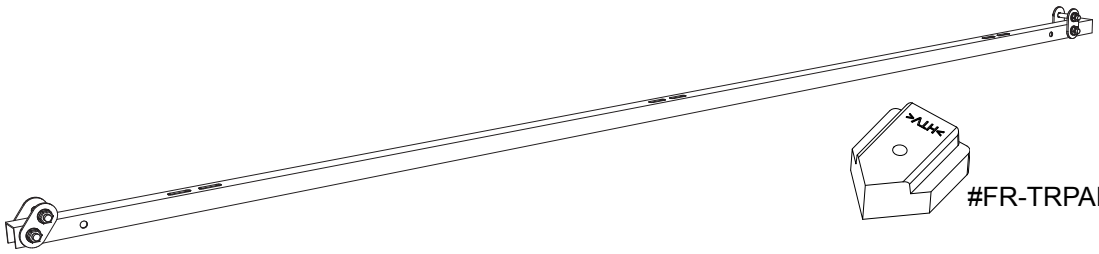


a) **U-Feet (#FR-UFOOT)** are compatible with most commercially available flashings, such as those outlined in sections 5.1.7, 5.1.8, 5.1.9. They provide an additional 2" rise above the flashing mount and attach directly to the frame front track.



b) **Round Feet (#FR-RFOOT)** are suitable for attachment to concrete ballast on a flat roof. Round feet allow some front and back movement of the rear legs, thus allowing a slight adjustment of the install angle.

b) **Roof Tracks (#FR-TRACK)** are the ideal choice if attaching to Uni-strut. They consist of a C-channel similar to the standard frame front track. Rubber pads (#FR-TRPAD) should be used between the roof track and the Uni-strut to prevent galvanic reaction of the dissimilar metals.



#FR-TRPAD

In cases where any option is viable, U-Feet, together with a suitable flashing mount, provide the most cost effective and flexible solution.

5.3.2. Rear X Brace Adjustment

The rear X brace components have a series of holes to allow adjustment of the location of the legs. If further adjustment is needed, additional ∅0.35" (∅9 mm) holes may be drilled to suit. As the grade of stainless steel used is quite hard, good quality drill bits are needed. Take care when using power tools. Never do any drilling of the frame while on the roof.

## 5.4. Flat Roof Installation

The high angle frame is adjustable and appropriate for installations on flat surfaces and provides adjustment from 27°-57°. The high angle frame kit combines with the standard frame components to form the complete frame assembly. Refer to Appendix 2 for diagram.

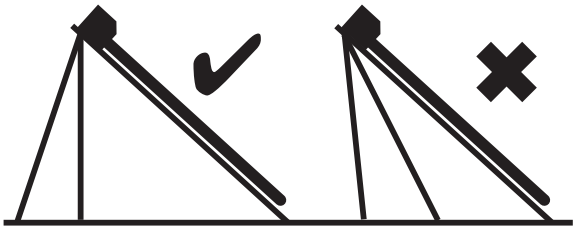
### 5.4.1. Frame Feet Anchoring

a) Frame feet should be bolted to the installation surface using 5/16" (8 mm) diameter bolts or a similarly sturdy fastening method. If possible stainless steel bolts should be used. Galvanized bolts must have a nylon/rubber washer under the head to prevent contact with the stainless steel in order to prevent galvanic corrosion.

b) The surface or concrete block must be strong/heavy enough to withstand load during high winds. Consult a professional structural engineer for design requirements. Refer also to section 3.13 for estimated wind loading values.

### 5.4.2. Adjusting Frame Angle

a) **Angle Adjustment:** The rear legs of the high angle frame comprise two interlocking pieces (top and bottom leg), which allow the length of the rear leg to be adjusted, thus changing the collector angle from between 27° and 57°. If using round feet, the legs can be moved backward slightly to lower the angle. The rear legs must never be positioned greater than a 90° angle (perpendicular) with the roof surface, meaning the legs must be behind the position of the manifold, not in front. See diagram to right.



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

c) **Lower Angles:** If an angle less than 27° is required the legs may be cut short, or contact Apricus for a set of short legs the same as those used on the mini demonstration 4 tube collector frame.

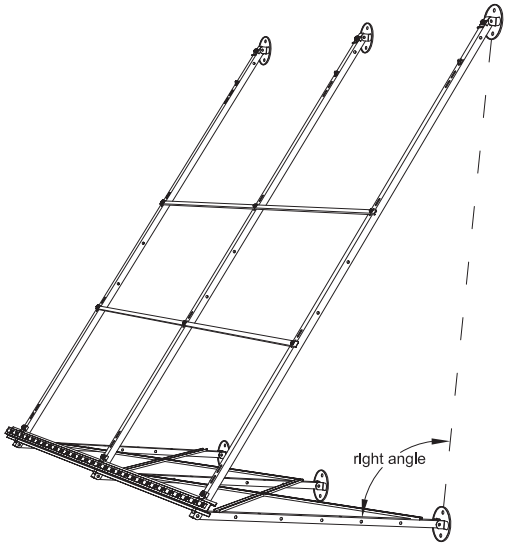
d) **Higher Angles:** If an angle greater than 57° is required, the mounting points of the rear feet may be raised. Raising the angle greatly increases the horizontal force during high winds and may require additional structural and/or hardware upgrades. Consult a building engineer for design requirements.

See also section 3.13 on wind loading guidelines.

## 5.5. Wall Mounting (Low, Mid or High Angle Frames)

### 5.5.1. Wall Frame Options

If mounting on a wall, the high angle frame kit may be used with the legs reversed so that they attach to the bottom of the standard frame channels rather than the top. The legs should be position perpendicular to the wall and adjusted as need in the same manner as described above.




### 5.5.2. Attachment Methods

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

b) **Boarding:** For wood or synthetic boarding, stainless steel lag screws of at least 5/16" diameter or greater with high sheer strength that can penetrate into the wall framework are necessary.

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

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

e) **Roof Eves:** When installing on a wall, consider the possible shading from eves, particularly in the summer (Unless this is part of the system design, in order to minimize summer heat output). Installing under an eve overhang also minimizes snow buildup on the collector in areas with regular, heavy snowfall.

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

**⚠ WARNING**

If the solar collector is installed above an area where people may walk, take appropriate measures to minimize the risk of injury, if a tube ever broke and glass fell onto the ground or people below.

## 5.6. Connection to Plumbing

### 5.6.1. Plumbing Connection

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

b) **Delayed Commissioning:** If the collector is to be installed (including evacuated tubes) prior to plumbing connection (e.g. on new house), high temperature resistant covers (aluminum foil) should be placed over the header inlet and outlet to prevent any contaminants (bugs, spiders, leaves, dust) entering the header. The solar collector will not be damaged by a short period of dry stagnation (1-2 weeks), however leaving the solar collector exposed to the sun and not commission for extended periods will void the warranty.

c) **Soldering:** The header connection is standard 3/4” (7/8” OD) copper pipe size and must be connected by soldering using 90/5/5 (tin/silver/antimony) or equivalent lead free solder. Maximum allowable lead content in solder for contact with potable water is normally 0.2% (or as specified by local plumbing code). In addition only use solder that is able to withstand temperature of at least 482˚F (250˚C) without softening.

When soldering, care must be taken to avoid exposing the manifold casing to the torch flame. Place a wet cotton cloth around the base of the header pipe to reduce at the silicone rubber seal. Point the flame away from the collector and anything flammable while soldering. Take care not to set the wet rag on fire. It is advisable to purchase a pocket fire extinguisher and keep it handy while soldering.

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

### 5.6.2. System High-Point Air Purge

a) In order to completely purge the air from direct flow and closed loop systems, a Tee fitting must be installed at the high point in the system. Usually, this Tee can be soldered direction on the collector outlet (hot), instead of just a 90 elbow. The Tee side-connect (bull, arm) will then be on the collector header pipe, the lower Tee connect (pass-thru, run) on the Return Line and a ball valve can be then be installed on the uppermost Tee connect (pass-thru, run). On the top side of the ball valve, an automatic air vent should be

installed TEMPORARILY. After flushing and charging is complete, the ball valve should be closed and the air vent removed and stored on-site. Leaving the air vent in place will lead to degradation over time potentially forming a leak on the roof.

b) Complete instructions for purging the collector of air are presented in detail in sections 7 & 8.

5.6.3 Leak Testing

a) BEFORE filling the solar loop piping, the collector must be plumbed to the Supply (Feed) and Return Lines and an AIR PRESSURE TEST performed in the mechanical room. The loop should be tested to 116 psi for at least 15 minutes or in accordance with local codes and regulations.

5.6.4. Insulation

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

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

c) **Protect Insulation:** EPDM (foam) insulation 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, flexible protective paint, PVC conduit or similar. If using a "line-set," ensure the casing is suitably rated for outdoor use and will not be easily torn during the installation process.

d) **Glass Wool Insulation:** For systems designed to allow stagnation, high temperature rated insulation such as glass wool or mineral wool should be used on piping, Supply and Return, within ~6 ft (~2 m) of the collector. 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 thick adhesive-backed aluminum foil or PVC jacket.

e) **Extra Insulation:** All system piping, both interior and exterior, should be completely insulated. This includes all potable piping between tanks and to the heat exchanger, as well as, the first 5 ft (1.5 m) hot outlet piping from the tank to the taps, as this is a significant point of passive heat loss. Also, insulate any blank ports on the tank, which will radiate heat. An additional insulation wrap around the tank can also further reduce daily passive heat losses.

f) **Roof Rats:** In some regions (California in particular), rats may attack insulation, and so consideration of this may be required. Birds have also been known to steal exposed, exterior EPDM to make nests. Refer to local regulations and common practices to protect the insulation from attacks.

g) **Public Areas:** In areas of public traffic, all exposed components must be maintained under 140°F or insulated/isolated. Adhere to local codes and regulations.

## 5.7 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 inserted into the manifold. The contact between the heat pipe condenser/tip and heat pipe port in the header needs to be tight in order to ensure good heat transfer. Under normal use, once the heat pipes are installed they should never have to be removed.

**⚠ NOTICE**

Do not install the heat pipes and evacuated tubes until system plumbing is completed, the solar loop is charged, the pump and controller are operational and fluid is currently circulating (set controller pump function to ON) unless the system (in particular insulation) is designed to withstand high temperature stagnation or the tubes are covered.

