

Apricus Solar Hot Water Systems

Technical Manual

Version 2.0 - March 2014





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1. Introduction

1.1 Foreword

Congratulations on taking a major step towards reducing your total home energy usage and making a positive difference to the environment we live in.

Apricus Australia is a provider of premium solar hot water systems. These systems use high efficiency evacuated tube collectors to provide free hot water generated purely by the sun's energy.

1.2 Scope

This manual has been designed to cater for the needs of the end-user, installer and service agent.

Refer to section '8.1 Apricus System Schematics' for AS/ NZS2712:2007 approved system designs. Any deviation from these system designs will NOT be eligible for government or state rebates.

Customised system designs and larger commercial systems should be validated and approved by a qualified hydraulic engineer prior to installation in collaboration with Apricus.

1.3 Terminology

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

- » AP-30: Standard Size solar thermal collector for commercial projects consisting of 30 Apricus evacuated tubes.
- » Bank (of collectors): Two to five Apricus collectors in series
- » Boost The process where a heating component (such as an electric element or gas heater) is used to provide additional heating when solar-heated water is not of an adequate temperature.
- » Clean Energy Regulator (CER) A statutory authority established to oversee the implementation of the Large-scale Renewable Energy Target (LRET) and the Small-scale Renewable Energy Scheme (SRES).
- » Closed loop: In a closed loop system the heat transfer fluid is pumped through the collectors and a heat exchanger is used to transfer heat from the collector loop to the water in the tank. Closed loop systems are used in areas where freezing conditions are common and the transfer fluid in the manifold is generally glycol or an antifreeze fluid. These systems are more expensive to construct and install, and require maintenance.
- » Collector The Apricus solar collector is the manifold with heat pipes and evacuated tubes inserted.
- » Drainback: Drainback systems use water as the heat

transfer fluid in the collector loop. The water drains by gravity back to the storage tank or an auxiliary (header) tank when the circulation pump stops, thus preventing overheating and freezing. This system provides a high level of protection as it does not rely on valves or controllers that could fail under adverse freezing conditions. The disadvantage of the system is that it requires a pump with a high static lift to fill the collector when the system starts up, it is also important that all piping is sloped, ensuring that the collector is at the top and the tank at the bottom. U-bends are strictly not allowed.

- » Expansion control valve (ECV) Installed on the cold mains line to relieve excess pressure.
- » Flow Line indicates the plumbing line running from the tank (or heat exchanger) to the inlet of the collector. This line incorporates the circulation pump.
- » Header is the copper "heat exchanger" pipes in the solar collector through which the water flows.
- » Heat Pipe: A copper pipe that sits inside the evacuated tube and is inserted into the collector manifold. A small volume of liquid acts as a heat transfer fluid. It absorbs heat via evaporation, and transfers heat to the system fluid via condensation.
- » Insolation solar radiation level, expressed in kWh/ m²/day
- » Manifold Refers to the solar collector which contains the header through which potable water flows.
- » Open Loop or Direct Flow: Open loop active systems circulate water directly from the tank, through the collectors. This design is efficient and lowers operating costs, but is not appropriate if the water supply is hard because calcium deposits quickly build up in the bottom header of the collector. Open loop systems have limited freeze protection, usually achieved through controller functions; by running the pump and forcing warm water from the tank to the collector, when the collector temperature approaches zero.
- » Pressure Limiting Valve (PLV): A valve installed on the cold water mains line designed to limit system pressure to a set design pressure. A typical value is 500 kPa.
- » Pressure temperature relief valve (PTRV) installed on the hot water storage tank to relieve pressure, and excessive temperatures.
- » Return Line indicates the plumbing line running from the outlet of the collector back to the tank.
- » Stratification the passive separation of water into distinct layers of different temperatures; where the temperature at the top of the tank can be significantly higher than the temperature at the bottom.



1.4 Certification

AS/NZS2712 - The Australian Standard for solar collectors. Testing to meet this includes resistance to glass breakage and impact resistance under certain conditions including hail, stagnation conditions, protection against water ingress and structural strength.

'Apricus Australia has obtained AS/NZS 2712:2002 certification through Global Mark. The certification number is 100633.'