## ⚠ WARNING

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

5.7.1. Heat Pipe Preparation

a) **Shield from Sunlight:** Do not remove the tubes from the box and/or expose the tubes to sunlight until ready to install, otherwise the heat pipe tip will become hot enough to cause serious skin burns. The outer glass surface should not become hot. Ideally, transport the tubes close to the bottom of the ladder or other roof access while still in their boxes. (Do not obstruct safe access.) There, the tubes can be be removed the box and prepared on the ground, before being taken up to the roof for insertion. NOTE: At this point, it is often helpful to cut the top 12" (30 cm) or so off the evacuated tube box, in order access the heat pipe bulbs for preparation without exposing the entire length of the tube to sunlight.

b) **Damaged Tube:** 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 pushing 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.

## ⚠ NOTICE

The powder content of the heat transfer 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.

c) **Heat Transfer Paste:** While holding the spring plate in place, pull the heat pipe out of the evacuated tube by about 3" (8 cm). Using the heat transfer paste, form a thin layer over the heat pipe head (not the top round end). This is easiest to do using a short length of insulation pipe. Squirt some of the heat transfer paste into the insulation, the use to coat each heat pipe tip with a thin layer and remove any excess from the tip. Using this method half a tube can coat 30 tubes.

d) **Shake:** Heat pipes contain a small amount of copper powder, which aids in heat transfer and provides freeze protection within the heat pipe itself. To ensure that the powder is at the bottom of the heat pipes, where is needs to be, before installing the tube and heat pipe, they should inverted (Fat bulb down), returned upright (Fat bulb at top) and then shaken up and down a few times to ensure the powder has all returned to the bottom. This should be done at ground level where there is no risk of hitting the tube on another object.

## ⚠ NOTICE

Don't forget to "shake" the tubes with heat pipes inserted as failure to do so may negatively effect the freeze protection properties.

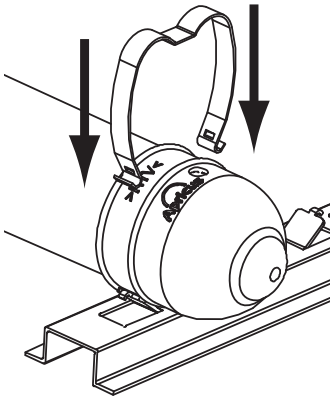
5.7.2. Heat Pipe and Evacuated Tube Insertion

a) **Lubricate Tube:** 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**

b) **Insert Tube:** While ensuring the metal spring plate is sitting in the mouth of the evacuated tube, firmly hold the evacuated tube and guide the heat pipe tip in past the manifold rubber seal and into the heat pipe port. Ensure the heat pipes are at the TOP DEAD CENTER of the evacuated tube and therefore aligned correctly with the heat pipe port.

c) **Insert Tube - Rotating:** Using no more than a 1/8$^{th}$ turn left and right twisting action, push the evacuated tube up into the manifold. The neck of the evacuated tube will push against the spring at the base of the heat pipe tip, forcing it fully into the port. DO NOT over rotate the tube when inserting otherwise the heat pipe will be turned out of alignment with the top of the tube, which will prevent proper heat pipe operation.

d) **Correct Insertion Depth:** The heat pipe and evacuated tube are fully inserted once the black coating of the evacuated tube has disappeared up into the manifold and no clear glass above the coating is visible. The bottom of the tube will sit so that the groove on the rubber cap lines up with clip point on the bottom track.



e) **Secure Tube:** As each tube is inserted (recommended) or, alternatively, once all tubes have been inserted, secure the tubes to the bottom track using the stainless steel clips as follows:

**Step 1.** Position the rubber cap so it is aligned with the bottom track and the Apricus logo is at the top. This ensures that drain holes in the cap are properly positioned. It DOES NOT have to be pushed hard up on the tube.

**Step 2.** Line up the clip with the hook on the bottom track and push down over the rubber cap. Favoring whichever side is more natural for you. When it engages you will hear a “click.”

**Step 3.** Without losing the first hook, center the clip over the top of the rubber cap and push down the other side until it “clicks” into position.

**Step 4.** Check to ensure both sides are correctly clipped over the hooks.

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

g) **Tube Movement:** If clipping tubes after all the them have been inserted, it may be necessary to push an adjacent tube slightly off to the side, while attaching the clip to allow enough room to operate. There is some flexibility in the manifold connection and the heat pipe and tube will not be damaged by this slight sidewards movement. Do not be too aggressive.

5.7.3. Post Installation Cleaning

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

5.7.4. Take Photographs

a) Always take several digital photographs of the solar collector on the roof. These serve as an important record, if there is ever an issue with the installation.

b) Send copies of ALL installation photos to Apricus at office-usa@apricus.com so we can add to the library of installations photos. Your installation may be eligible for creation of a case study, promoting your company, and even awards and prizes that Apricus offers to top installers from time to time.

c) Complete an installation record form in triplicate. Leave the original with the owner, retain a copy for your own records and fax or mail a 3rd copy to Apricus office in USA. The home owner should also be encouraged to complete an installation record online at www.apricus.com

## 5.8 Post Installation

5.8.1. Collector Operation

Once all the tubes are installed and the sun is shining, the solar collector will begin to produce heat after a 5-10 minute warm up period. Check the controller and pump for correct operation and adjust settings as required. Make sure that you have set the controller in a suitable mode for normal automatic operation.

5.8.2. Clean Up

a) Once the system is confirmed as operating correctly, ensure the installation site is cleaned of all garbage. Presentation is extremely important!

b) All trash should be recycled, whenever possible.

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

# 6. Controller Installation & Operation

## 6.1. Controller Overview

a) The Apricus controller is a dynamic controller that can be programmed to suit specific system needs. Multiple inputs, outputs and system monitoring are all utilized to make ensure the system runs as efficiently as possible.

For more detailed information please refer to the complete Apricus Controller Manual.

## 6.2. Controller Design

a) The Apricus controller comes pre-mounted to the direct or closed loop pump station.

b) LCD display provides comprehensive system information

c) 4 button controls for easy menu navigation

d) Fully adjustable system functions and settings

e) PC Software based programming of all functions (easy setup)

| | |
|---|---|
| **Ambient temperature range for normal operation** | 32°F – 122°F |
| **Electrical Protection**<br>**Installation Category**<br>**Pollution Degree** | IP20<br>II<br>2 |
| **Fuse**<br>**Power supply**<br>**Maximum Power Consumption** (with all outputs activated) | 5A 120Vac ( 5x20mm)<br>120Vac +/- 10% 60Hz<br>4.2A (~504W) |
| **Outputs:**<br>**P1** (Main pump with standard or PWM speed regulation):<br>**P2** (Pump with standard or PWM speed regulation, Booster pump, valve):<br>**P3** (Extra, Additional heat, cooling…) | <br>Triac 1.0A 120VAC.<br><br>Triac 1.0A 120VAC<br>Relay 2A 120VAC |
| **Inputs:**<br>**T1** (Collector1):<br>**T2** (Tank1):<br>**T3** (Extra sensor):<br>**T4** (Extra sensor, Tank2, Collector2):<br>**T5** (Collector return):<br><br>**T6** (Flow meter):<br><br>**GDS1** (Grundfos Flow meter):<br><br>**GDS2** (Grundfos Pressure sensor): | <br>PT 1000 type<br>PT 1000 type<br>PT 1000 type<br>PT 1000 type<br>PT 1000 type<br><br>Impulse type (low voltage 5V)<br><br>Analog type<br>(Grundfos **VFS**)<br>Analog type<br>(Grundfos **VPS**) |
| **Sensors delivered:**<br>**1 Collector sensor**<br>**1 Tank**<br>**1 Extra** | <br>PT1000 (1.5M 356°F)<br>PT1000 (3M 221°F)<br>PT1000 (3M 221°F) |
| **Software version** | Displayed during the start-up<br>**Version xxxxxx** |

## 6.3. Sensors

6.3.1. Sensor Information

a) The Apricus controller comes pre-wired for power and control of the Grundfos pump. All sensor wires must be installed manually. The controller is able to read up to 5 temperature sensors as well as data from digital flow meters.

The most common positions for the sensors are as follows:

Sensor 1 (T1): Collector
Sensor 2 (T2): Bottom of the tank
Sensor 3 (T3): Between ⅓ and halfway down from top of tank

Correct sensor locations for various system configurations are presented in the system diagrams in the Apricus OG300 Systems Manual.

b) The Apricus controller utilizes PT1000 type sensors (thermistors) that have no polarity.

c) Sensors should not be fully immersed in water.

d) Sensors should be coated with silicone thermal paste to aid heat transfer.

e) Protect Sensor Wires: Sensor wires should not be exposed to sunlight and must be protected from contact with sharp metal edges that could cut the wire or through its insulation. This is especially important when pulling the T1 wire through the roof space. The collector sensor wire must not be run underneath the insulation against the metal pipe as high temperatures will interfere with accurate readings to the controller and can damage the wire.

6.3.2. Temperature Sensor Installation - Collector

a) **Sensor Well Location:** The temperature should be measured at the hottest point in the collector: the outlet of the collector manifold or the outlet of the last collector manifold in a series. There is a temperature sensor well next to both plumbing ports on the collector. This allows whichever port is most convenient for the particular installation to be chosen as the outlet.

b) **Sensor Insertion:** The solar controller's temperature sensor should be coated with a thin layer of heat transfer paste (same as is used on the heat pipe bulbs) and inserted into the sensor well to the full depth. The fit may be a bit loose.

c) **Water Ingress:** Use a silicone sealant to prevent water ingress and to help secure the sensor inside the well.

d) **High Temperatures:** Ensure that sensors and, in particular, the sensor wire used on the collector are high temperature rated 395˚F (200˚C). Make sure that the wire can also be used in an exterior environment.

e) **Sensor Wire:**

i) Do not run the wire directly against the metal pipe as the wire may be damaged, instead run outside the insulation.

ii) Do not run the wire inside conduit with electrical cables (check local electrical code).

iii) Use cable ties (11"cable ties fit nicely around 3/4" pipe with 3/4" wall insulation) to secure at regular intervals. Avoid loose, drooping wire, keep it close to the insulation.

iv) Some line-sets include a wire beneath the outer wrap. This should be connected to the sensor wire with good quality, watertight soldered, plug connection or weather-resistant connectors.

v) The wire can be extended up to 60' (20 m) using appropriately rated 18-2 thermostat wire. For longer distances, thicker gauge wire may be needed. After installing sensors with long extensions, check to ensure accurate temperature readings are being provided.

vi) Ensure the wire is not able to rub against any surfaces that could cause wear or cut the casing. Poor sensor readings are often caused by electrical interference with the wire or exposed wiring shorts.

6.3.3. Temperature Sensor Installation - Tank

a) **Solar Ready Tanks:** Some tanks on the market may have sensor ports incorporated into the tank. These ports may or may not be in the best location for the system configuration being used. If they are, then coat the sensors with a thin layer of heat transfer paste and insert full depth. Secure the cables in place to prevent them from losing contact over time. It is vital that accurate readings of the tank temperature are taken.

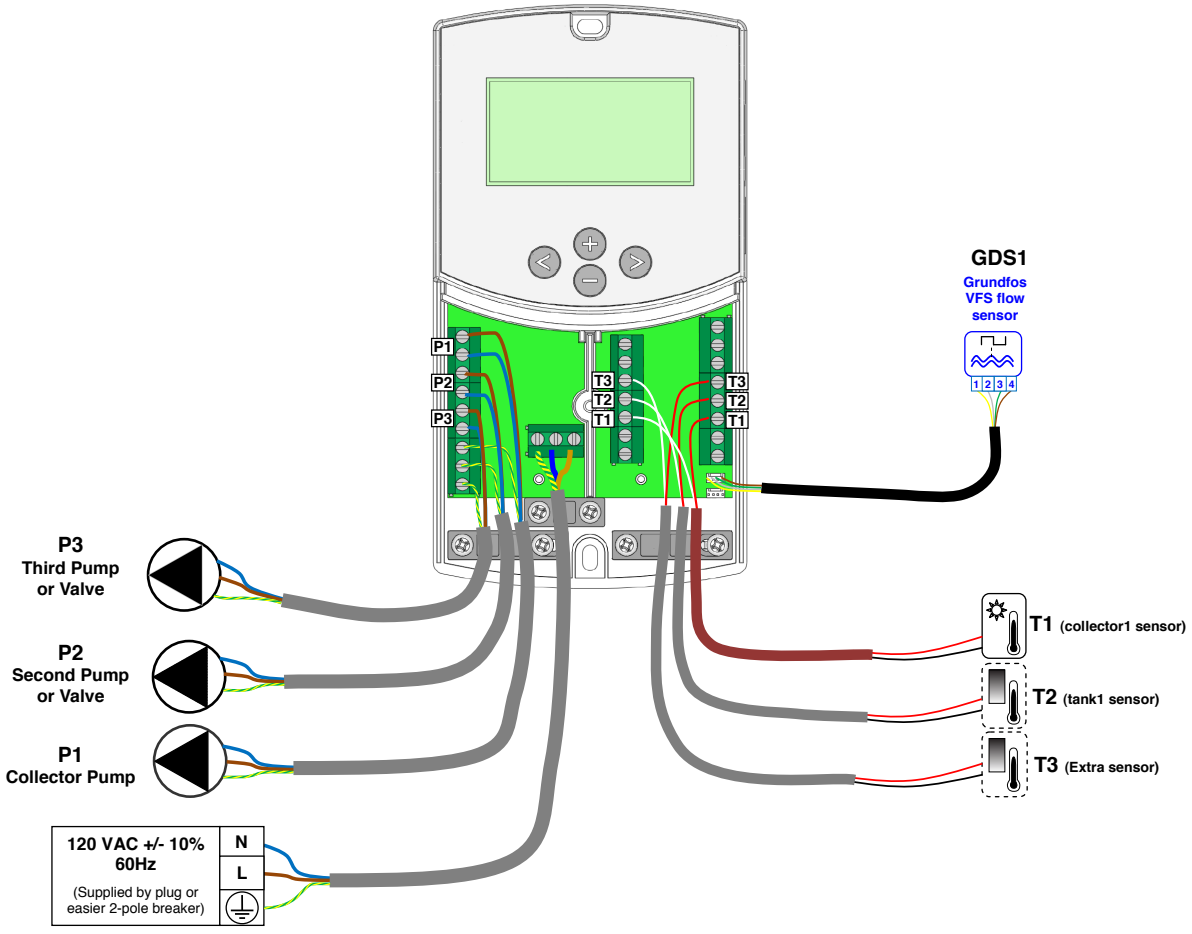
b) **Custom Sensor Port Location:** Tanks without sensor ports should have a thermal well retrofitted where applicable.

**⚠ NOTICE**

All sensor wiring must be protected from environmental influence which would otherwise effect their intended operation.

## 6.4. Electrical & Sensor Connection

a) Diagram below provides details of the power, relay and sensor connections.



## ⚠ WARNING

Any electrical work must be performed by a licensed electrician and adhere to local electrical safety regulations, as required.
Do not connect controller to power supply until all wires are connected and the front case is closed. Also, make sure the controller does not turn on the pump until it is flooded. Take care when working near electricity, especially in wet areas.

b) In North America, Apricus controllers are 110 Volts, 60 Hz. They should not be used with higher voltage power supplies.

c) It is highly recommended that the solar loop (copper or stainless steel) be grounded to avoid lighting related damage. In areas prone to lightning strikes, the power supply to the controller should also be suitably protected.

d) The Apricus controllers are supplied with a standard North American plug. No cutting or extension of the cable is permitted unless completed by a qualified electrician.

e) The Apricus controller is suitable for INDOOR use only. Also, ensure the operating temperature is within the acceptable range 32˚F - 122˚F and the unit is not exposed to high humidity or condensation.

### 6.5. Controller Functions

a) **Controller Purpose:** The primarily purpose of the Apricus controller is to regulate the operation of the controller circulation pump. Many additional functions are also available, including: regulating tank temperature, providing freeze protection, measuring energy output and more.

b) **Basic Operation:** In a solar water heating system, maximum efficiency is attained by extracting heat from the collector as quickly as possible, thus allowing the collector to run at the lowest possible temperature. The controller achieves this by measuring the temperature at the outlet of the solar collector and also the bottom of the solar storage tank. This temperature difference is referred to as a delta-t, often written as $\Delta t$. When the collector is hotter than the bottom of the tank by a set amount, usually between 8°F and 20°F (5°C and 11°C) the controller will supply power to the pump which circulates water through the collector. Once the temperature difference drops below a minimum the pump turns off again. This cycle continues throughout the day. The frequency and duration of pump operation is dependent on solar radiation levels.

If the variable speed function is activated (recommended), the speed of the pump will be automatically regulated by the controller to maintain an optimum flow rate and keep the collector between the maximum and minimum delta-t set levels. This maximizes the system efficiency and also reduces electricity usage.

c) **Basic Functions:** Basic functions for closed loop and direct flow system are presented in sections 7.11.2 and 8.10.2 respectively. Also, refer to the system schematics in the Apricus OG-300 Systems Manual for recommended settings for each system configuration.

d) **Pump Run Times with ON/OFF Pump Control:** The correct delta-t setting (dTMax tank1 & dTMin tank1) will vary slightly from system to system depending on the flow rate and length of the pipe run. Optimally, each time the pump operates, the heat in the collector is transferred all the way back to the tank and is not allowed to sit in the Return Line, where it would otherwise loose heat.

For example: A 16 ft (5 m) pipe run in ½" copper has a fluid content of about 0.24 gallons, plus 0.2 gallons for an AP-30 collector. With a total of 0.44 gallons, a flow rate of 0.8 gpm would take 20-25 seconds to transport the hot fluid in the collector back to the tank. A longer pump run time would waste electricity and promote heat loss from the pipes.

A more common pipe run length of 40 ft (12 m) in ½" copper has a fluid content of 0.48 gallons, plus 0.2 gallons for an AP-30 collector. With a total of 0.68 gallons, a flow rate of 0.5 gpm would take about 60 seconds to transport the fluid in the collector back to the tank.

This basic calculation can help to determine how long the pump should be running for each cycle. See below for recommended controller settings. The operation of the pump can be tested by feeling the flow and return lines (or using temperature probes if too hot). The pump should turn off shortly after the heat has returned back down the return line and the temperature drops to a similar level as the flow line.

e) **Recommended Delta-t Settings for ON/OFF:**

If the pump is shutting off prematurely, reduce the dTmin value.

If the pump is running for too long increase the dTmin value.

i) **Direct Flow Systems**

<20' pipe run suggested setting: dTMax = 14˚F (8˚C)  dTMin = 7˚F (4˚C)

>20' pipe run suggested setting: dTMax = 14˚F (8˚C)  dTMin = 4˚F (2˚C)

ii) **Closed Loop System**

<20' pipe run suggested setting: dTMax = 21˚F (12˚C)  dTMin = 11˚F (6˚C)

>20' pipe run suggested setting: dTMax = 21˚F (12˚C)  dTMin = 7˚F (4˚C)

f) **Recommended Delta-t Settings for Variable Speed:**

The length of the pipe run is not such an important consideration for variable speed pump systems. During good sunny conditions the pump will run continually and the controller will modulate the flow rate to maintain a suitable delta-t level.

Closed loop systems will require a slightly high dTMax and dTMin, because the heat exchanger requires a higher delta-t to achieve good heat transfer. Setting the dTMin to less than 7˚F (4˚C) could result in the pump running continually because the potable side of the heat exchanger may only ever get within 8°F of the solar loop and will therefore never be able to close the to the 7°F dTMin setting.

During poor solar conditions, if the pump is circulating continually, then the dTMin should be increased slightly.