SRCC - The Solar Rating and Certification Corporation (SRCC) is a not for profit organization that assesses solar collectors. This allows solar collectors to be compared to one another on an independent platform. There is also a similar program for solar water heating systems.

'Solar Collector – SRCC OG-100 North America Apricus has obtained SRCC OG-100 for the AP-10, 18, 20, 22 & 30 tube evacuated tube solar collectors. Certification numbers: 100-2004003A/B/C/D. Apricus North America has obtained SRCC OG-300 for a full range of systems.'

ITW - Solar Keymark is the most widely recognised European standard for solar collectors. The testing done through this standard ensures that the collectors are reliable in both performance and quality.

'Apricus has obtained Solar Keymark certification for its AP-10, 20, 22 & 30 tube evacuated tube solar collectors.'

AS/NZS3498 - Applies to the hot water system. By meeting this standard, the tank, and the entire system meets requirements. Most importantly is the Watermark certificate meaning that all the products that Apricus provides in a given system from collector through to valves will meet Australian standard in relation to potable water.

'Apricus Australia has obtained AS/NZS3498 for all the systems available in the CER register through Global Mark. The certification number is 40107.'

1.5 Conversions

- 1kWh = 3600kJ = 860kcal
- 1 kcal will heat 1 litre of water by 1°C
- 1 J/s = 1W = 0.860421kcal/hr
- 1kWh/m2/day = 3.6MJ/m2/day

2. Warnings and Precautions

2.1 Installer Requirements

Installation must be completed by a licensed plumber in accordance with the requirements listed below, as well as any relevant local standards and regulations.

- » AS/NZS 3500 National Plumbing and Drainage Code.
- » AS/NZS 2712.2007 Solar and Heat Pump Water Heaters: Design and Construction.
- » AS/NZS 4234.2008 Heated Water Systems Calculation of Energy Consumption.
- » AS/NZS 5601.2004 Gas Installations

2.2 Occupational Health and Safety

The installer must adhere to occupational health and safety guidelines and other relevant industry associations. Under no circumstances should any installer attempt to install an Apricus solar hot water system without reading and understanding this installation manual. For any queries Apricus staff may be contacted on 1300 277 428.

2.3 Over Pressure and Temperature Protection

2.3.1 Pressure Temperature Relief

Any system design must allow a means of pressure release at no more than 850kPa, using a PTRV. The PTRV must have a downward direction copper pipe connected that is open to the atmosphere, running the expelled hot water or air to a safe, frost free and appropriate drainage location. From time to time the PTRV may discharge small amounts of water under normal operations, this can be up to 10% of tank capacity. If the tank is installed indoors, a safe-tray must be installed beneath the hot water tank to safely collect any water expelled from the PTRV.

2.3.2 Mains Pressure Control

Where the mains pressure supply can exceed or fluctuate beyond the pressure of 500kPa, a pressure-limiting valve must be fitted to the cold mains line. The device is installed after the isolation valve (duo valve) and should have a pressure limit of 500kPa.

In some states it is a mandatory requirement that an expansion control valve be fitted on the cold mains line to provide a form of pressure relief. A separate drain line must be run for this relief valve (as per AS/NZS 3500). If unsure please check with the local authority.



2.4 Water Quality

Water quality is an important aspect of system lifetime. For the system to be warranted, the water used in the system must meet the requirements outlined in Table 1.

Table 1. Water Quality Threshold Values

Total Dissolved Solids	< 600 mg/L or ppm
Total Hardness	< 200 mg/L or ppm
Electrical Conductivity	850 μS/cm
Chloride	< 250 mg/L or ppm
pH Level	Min 6.5 to Max. 8.5
Magnesium	< 10 mg/L or ppm
Sodium	< 150 mg/L or ppm

If in doubt contact your local water authority or have a water test completed. In areas of poor water quality all major components will have a reduced life due to the harshness of the water.

In areas with "hard water" (>200 mg/L or ppm), it is advised to install a water softening device to ensure the long term efficient operation of the system is met. It is also advisable that a glass-lined tank is used as opposed to a stainless steel tank, since the glass-lined tank has a sacrificial anode to protect from corrosion.

2.5 Legionella Control

Legionella bacteria can be found naturally in the environment and thrives in warm water and damp places. It can weaken the body's immune system, which can increase the chances of developing Legionnaires' disease.