During sunny weather, if the pump regularly turns off, the dTMin should be reduced slightly.

i) **Direct Flow Systems:** Suggested setting: dTMax = 14˚F (8˚C)  dTMin = 4˚F (2˚C)

iiv) **Closed Loop Systems:** Suggested setting: dTMax = 20˚F (12˚C)  dTMin = 5˚F (4˚C)

## 6.6. Complete Controller Menu Overview

Available menu items will differ depending on which System type is chosen. See 1.3 in table below.

| **1 Service** | |
|---|---|
| 1.1 Language | English, Deutsch, Français, Svenska, Spanish |
| 1.2 Time & Date | Select the date or time line with **(+)** or **(-)** |
| 1.3 System | Choose between 5 systems, System 1 is default |
| 1.3.1 System 1 | Basic system, with 1 tank, 1 pump, 1 collector array and 2 or 3 sensors |
| 1.3.2 System 2 | System with 2 tanks, 1 pump, 1 valve, 1 collector array and 3 sensors |
| 1.3.3 System 3 | System with 2 tanks, 2 pumps, 1 collector array and 3 sensors |
| 1.3.4 System 4 | System with 1 tank, 1 pump, 1 valve, 2 collector arrays with 2 different cardinal directions (East / West) and 3 sensors |
| 1.3.5 System 5 | System with 1 tank, 2 pumps, 2 collector arrays with 2 different cardinal directions (East / West) and 3 sensors |
| 1.4 Extra function | Choose between 3 extra functions |
| 1.4.1 Thermostat | Use to connect an auxiliary or back-up heat source to your system |
| 1.4.2 Cooling | Use to cool down the primary solar tank during times of high solar irradiation |
| 1.4.3 Diffcontrol | Use to transfer heated water from one storage tank to another (System 1 only) |
| 1.5 External Sensor | Use for collectors that require the sensor to be mounted on the piping external to the collector manifold |
| 1.6 Protection function | Will automatically activate, when the collector temperature reaches the Maxtemp |
| 1.6.1 MaxTemp | Adjustable from 230°F to 302°F with factory default set at 248°F |
| 1.6.2 Cooling | Activates the solar pump (P1 or P2), if the temperature on the collector arrays (T1 or T4) exceeds the collector Maxtemp |
| 1.6.3 Overheat protection | Will stop all collector circulation, when the collector temperature registers more than 50°F above the collector Maxtemp |
| 1.6.4 Freeze Protection | Will keep the solar panel temperature above the Freeze Protection Temperature setting level by activating the solar pump |
| 1.7 Flow meter | If no flow meter is installed, you must manually enter the max (100%) pump flow in gallons/minute |
| 1.8 Reset to Factory default settings | Reset all settings to their factory default |
| 1.9 Reset operation time | Reset the all of the operation hours to zero |
| 1.10 Time graph temperatures | Adjusts the graphical scale for the Temp vs. Time graphs |
| 1.11 Time graph operation | Adjusts the graphical scale for the Operation h menu vs. time graphs |
| 1.12 Calibration of sensors | Calibrate all the temperature sensors connected to your system |
| 1.13 US Version | Allows selection of the units of measurement that will be displayed |
| 1.14 Pump P1 | Choose the type of the pump speed control used on the output P1 (Type: No SC, PhAC SC or PWM SC) |
| 1.15 Pump P2 | Choose the type of the pump speed control used on the output P2 (Type: No SC, PhAC SC or PWM SC) |
| 1.16 GDS1 | Select inputs for analog GRUNDFOS sensors (Type: NC not connected, VFS Flow sensor or VPS pressure sensor) |
| 1.17 GDS2 | Select inputs for analog GRUNDFOS sensors (Type: NC not connected, VFS Flow sensor or VPS pressure sensor) |
| 1.18 Priority tank | Designate one of the system tanks as priority (tank1 or tank2) Will only display if configuring a system with two tanks |

| | |
|---|---|
| **2 Setting** | |
| 2.1 Maxtemp tank1 | Maximum desired water temperature in tank1 |
| 2.2 dTMax tank1 | Difference (ΔT) between collector temperature (T1) and tank1 temperature (T2) - will engage pump1 |
| 2.3 dTMin tank1 | Difference (ΔT) between collector temperature (T1) and Tank1 temperature (T2) - will disengage pump1 |
| 2.4 Maxtemp tank2 | Maximum desired water temperature in tank2 |
| 2.5 dTMax tank2 | Difference (ΔT) between collector temperature (T1) and tank2 temperature (T4) - will engage pump1 with system2 or pump2 with system3 |
| 2.6 dTMin tank2 | Difference (ΔT) between collector temperature (T1) and tank2 temperature (T4) - will disengage pump1 with system2 or pump2 with system3 |
| 2.7 Mintemp Prio tank | Minimum temperature setting for the priority tank of systems with two tanks |
| 2.8 Min rev pump | Minimum speed of pumps set to Phase SC (PhAC SC) |
| 2.9 Boost time (Booster pump) | Select the running time of P2 (Booster Pump) |
| 2.10 Mintemp Collector | Select the minimum collector temperature required for system start-up |
| | |
| **Extra Functions** | (Only available if the corresponding Extra function was selected in the Service menu) |
| 2.11 Thermostat Function | |
| 2.11.1 Start | When the water temp. at the location of T3 drop below this setting P3 will start. |
| 2.11.2 Hysteresis | When the water temp. at the location of T3 exceeds the Start temperature plus the Hysteresis setting, P3 will shutoff. |
| 2.12 Cooling Function | |
| 2.12.1 Cooling start | When the water temp. in the top of system tank (T3) is above this setting P3 will start |
| 2.12.2 Cooling hysteresis | When the water temp. at the top of system tank (T3) falls below the Start temperature minus the Hysteresis setting P3 will shutoff |
| 2.13 Diffcontrol Function | |
| 2.13.1 Max cold tank | When the temp. at the top of the external tank (T3) is above this setting P3 will shutoff |
| 2.13.2 Min warm tank | When the temp. at the top of the system tank (T4) is above this setting P3 will start |
| 2.13.3 Max cold tank | When the temp. at the top of the system tank (T3) is above this setting P3 will shutoff |
| 2.13.4 Min warm tank | The temp. at the top of the external tank (T4) is above this setting P3 will start |
| 2.13.5 dTMax | Temperature difference (ΔT) between the tank designated as cold storage (TC) and the one designated as warm storage (TW) at which P3 will start |
| 2.13.6 dTMin | Temperature difference (ΔT) between TC and TW at which P3 shutoff |
| | |
| **3 Operation** | |
| 3.1 Automatic and Off operation | To turn ON the system, change the setting to AUTOMATIC |
| 3.2 Manual testing operation | This mode allows you to check the performance of all pumps, valves and sensors |
| | |
| **4 Operation Hours** | This menu offers both a data view and a graph view for the Operation, dT, Power and Energy values. |
| Operation | Displays data and graph view of operation hours |
| dT | Displays data and graph view of temperature differential |
| Power | Displays data and graph view of kBTU/hour |
| Energy | Displays data and graph view of kBTU |
| 4.1 SD Card option | To store data and transfer system settings from your PC to the Solar Control |
| | |
| **5 Temperatures** | This menu displays the temperatures of all connected sensors. |
| T1 – Collector | Displays the temperatures of collector1 sensor |
| T2 – Collector2 | Displays the temperatures of collector2 sensor |
| Tank1 bottom | Displays the temperatures of tank bottom sensor |
| Tank top | Displays the temperatures of tank top sensor |

## 6.7. Controller Display & Operation

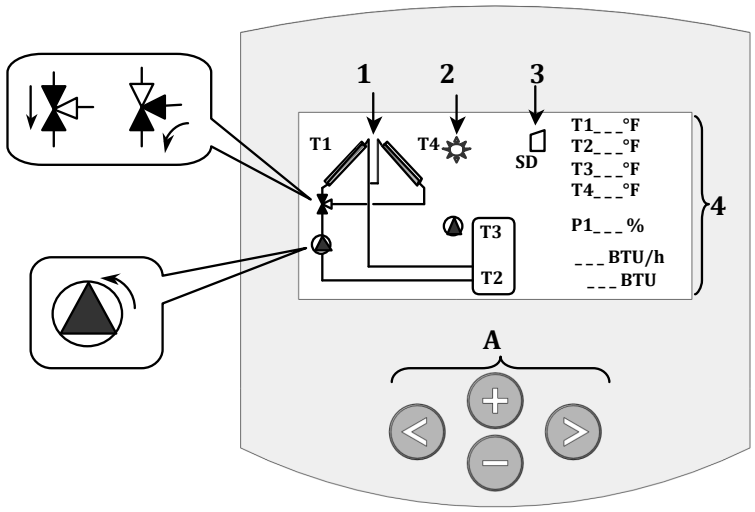
**1:** Simplified drawing of the installation.

- The pump symbols rotate when pumps are activated.
- The filled triangles on the 3-way valve symbol indicate the circulation

**2:** Solar storage is working.

**3:** SD card is inserted and active.

**4:** Temperature sensor readings, pump speed indicators, power and energy output.




**NOTE: System 4 shown in example.**

**A:** Keypad description

**+** Navigation key up or plus key

**-** Navigation key down or minus key

**<** Navigation key left

**>** Navigation key right

## 6.8. Controller Operation

a) To change the settings on your controller please follow these steps:

Press > to enter the Navigation Menu. (The active menu is highlighted in black at the top of the display)

Use the + or - buttons to navigate the menus. The selection cursor (▸) will indicate the current submenu.

Press > to enter the selected menu and/or < to return to the previous menu.

For more complete instructions please refer to the complete controller manual, supplied with each unit.

# 7. Maintenance & Repair

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

**⚠ WARNING**

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

Periodic inspections by an Apricus Authorized Person is recommended to ensure optimum system operation.

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

## 7.1. Cleaning (HOMEOWNER)

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

During autumn, leaves may accumulate between or beneath the tubes. Please remove these leaves regularly to ensure optimal performance and to prevent accumulation of ignitable material (if in high fire risk area). The solar collector will NOT cause the ignition of flammable materials. Such cleaning may only be completed by the homeowner if the tubes are easily and safely accessible (refer also to 3.1 for safety considerations)

## 7.2. Inspection (HOMEOWNER)

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

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

i) Pressure gauge reading

ii) Temperature gauge reading (both of these are on the different portions of the same gauge)

iii) Pump operation (i.e. sound)

iv) Flow meter reading

b) Visual check for degradation of pipe insulation

c) Visual inspection of solar collector tubes

**⚠ WARNING**

The following maintenance may ONLY be completed by Authorized Persons

### 7.3. Broken Tube

a) If a tube breaks, 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) Always wear safety goggles and gloves when handling broken glass. 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 and safety glasses must be worn when handling broken glass.

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

iii) 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.

### 7.4. Insulation

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

b) For any insulation that is exposed exterior conditions, (sunlight and water), ensure protective cover/wrap/foil is in good condition, replacing as required.

### 7.5. Heat Transfer Fluid

a) Heat transfer fluids that are exposed to stagnation temperature may break down over time, which will cause the fluid to become acidic and loose anti-freeze properties. It will general become “sludgy,” which can reduce circulation efficiency. This is particularly the case for GRAS propylene glycols, but will also occur with “high-temp” rated glycols, such as DowFrost HD. Refer to 3.31 for more information on heat transfer fluids or consult the manufacturer of the fluid.

b) Ideally, heat transfer fluid should be inspected and tested annually, but least once every 3 years. The following checks should be completed:

i) Check for cloudiness or sludging that would indicate indicate fluid breakdown

ii) Check pH, should be within the range specified by the manufacturer

iii) Use hydrometer to check freeze protection level

### 7.6. Draining the Collector

During system maintenance or in preparation for extremely and/or extended cold conditions, draining the collector manifold may be required. If the building is going to be vacant for longer than 45 days at a time, the system must be drained and the collectors covered with a tarp. Refer to sections 7.10 and 8.9 for specific instruction on draining.

### 7.7. Other Components

Other parts of the system such as the storage tank and the electric, gas or tankless water heater or boiler should be serviced and inspected according to their specific manufacturer’s maintenance guidelines.

## 7.8. Freezing

a) If the pump or controller fails or a power outage occurs, during an extended sub-zero period, a direct flow (water) system may suffer from freeze related damage. This can be indicated by no pump flow due to pipe blockage or, after the system thaws out, leaking due to a burst pipe.

b) Exposed copper piping, particularly near elbows or connections is the most likely location for freeze damage to occur. Once the system thaws, leaks will need to be repaired.

c) To repair, isolate flow to the collector or drain the system and repair/replace any damaged piping, then re-commission the system. An air test is recommended before recommissioning. Refer to 7.10 and 8.9 for instruction on draining the system.

d) If freezing is a regular occurrence, a closed loop system is a better option for the climate and the system should be converted.

## 7.9. Maintenance Plan

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

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

## 7.10. Maintenance Equipment

In order to allow efficient completion of maintenance activities, the following equipment should be kept on site, if applicable to the system configuration.

a) Automatic Air Vent - this should have been removed after initial filling of the system. It should be kept on site in a sealed plastic bag, cable tied to the tank or pump station piping and marked as follows:

“Automatic air vent for highest point of solar collector loop. DO NOT discard and DO NOT install permanently.”

b) Copies of the installation manuals, MSDS sheets and any other documentation supplied with the components of the system.

c) A copy of system diagram along with notes of any non-standard or notable aspects of the design. See Apricus OG-300 Systems Manual for system diagrams. If the diagram is NOT present, develop a clear line drawing of system.

d) Labeling of key components and piping. See also 3.24.

## 7.11. Replacement Parts

For all major component replacements, contact the local Apricus dealer or distributor or contact Apricus Inc. via email at office-usa@apricus.com or phone 877-458-2634.

# 8. Troubleshooting

**⚠ WARNING**

Apart from those inspection items specifically outlined as “HOMEOWNER”, any maintenance or repair must only be completed by Authorized Persons. The solar collector warranty may be void if non-Authorized Person attempt to maintain or repair the solar collector or associated system components. The solar system operates at high pressure and high temperature and can result in damage to both property and personal injury if not correctly operated and maintained.

CL = Specific to Closed Loop DF = Specific to Direct Flow DB = Specific to Drainback

| Problem | Cause | Solution |
|---|---|---|
| Pump not ON during good solar radiation conditions | Temperature sensors not working properly | • Check that sensor is installed correctly<br>• Check that sensor wire is not damaged<br>• Check sensor Ohm reading with Ohm to °F chart in controller manual |
| | Controller settings incorrect | • Check controller is set to AUTO operation<br>• Check maximum tank and collector settings |
| | Controller Max Temp setting has been reached | • Check maximum tank and collector settings |
| Pump cycling ON and OFF during good solar conditions | Partial shading of collector | • Check collector location for shading |
| | Excessive system flow rate | • Adjust restrictor screw on flow meter<br>• Reduce pump speed (select slower speed) |
| | Controller settings incorrect | • Check if differential (dT function) is correct, dTMin may be set too high, reduce to 2˚C / 4˚F |
| Pump always ON even during minimal solar radiation conditions | Insufficient flow rate | • Check flow gauge for proper flow rate<br>• Adjust restrictor screw on flow meter<br>• Check that all isolation valves are open |
| | Air lock in piping system | • (DF/CL) Release air from air vent on highest point<br>• (CL) Purge system of air by following Fill and Pressurize procedure described in section 7.9. |
| | Sensor location too low | • T2 sensor (bottom tank) should be slightly above the level of the solar flow port. If below the flow port, the pump may run continually even when there is no solar heat. |
| | Controller settings incorrect | • dTMin may be set too low. Increase 2-3˚ especially if closed loop system. |
| Pump running at night | Controller settings incorrect | • (DF) Check that freeze protection setting is correct. Intermittent circulation is freezing conditions is normal. Ensure pipes are well insulated. |
| | Poor Sensor Reading | • (DF) Tank S2 sensor not getting accurate reading |
| Fluid dumping from pressure relief valve on pump station | Faulty pressure relief valve | • Replace pressure relief valve |
| | Faulty expansion tank | • (CL) Replace expansion tank on pump station |
| Fluid dumping from pressure relief valve on tank | Excessive tank temperature | • Check Maxtemp Tank1 setting of controller<br>• Check tank sensor (T2) operation |
| | Faulty expansion tank | • Replace expansion tank on potable water side |

| Problem | Cause | Solution |
|---|---|---|
| Poor Solar Heating Contribution (Compared to previous output at same time of year) | Increased hot water demand | • Check if hot water demand has increased, which would reduce the % contribution from solar even with the same level of output |
| | Insufficient flow rate | • Check flow gauge for proper flow rate, check pump operation if flow rate insufficient<br>• Adjust restrictor screw on flow meter<br>• Check heat transfer fluid pH, color and viscosity, may need to be flushed and replaced. |
| | Partial shading of collector | • Check collector location for shading or snow build up. If snow buildup, ensure bottom of collector is raised off roof, and angle of install is at least 45° |
| | Heat loss from pipes | • Check that insulation is still in good condition with no exposed hot piping |
| | Damage to evacuated tubes | • Check that evacuated tubes are all intact and the bottom is still silver |
| | Heat pipes not operating | • Check that heat pipes are making good contact in header, and are hot at the tip |
| | Scale build up in brazed plate HE (if BPHE used) | • Flush sediment from tank<br>• Back flush BPHE with vinegar (or equivalent)<br>• Install sieve and clean out valve before pump on BPHE loop. |
| Poor Solar Contribution (Compared to expected levels) | Thermo-siphoning | • System may be reverse thermo-siphoning at night. Ensure check valve after or in pump is working. May need to install heat trap (downward U shaped pipe) on return line close to tank. |
| | Insufficient pump run time | • For normal ON/OFF pump operation (not variable speed) ensure the pump is running long enough for the heat from the collector to return to tank - feel return line with hand (careful) to check. Reduce dTMin value slightly. |
| | Pump cycling too long and dissipating heat | • dTMin value set too low, especially if closed loop system (applies to ON/OFF or variable speed)<br>• T2 sensor too low in tank, always reading cold water. Move to correct location. |
| | Excessive tank heat losses | • Insulate both the hot and cold water pipes connected to the storage tank. A check valve (spring not flap) on the cold and hot pipe close to the tank will help reduce heat migration up the pipe.<br>• Insulate any exposed fittings and valves on the storage tank. DO NOT impair the operation of the PTRV. |
| Not enough hot water | IF ELECTRIC Electric not heating water | • Check operation and power supply to element<br>• Replace element if necessary<br>• Check controller boost settings |
| | IF BOILER or GAS TANKLESS Booster not heating water | • Check gas/fuel supply<br>• Check operation of boiler/heater<br>• Check controller boost settings |
| | Faulty tempering valve | • Check operation of tempering valve |
| | Increased hot water demand | • Install larger capacity boiler/booster<br>• Revise boost settings of controller<br>• Install larger storage tank |
| Intermittent short batches of cold water when showering | Faulty tempering valve | • Check operation of tempering valve |
| | Faulty tankless gas booster operation (if post gas system) | • Check operation of tankless gas booster |

| Problem | Cause | Solution |
|---|---|---|
| System operation is noisy | Air in system piping | • Release air from air vent<br>• Purge system of air by following Fill and Pressurize procedure described in section 3.7 |
| | Steam forming in collector | • Check system pressure, collector pressure must be at least 20 psi / 1.37 bar<br>• Use Solar Hi-temp heat transfer fluid |
| | Sediment buildup in bottom of tank or on electric element | Flush tank clean of sediment. If tank is more than 7-10 years old, replace. If in area with hard water should flush every 6-12 months and/or install water softening equipment. |

# 9. Warranty

## MANUFACTURER LIMITED WARRANTY

Solar Thermal Components

### LIMIT OF LIABILITY

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

Some states do not allow the exclusion or limitation of incidental or consequential damages and some states do not allow limitations on how long implied warranties may last, so the above limitations may not apply to you.

WITH RESPECT TO ANY END-USER OTHER THAN A CONSUMER END-USER WHICH PURCHASES APRICUS PRODUCTS FOR COMMERCIAL, INSTITUTIONAL, INDUSTRIAL OR OTHER NON-RESIDENTIAL PURPOSES, APRICUS DISCLAIMS ANY IMPLIED WARRANTY OF MERCHANTABILITY OR IMPLIED WARRANT OF FITNESS FOR A PARTICULAR PURPOSE AND FURTHER DISCLAIMS ANY LIABILITY FOR SPECIAL, INDIRECT, SECONDARY, INCIDENTAL, OR CONSEQUENTIAL DAMAGES ARISING FROM OWNERSHIP OR USE OF THESE PRODUCTS, INCLUDING PERSONAL INJURY, INCONVENIENCE, LOSS OF USE OR LOSS OF INCOME.