To ensure legionella growth is inhibited, the boosting regime must meet the guidelines as shown in section 3.2.2 Table 3. This is in accordance with 'AS3498.2009 Authorisation requirements for plumbing products - water heater and hot-water storage tanks'

It is therefore, very important that the auxiliary boosting system remains on. It will only activate if the temperature falls below the temperatures outlined in section 3.2.2 Table 3.

2.6 Weather Related Issues and Acts of God

2.6.1 Freeze Protection

All Apricus systems have freeze protection built in. This is provided by the controller which will circulate water through the collector once the temperature falls below 4°C. This freeze protection method has passed Frost Level 2 protection (down to -15°C) in line with AS/NZS 2712:2007.

⚠ WARNING

Freeze protection will not operate if there is no power supply to the controller or pump.

2.6.2 Lightning Protection

At installation locations that are prone to lightning strikes, it is advisable to earth/ground the copper circulation loop of the collector to avoid lightning related damage, or electrical safety issues. Refer also to local building codes regarding lightning safety and grounding.

The inclusion of a residual-current device (RCD) is highly recommended for these lightning prone areas.

2.6.3 Hail Resistance

The borosilicate glass evacuated tubes have been tested under the Australian Standards requirement (AS/NZS 2712:2007 – Solar and heat pump water heater – design and construction). The impact resistance test results indicate that the evacuated tubes are able to withstand impact from hailstones up to 25mm/1" in diameter at 25 m/s.

In the unlikely circumstance that an evacuated tube should become broken it can be easily replaced. The solar collector can still function properly with one or more broken tubes, however it will result in a reduced heat output from the collector. A broken evacuated tube should be replaced by professional installers or service agents only.

2.7 Stagnation and No-Load Conditions

2.7.1 Information on Stagnation

Stagnation refers to the condition that occurs when the pump stops running, due to pump failure, power blackout, or as a result of the high tank temperature protection feature built into the controller, which turns the pump off.

The system is designed to allow stagnation to prevent the tank from overheating. This means that the collector and plumbing in close proximity may reach temperatures of up to 170°C; therefore components that may be exposed to the high temperatures such as valves, plumbing or insulation, should be suitably rated.

The system designs listed in the 'CER' Register meet the No-load system requirements detailed in AS/NZS 2712:2007. This means that they will not dump large volumes of water from the PTRV and do not require an auto air-vent.



During periods of extended stagnation, condensation pressure shocks can occur in the tank. When the tank is topped out and suddenly a hot water load is drawn from the tank this can lead to rapid mixing of cold water and superheated steam in the return line mixing. This can produce a "gurgling" noise, as the steam is hypothesized to collapse on itself upon rapidly cooling and condensing. This is a normal occurrence in any hot water storage system and does not affect the system's operation

2.7.2 Hydrogen Build Up

Glass lined (vitreous enamel) tanks are fitted with a Magnesium anode to provide corrosion protection for the tank from the storage water. Small quantities of hydrogen gas can be released by the anode, which generally remains dissolved in the water and flushed away as hot water is used from the tank. Depending on the water quality there may be a degree of hydrogen build-up in the tank if the water heater hasn't been used for two or more weeks.

To resolve the build-up of hydrogen within the tank "purge" the tank for approximately 30 seconds from the lever on the PTRV.

2.7.3 Water Boiling Temperatures

The boiling point of water varies based on the pressure within the hot water system. Under stagnation and no load conditions, the solar collector has the potential to reach temperatures well above 100°C. As the water temperature rises and water expands this creates pressure within the system. As the temperature rises, so too does the boiling point of water. This is why the solar hot water system (despite being at temperatures in excess of 100°C) will not boil and produce steam. Table 2 Illustrates how the boiling point increases with pressure.

Table 2. The Relationship Between Pressure and Boiling Point

Pressure (kPa)	Boiling point (°C)
101	100
203	120
304	133
405	143
507	151
608	158
709	164
811	170

2.7.4 Delayed Installation or Use

The manifold and tubes should not be installed and sitting dry (no fluid) for more than 14 days. Prolonged dry stagnation may void the warranty as it could affect heat pipes or tube longevity.

The manifold MUST NOT be left without tubes and installed on the roof for any period of time, particularly during periods of rainfall or snowfall. There is a high probability of water entering the manifold and causing damage to the glass wool insulation.

If the installation cannot be completed fully and the system must be left dry for a period longer than 14 days, the collector must be covered. The collector can be covered with a durable, waterproof cover to prevent water ingress, or access to insects or birds.



3. Information for End-User

3.1 How Solar Heating Works

3.1.1 Introduction

Apricus strongly believe in informing the homeowner about the basic operation of the solar water heating system. By gaining a basic understanding you can develop realistic expectations about the operation of the system, develop habits which maximise energy savings and most importantly, ensure safe and reliable operation.

3.1.2 Summer and Winter Solar Heating

Solar radiation is only half or one third as strong in the winter months compared to summer, and therefore not able to provide the same amount of hot water as in summer. For optimal performance of the solar system it is recommended that the collectors be angled (pitched) at no less than 20 degrees. For increased performance during winter it is recommended that collectors are pitched at latitude plus 10-20 degrees, Correct tilting of the system will provide increased year round performance and reduce energy costs further.

3.1.3 How the Apricus System Works

The Apricus solar collector converts the sun's energy into heat, quite different to photovoltaic (PV) solar panels, which convert the sun's energy into electricity.

How the Apricus system works:

- 1. The evacuated tubes absorb the sun's energy and convert it to usable heat.
- 2. The heat inside the evacuated tube, is carried via copper heat pipes to the insulated manifold, this contains a copper heat exchanger.
- 3. An electronic controller measures the temperature of water in the manifold and compares it to the water in the bottom of the storage tank. If the manifold temperature is higher, the controller switches on a circulation pump which brings the solar heated water back down to the storage tank.
- 4. Throughout the day, the controller switches the pump on and off to continuously heat water in the storage tank.
- 5. When the maximum temperature in the tank is reached (85°C), the pump is turned off and no more water is circulated until the temperature drops below this value.

3.2 How Boosting Works

3.2.1 Boosting Explained

If the solar contribution during the day is not enough to raise the water to a suitable temperature, an electric or gas booster can provide additional heating. During sufficient sunny weather, the solar collector will normally be able to provide enough hot water, but during winter months and overcast days boosting may be required.

As a regulatory requirement, all solar hot water installations must include a tempering valve which mixes the hot water coming out of the storage tank with cold water to limit the temperature to 50°C.

3.2.2 Legionella Bacteria - Importance of Boosting

It is a legal requirement that water be heated on a regular basis to kill Legionella bacteria that can lead to Legionnaires disease. The frequency this temperature must be reached varies, and is explained in Table 3:

Table 3. Minimum Heat Requirements

Type of Apricus System Installed	Minimum heat requirements
Bottom element electric boosted system	Once per week to 60°C for 32 minutes
Mid element electric boosted system	Once per day to 60°C
Gas boosted systems	Minimum 70°C each time water is used

3.2.3 Electric Boosted Systems

If the system is electric boosted, when the electric element is activated it will heat up all the water above the element to 60°C (or the thermostat setting). This heating can take as long as 3-4 hours if the tank is cold.

Note: Apricus recommends that the electric booster is left on, or controlled by a suitable timer.

3.2.4 Gas Boosted Systems

Depending on the gas booster used, the start-up temperatures vary. For an Apricus gas booster, if the incoming water temperature is less than 55°C, the booster will activate and heat water to 70°C. If the incoming water is greater than 55°C the booster will not start and water will flow directly to the outlets.

Non Apricus boosters are typically configured to heat any water below 70°C to 70°C. Refer to the individual booster manual for more detailed information on these settings.



3.3 System Maintenance & Precautions

3.3.1 System Maintenance

- Cleaning The Apricus tubes do not usually need cleaning, regular rain and wind should keep the tubes clean.
- Pressure & Temperature Relief Valve (PTRV) The PTRV is located near the top of the hot water storage tank. It is designed to release pressure in the tank as water expands and contracts during normal heating.

The lever on the PTRV should be carefully lifted for a few seconds then placed down, once every 6 months. This will help prevent any debris or scale build up in the valve.

⚠ WARNING

When the PTRV is lifted hot water will be discharged. Ensure the drain pipe from PTRV is clear.