Apricus assumes no responsibility under this Limited Warranty for any damage to the Products caused after they have left the control of Apricus, including but not limited to damages caused by any trades people or visitors on the job site, or damage caused as a result of post-installation work. This Limited Warranty shall be invalidated by any abuse, misuse, misapplication or improper installation of the Products.

### GENERAL

Apricus warrants its Solar Collectors and Accessories (the “Products”) to be free from defects in workmanship under normal usage for the applicable Warranty Period from the date of installation. This Limited Warranty extends to the End-User of the product at the original installation location, and is not transferable.

In the event of a defect, malfunction or other failure of the Products occurring within the applicable Warranty Period which is not caused by any misuse or damage to the Product while in the possession of the End-User, Apricus will remedy the failure or defect within a reasonable amount of time. The remedy will consist of repair or replacement of the Products, or refund of the purchase price, in Apricus’s sole discretion. However, Apricus will not elect to refund the purchase price unless it is unable to provide a replacement, and repair is not commercially practical and cannot be made within a reasonable timeframe. After a reasonable number of attempts by Apricus to remedy any defects or malfunction, the End-User will be entitled to either a refund or replacement of the product or its component parts. The remedies stated herein are the sole remedies for defects within the applicable warranty period.

### WARRANTY PERIOD

The “Effective Date” of warranty coverage is the installation date as recorded on the installation record form, purchase invoice date, or, if neither are available, the date of manufacture plus sixty (60) days.

| Component | Coverage |
|---|---|
| Apricus Solar Collector:<br>Copper heat transfer header | Fifteen years parts |
| Apricus Solar Collector:<br>Evacuated Tubes and Heat Pipes | Ten years parts |
| Apricus Solar Collector:<br>Mounting Frame | Fifteen years parts |
| Heat Dissipater (HD-25) | Ten years parts |
| Pump Station(s)<br>Dissipation Valve (APS-ADD-HDIS)<br>Brazed Plate HE (APS-ADD-12DWBPHE) | Five years parts<br>Three years parts for circulation pumps<br>2 years parts for valves |
| Solar Controller | Two years parts |

### WARRANTY EXCLUSIONS

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

(a) The design or structure of the Products are attempted to be modified or altered in any way, including by not limited to attaching non-Apricus approved appliances or equipment;

(b) The Products are not installed or repaired in accordance with applicable local codes;

(c) The Products are not installed by qualified, suitably licensed persons;

(d) The installer had not received Product installation training by an authorized Apricus distribution partner:

(e) The installation was not completed in line with the guidelines of the then current Apricus installation manual;

(f) System is exposed to excessive system pressure;

(g) Solar collector is exposed to flow rates in excess of 15Lpm / 4gpm;

(h) Any system component is damaged due to freezing;

(i) Any system component leaks due to corrosion;

(j) Water quality is not within specified limits, and/or non-approved heat transfer liquids are used;

(k) Damage to the collector header is caused due to heat buckling;

(l) Failure is due to wind, hail, storms or other acts of God;

(m) Failure or loss of efficiency is due to lime-scale formation;

(n) Failure is due to lightning damage, electrical power interruption or dirty power supply;

(o) Electrical devices are installed in an environment that exceeds their specified operating range;

(p) Temperature sensors fail due to water ingress, electrical shorting, or electrical interference;

(q) Failure of the circulation pump due to running the system dry;

(r) Product serial tag or other identification is defaced or removed;

(s) Product is relocated from its original point of installation;

(t) Collector is not commissioned and is left to dry stagnate for a period exceeding 14 consecutive days;

(u) Any operation exceeds the documented design limits of the system components.

# MANUFACTURER LIMITED WARRANTY

Solar Thermal Collector

## HOW TO OBTAIN WARRANTY CLAIM SUPPORT

### End User Obligations

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

(a) Firstly determine if the Product is within the applicable Warranty Periods. This can be determined by referring to the installation record form, or alternatively the original purchase invoice. If neither documents are available, the serial number and manufacturing date will need to be read off the Product serial tag. Some Products may be installed in a location that is not accessible to the End-User and so the information may only be obtained by a qualified service technician.

(b) Contact the company who installed the original Product, or, if unknown or unable to be contacted, contact Apricus directly:

*PO BOX 167 Branford, CT, 06405, USA.*

*Phone: 203 488 8215 Fax: 203 488 8572*

*Email: warranty-usa@apricus.com*

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

(i) Information related to the manner in which the Product(s) were installed

(ii) The history of operation

(iii) Any repairs that may have been made

(iv) Evidence that the Product(s) were installed by a qualified, licensed contractor.

(v) Evidence that the Product(s) were installed in accordance with the applicable Products Installation Manuals and any special written design or installation guidelines by Apricus for this project.

(vi) Evidence that the Product(s) were installed in accordance with all applicable local building, plumbing and electrical codes.

### Customer Satisfaction

We believe you will be fully satisfied by the service you receive from the local Apricus representatives and from Apricus. However, because our aim is your complete and lasting satisfaction, Apricus adds another feature to your warranty's protection. In the unlikely event that you feel our response to a warranty service request is not satisfactory, Apricus offers you an opportunity to air your complaint in an impartial Mediation process.

The opportunity to mediate any complaint made by an End-User is hereby extended to all End-Users. If you are a Consumer End-User, the provisions of the federal Magnuson-Moss Warranty Act provide that you may not file suit against Apricus until your claim has been submitted to Mediation for an informal dispute settlement and a decision has been reached.

# 10. Disclaimer

Apricus Solar Co., Ltd. and Apricus, Inc. withhold 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 neither, Apricus Solar Co., Ltd. nor Apricus, Inc. 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.

# 11. Installation Checklist

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

| | |
|---|---|
| **ROOF** | |
| Collector is facing due south, or as close to as possible. | |
| Manifold is not significantly shaded between 9 am - 3 pm. | |
| Manifold is not likely to be struck by falling objects such as branches, falling fruit, or other nearby objects | |
| Collector is installed at an angle of between 20˚ – 80˚, preferably at 15-20˚ above latitude angle. | |
| In areas prone to large hail (>∅20mm or ∅3/4”), collector is installed at an angle of 40˚ or greater. | |
| In areas prone to snow, collectors is installed at angle of 45˚ or greater. | |
| Tank and pump station are easily accessible and not blocking other equipment | |
| Collector is attached to framework of suitable strength and wind loading has been fully considered. Framework has been reinforced as required. | |
| All piping is suitably insulated and any external piping is protected from UV damage and water ingress. | |
| All piping is held securely in place and will not vibrate or sag. | |
| Roof penetrations are well sealed and will not leak. | |
| If drainback system, collector and piping are installed with ¼” per foot slope continuously to mech. room | |
| Path of broken glass in case of collector storm damage has been considered and explained to the customer. | |
| Evacuated tubes have been cleaned. | |
| **UTILITY ROOM** | |
| System and expansion tank have been pressurized to the recommended level (Closed loop) | |
| System is free of air and flushed correctly with heat transfer fluid (Closed loop) | |
| Water quality is within allowable limits (Direct flow) | |
| Flow rates have been checked; peak, minimum and variable speed flow rates | |
| All piping is suitably insulated | |
| Pump station is mounted correctly and to suitable strength framework. | |
| Controller operation has been checked and turned to Automatic. | |
| Controller SD card has been turned ON. | |
| If direct flow system, frost protection has been turned ON. | |
| Pressure relief valves are in place and drain to suitable location | |
| Plumbing is leak free - solar loop has been air pressure tested to 116 psi for at least 15min. | |
| Pump, controller and all electrical connections are protected from water ingress. | |
| **CUSTOMER SERVICE** | |
| System operation has been explained to customer | |
| Installation record form has been completed and copy provided to customer | |

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

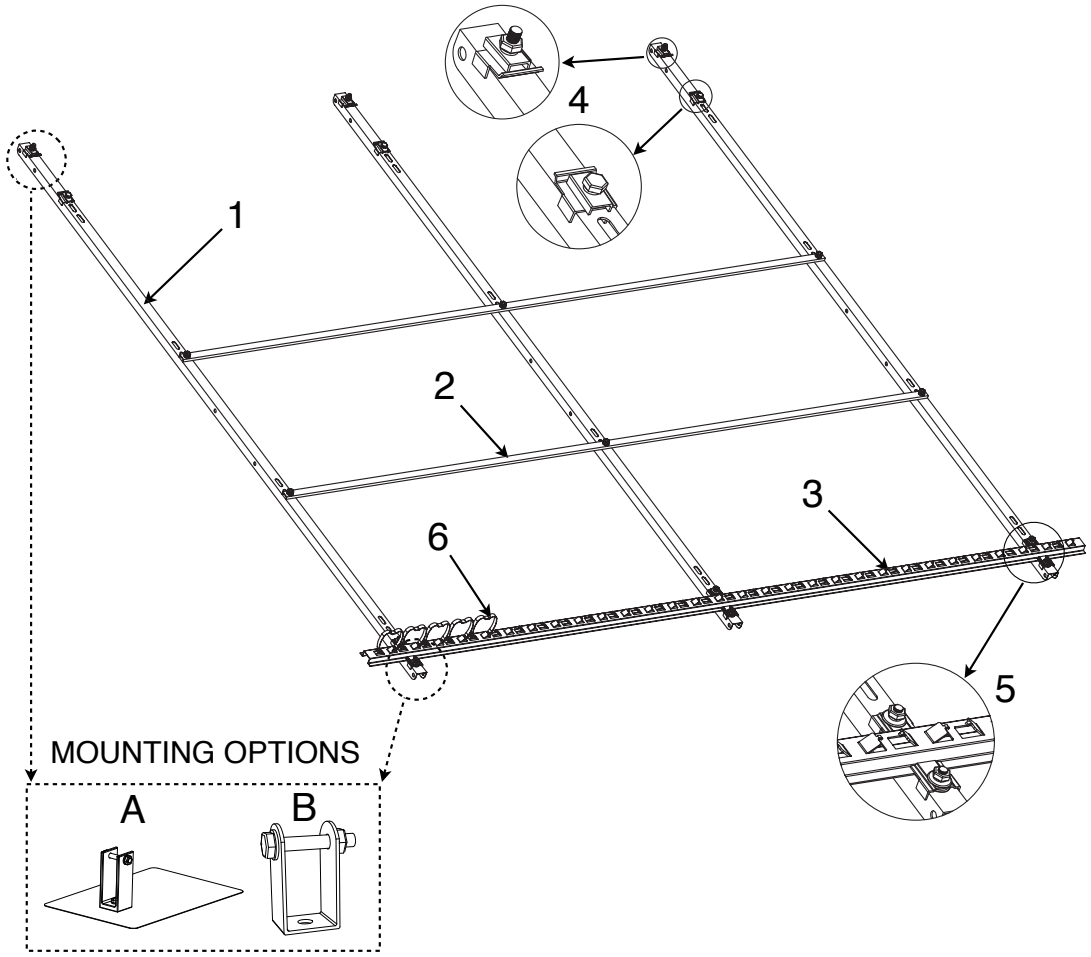
# 12. Appendices

## Appendix 1 - Standard Frame Kit Assembly Diagram

Apricus Solar Collector Standard Frame Kit

Part #: FR-XX-STANDARD*

This frame is provided standard with each Apricus AP solar collector and is suitable for flush roof mounting. For installation at an angle, part FR-XX-HIGH (high angle kit) is required. There are 2 roof mounting options which should be ordered separately.




### FR-XX-STANDARD PARTS*

| # | Part Name | Part Quantity | |
|---|---|---|---|
| | | 10 & 20 tube | 30 tube |
| 1 | FR-FTRACK | 2 | 3 |
| 2 | FR-HBRACE | 2 | 3 |
| 3 | FR-BRACK-XX | 2 | 3 |
| 4 | FR-TOP-APLATE | 4 | 6 |
| 5 | FR-BOTTOM-APLATE | 4 | 6 |
| 6 | FR-TCLIP | 10, 20 | 30 |

* "XX" indicates the number of tubes, so 10, 20 or 30

### ROOF MOUNTING OPTIONS

| | Part Name | Qty/Set | Sets/Collector | |
|---|---|---|---|---|
| | | | 10, 20 tube | 30tube |
| A | *FLASHING OPTION (Asphalt Shingle Roof)* | | | |
| | FR-FLASHING-KIT | 2 | 2 | 3 |
| B | *U-FOOT OPTION (Flashing or Stanchion Mount)* | | | |
| | FR-UFOOT | 2 | 2 | 3 |

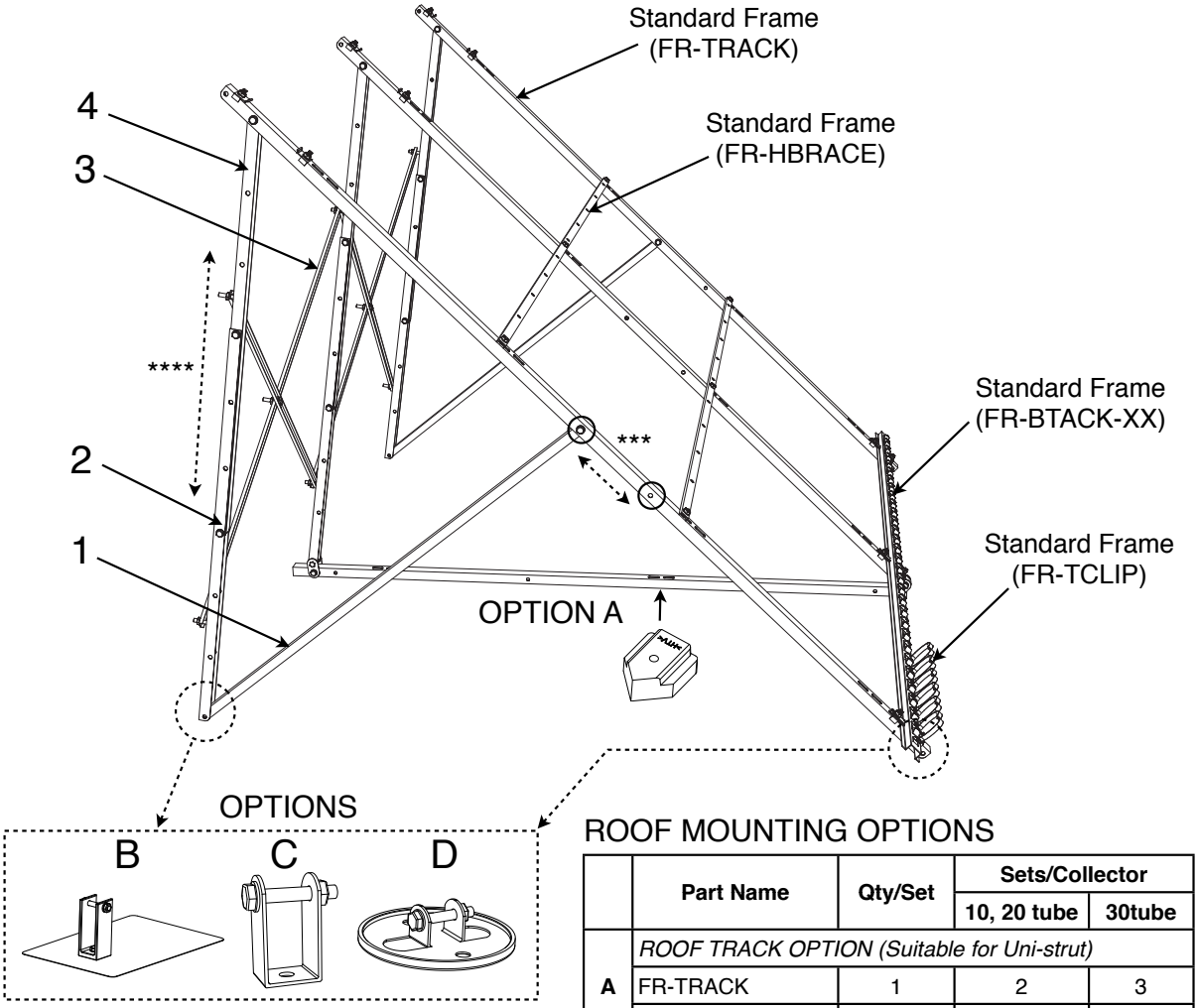
Mounting Kits come with nuts and bolts for connecting to the frame. Use 5/18" roof fasteners to secure to roof.

## Appendix 2 - High Angle Frame Kit Assembly Diagram

Apricus Solar Collector High Angle Frame Kit

Part #: FR-XX-HIGH*

The components in the High Angle Frame Kit combine with the standard frame to form the complete frame assembly shown below.
There are 4 roof mounting options which should be ordered separately.




### FR-XX-HIGH PARTS*

| # | Part Name | Part Quantity | |
|---|---|---|---|
| | | 10 & 20 tube | 30 tube |
| 1 | FR-DBRACE** | 2 | 3 |
| 2 | FR-BRLEG | 2 | 3 |
| 3 | FR-TRLEG | 2 | 3 |
| 4 | FR-RXB-HIGH-XX | 2 | 4 |

* "XX" indicates the number of tubes, so 10, 20 or 30
** NOT used when roof mounting OPTION A is chosen.
*** Choose from two hole locations to fine-tune angle.
**** Change length to adjust angle through range of 27-52°.
To reach 27° remove the top leg.
For angles less than 27° FR-DBRACE is not required.
Adjust leg position forward/backward to further adjust angle.