- Visual Check Apricus recommend periodic visual checks of your system:
- a. Check for leaks around the storage tank and pipe work
- b. Ensure the pump station is dry and free from moisture
- c. If the tubes are safely visible from ground height, ensure all tubes are still dark in colour. (Note: if the tubes are a milky/white colour the vacuum has escaped and the tube will not be working as efficiently as it should be)

⚠ WARNING

Pipe work can be extremely hot, do not touch any exposed copper piping.

3.3.2 Glass Lined Tank Precautions

Glass lined (Vitreous enamel) tanks are fitted with a magnesium anode to provide corrosion protection for the tank from the stored water. Apricus recommend the anode be inspected at least every three (3) years, and serviced as required.

Small quantities of hydrogen gas can be released by the anode which generally remains dissolved in the water. This is then flushed away during normal use.

Depending on the water quality there may be a degree of hydrogen build up in the tank if the water heater hasn't been used for two or more weeks. To resolve the build-up of hydrogen within the tank "purge" the tank for approximately 30 seconds from the lever on the PTRV.



3.4 End-User Troubleshooting Guide

Table 4. Basic Troubleshooting Guide

Problem	Cause	Solution	
Pump Continuously Running	Air lock in manifold	Contact Apricus Australia	
Pump Continuously Running	Insufficient flow rate	Increase pump speed	
Pump is not circulating even	Maximum temperature reached in the tank	This is normal operation, controller switches pump off once maximum temperature is reached to prevent over-heating.	
during sunny weather	Possible sensor issue	Contact Apricus Australia	
Why is the pump running at	Freeze protection operating	This is normal, but if the pump is running more than once an hour, additional insulation on the collector line should be installed.	
night? Possible faulty non-return valve		Contact Apricus Australia	
Why is the controller L.E.D. light flashing red?	Possible sensor issue	Contact Apricus Australia	
	Electric or gas booster is not configured correctly	Ensure gas booster is operational. Electric booster should have the thermostat temperature set to at least 60°C. Booster must be left on off-peak, or controlled by timer.	
Why is the water not hot enough?	Household hot water usage too high	Contact Apricus Australia for advice. Remember an efficient shower head uses 9 litres/minute. (10 minute shower = 90ltrs water)	
	Tempering valve installed	A tempering valve must be installed on every solar hot water system. Tempering valves will mix water down to 50°C	
		Tempering valve may need replacing or servicing.	



4. Pre-Installation

4.1 System Selection

Proper system selection is crucial to ensure that all the hot water needs for the home are being met. The system should be designed to meet 90-100% of the household needs in summer and 50-60% in winter.

A number of considerations need to be made including: the number of residents in the house, the time of day when most hot water will be used, the location of the customer within Australia and the resources available on site.

Apricus Australia has designed its systems to meet the optimal demand required in most residential homes for domestic hot water requirements. Figures 1 & 2. Show a sizing guide which can be used as a "Rule of Thumb" for choosing a system that best meets the needs of the household.

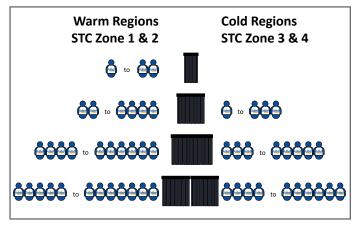


Figure 1. Collector sizing guide

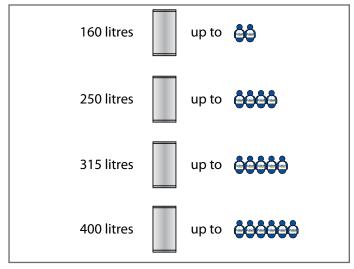


Figure 2. Tank sizing guide

4.2 Site Inspection

4.2.1 Collector Location

The location of the solar collector is crucial to achieving optimal system performance. A number of factors need to be considered when determining the placement of the collectors on the roof of a building. These are detailed below:

- Solar collector vicinity to tank: The collector should be positioned as close as possible to the storage tank to avoid long pipe runs and minimise heat loss.
- Collector Orientation with respect to the sun: To ensure optimal heat output the collector should face the equator, which in Australia and New Zealand (Southern hemisphere) is due North. A deviation of up to 15° east or west off due north is acceptable, and will have minimal affect on heat output.
- Collector Plane: Both sides of the manifold can be used interchangeably as the inlet and outlet ports. However, if the manifold is not level horizontally, the higher side must be used as the outlet since hot water rises.
- Collector Angle: So that the collector achieves maximum solar exposure, collectors are to be installed at an angle of the location's latitude +/- 10°. E.g. Sydney is at 34° S latitude, therefore the optimal angle for the collector on the roof would be 24-44° S. In some installations it may desirable to achieve an install angle of +10° latitude as this will optimise winter output since the sun is lower in the sky during Winter. This can also reduce stagnation effects in summer from over sizing.
- Shading: Collectors should be located so that shading does not occur for at least 3 hours either side of 12pm noon local time. Partial shading due to small objects such as antennas and small flues are not of great concern.

4.2.2 Mounting Frame Location

Prior to installation of the mounting frame it is essential to carry out a site inspection and ensure that the site is compliant with the conditions stipulated in section '8.2 - Conditional Requirements'. In the case where conditional requirements are not met, a certified structural engineer may also be consulted prior to install to provide professional design work that will allow for the site to accommodate Apricus certified mounting frame systems.



4.2.3 Storage Tank Location

- The storage tank should be located as close as possible to the most frequent draw off points in the building such as the bathroom or kitchen. If the storage tank is located a long way from hot water draw points a hot water circulation loop on a timer may be considered to reduce the time-lag for water to heat up and resultant water wastage.
- The tank should not obstruct any windows, doors or exits and should cause minimal intrusion to the existing site.
- For glass-lined tanks, consider the requirement of anode removal and replacement maintenance.

4.3 Transport and Unpacking

4.3.1 Transport of Components

- When transporting boxes, note the orientation of the "THIS WAY UP" arrows.
- Ensure all boxes are strapped and secured to prevent movement during transit.
- All tanks must be transported upright. Stacking is not recommended for any tanks.
- Products should always be handled with care. Damage occurred during the transportation is not covered under product warranty.

4.3.2 Unpacking of Components

- When unpacking, take care to ensure that the components are not damaged in the process.
- Avoid using sharp blades or knives as this can scratch the surfaces of the products particularly the evacuated tubes and tanks.
- For evacuated tubes and heat pipes, tear open both ends of the box(es) to allow inspection of the vacuum at the bottom and for the heat pipes to be exposed for the application of heat transfer paste.

4.4 Component Inspection

4.4.1 Evacuated Tubes & Heat Pipes

- Ensure that the evacuated tubes are all intact, the bottom of each tube should be silver. If a tube has a white or clear bottom, it has lost its vacuum and should be replaced. In this case, the heat pipe should be removed and inserted into the replacement tube.
- The evacuated tubes have rubber tube caps on the end, these are to protect the bottom tip of the glass tube from being broken.
- Heat pipes are bright and shiny when newly manufactured, but will dull and may form dark-grey surface discoloration over time. This is due to mild surface oxidation (when exposed to air) and does not affect the heat pipe's operation.

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

A I

WARNING

NEVER touch the inside of the evacuated tube or heat pipe tip after exposure to sunlight.

WEAR thick leather gloves if handling the heat pipe. WEAR safety glasses at ALL times when handling the glass tubes.

4.4.2 Pump Station Inspection

Every domestic solar hot water system supplied by Apricus comes with an Apricus Pump Station Kit. The Apricus Pump Station Kit comes bundled with the essential components required for installation of a solar hot water system. The kit comes pre-packaged and can easily be connected to plumbing.

Pump station components include:

- Check valve
- Pump unions
- Flow meter
- Tempering valve (solar rated)
- Circulation pump
- Controller
- Pump station lid & base

4.4.3 Mounting Frame System

Ensure that all necessary components required for installation have been received in the packaging. Figure 3 & 4 are diagrammatic guides showing what is included in a typical mounting frame system. Refer to 8.2.2. Appendix Table 11, 12a & 12b for number of frame components required.