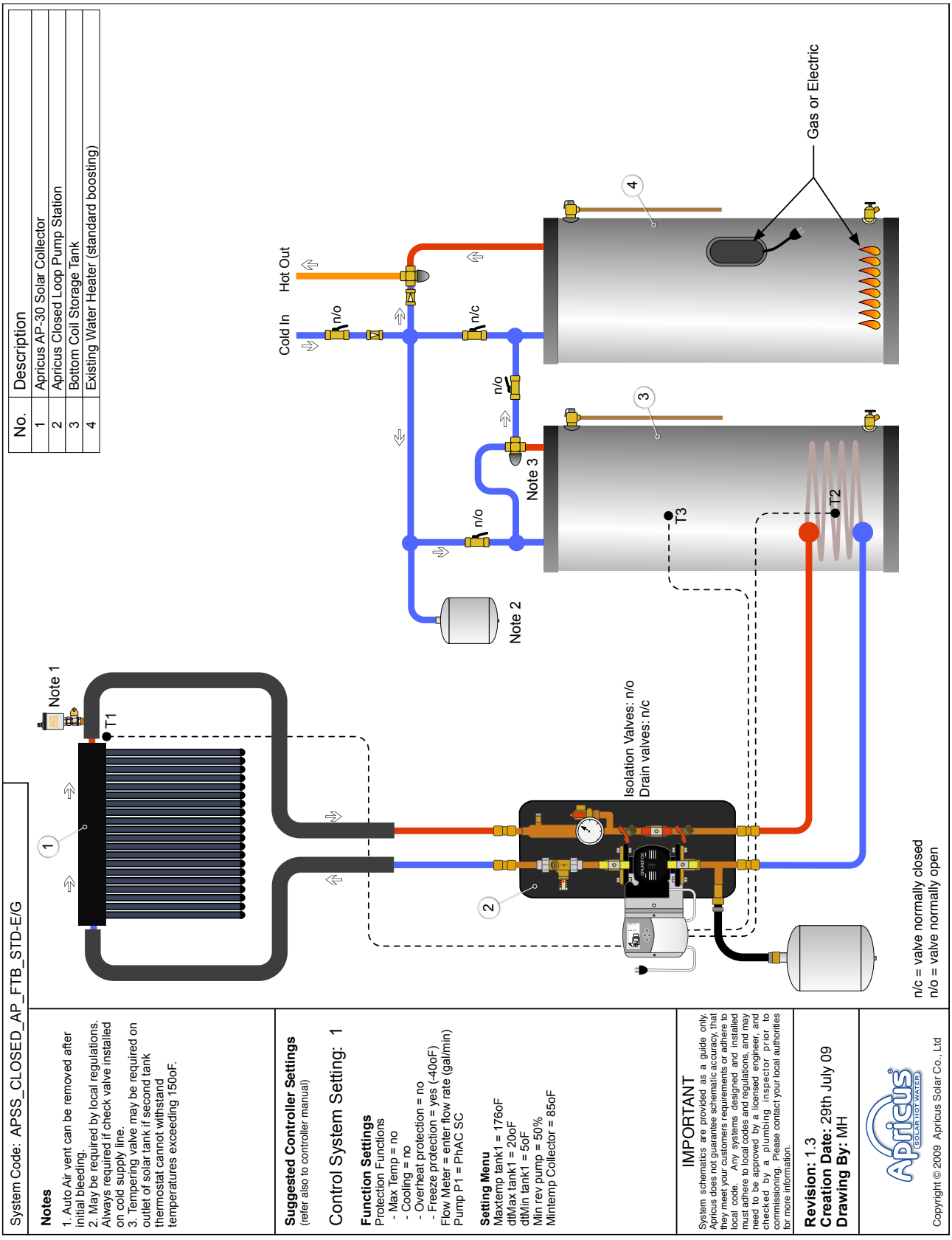
### ROOF MOUNTING OPTIONS

| | Part Name | Qty/Set | Sets/Collector | |
|---|---|---|---|---|
| | | | 10, 20 tube | 30tube |
| A | *ROOF TRACK OPTION (Suitable for Uni-strut)* | | | |
| | FR-TRACK | 1 | 2 | 3 |
| | FR-TRPAD | 3 | 2 | 3 |
| B | *FLASHING OPTION (Asphalt Shingle Roof)* | | | |
| | FR-FLASHING-KIT | 2 | 2 | 3 |
| C | *U-FOOT OPTION (Flashing or Stanchion Mount)* | | | |
| | FR-UFOOT | 2 | 2 | 3 |
| D | *ROUND FOOT OPTION (Flat Roof, Concrete Ballast)* | | | |
| | FR-RFOOT | 2 | 2 | 3 |
| | FR-RFCOVER | 2 | 2 | 3 |

Mounting Kits come with nuts and bolts for connecting to the frame. Use 5/18" roof fasteners to secure to roof.

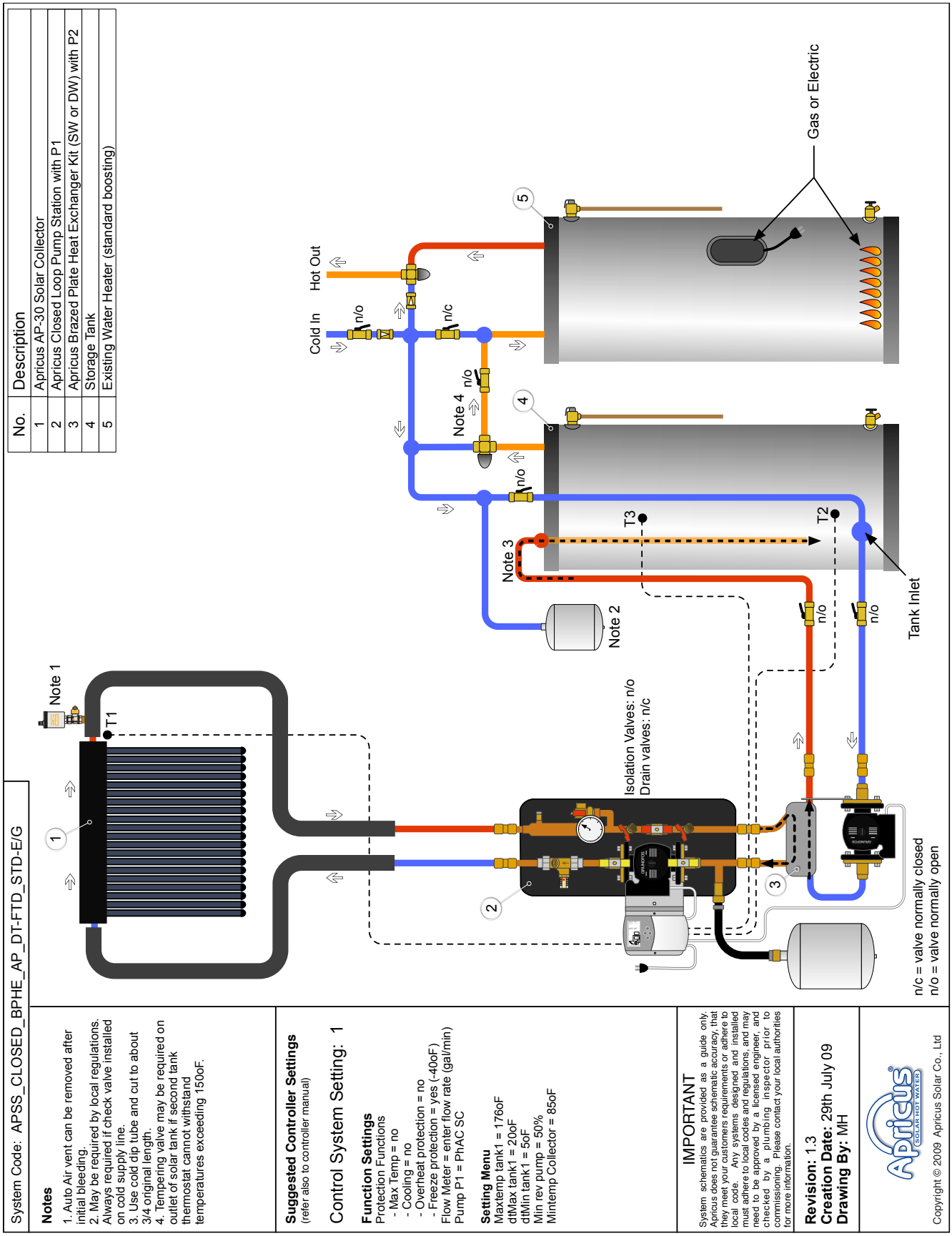
# Appendix 3 - Sample Closed Loop Internal Coil Schematic

Visit www.apricus.com for full system schematics



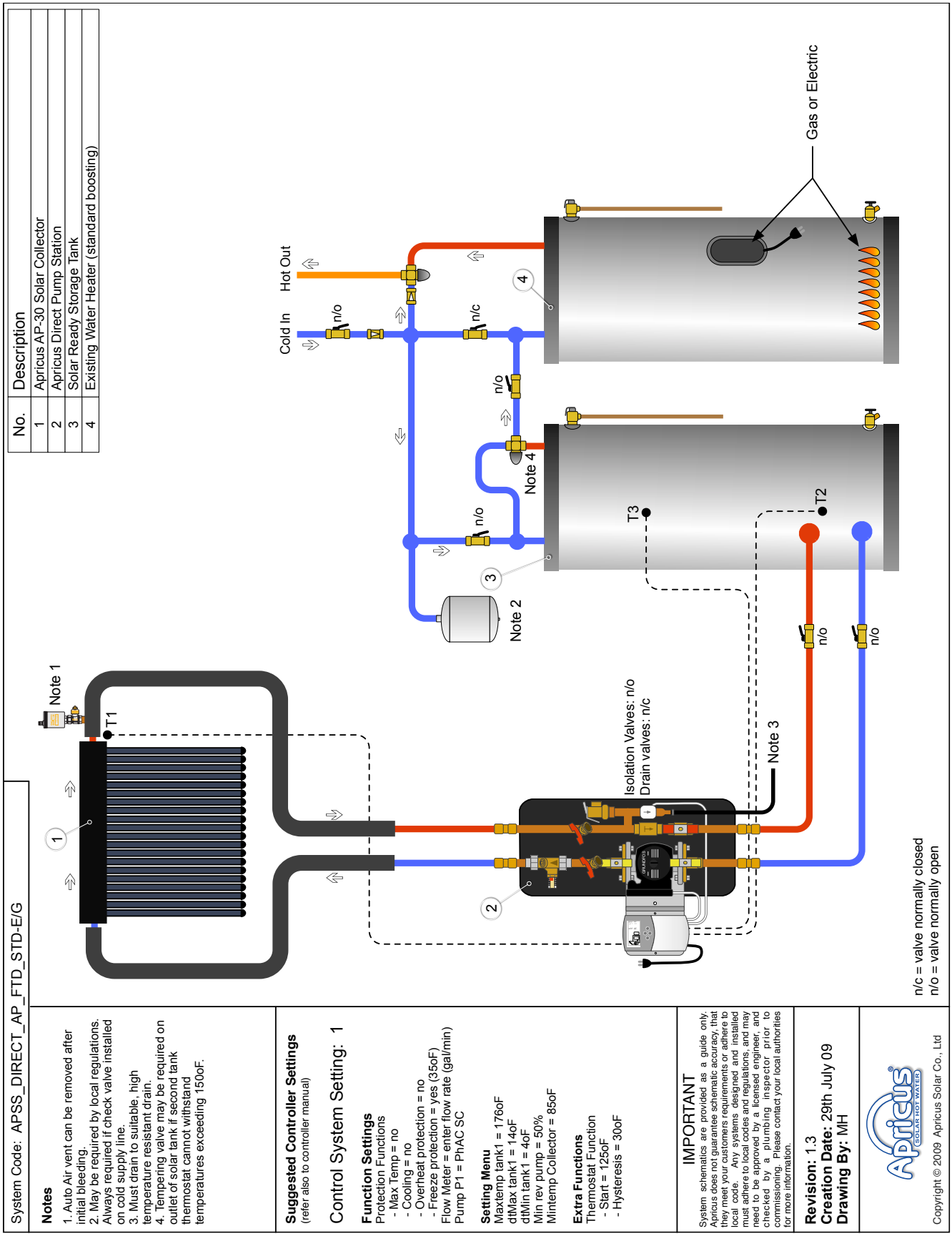
# Appendix 4 - Sample Closed Loop External Heat Exchanger Schematic

Visit www.apricus.com for full system schematics



# Appendix 5 - Sample Direct Flow Schematic

Visit www.apricus.com for full system schematics



# Appendix 6 - Sample Drainback Schematic

Visit www.apricus.com for full system schematics