Apricus Flush Mount

This diagram shows our standard AP-30 flush mounted frame suitable for use in all wind regions with: $5 \times 10^{-2} \times$

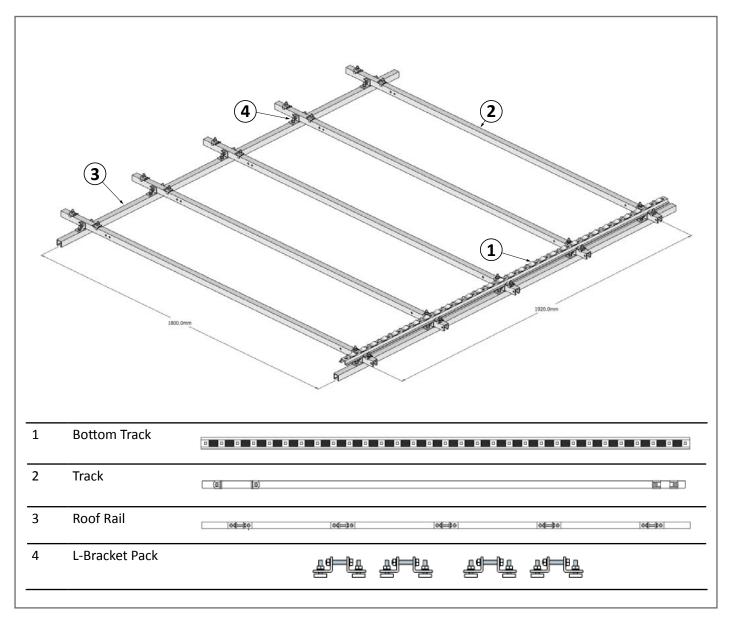


Figure 3. Flush-Mount Frame at 1800 mm spacing with 5 tracks.



Apricus Tilt Mount

This diagram shows a typical cyclonic wind region C frame with: 5 x Tracks, 5 x L-Bracket packs and 5 x Rear Legs. Most regions across Australia only require 3 x Rear Legs.

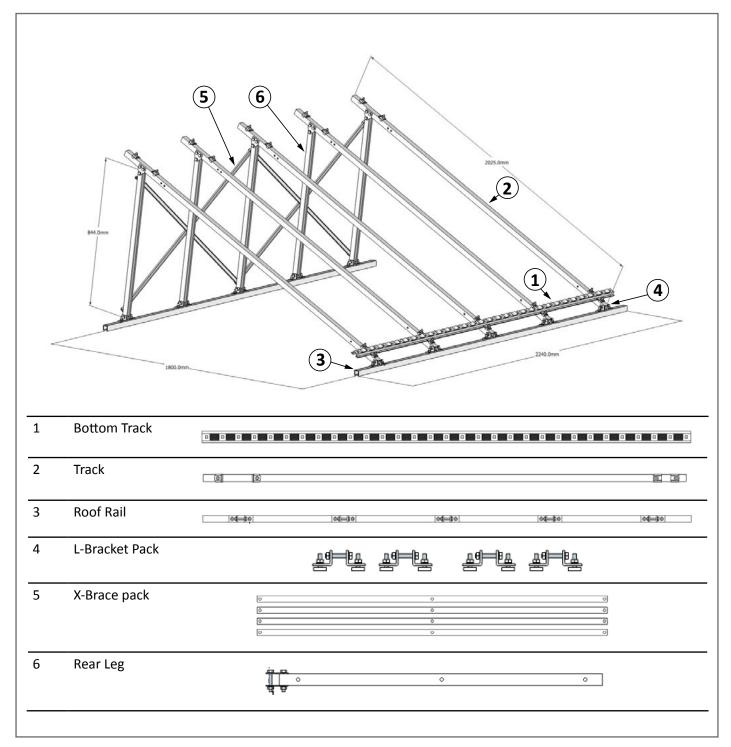


Figure 4. Tilt-Mount Frame at 1800 mm spacing with 5 tracks.



5. Installation

5.1 Mounting Frame System

Apricus Australia's solar evacuated tube mounting frame systems are made of high-grade extruded anodized aluminium frame 6005-T5.

There are four easy to install mounting options: flush mounted with roof rail, flush mounted with roof straps, low angle tilt 30 degrees and high angle tilt 45 degrees.

Our frames are suitable to use in wind regions A, B, C and D, however these are subject to a set of conditional requirements. Under this set of conditional requirements (see section 8.2 Conditional Requirements) these systems are certified to Australian Standard AS/NZS 1170.2:2011 Structural Design Actions Part 2: Wind Actions. See section 8.3 Mounting Frame Certification.

At time of publication, Apricus has applied for Northern Territory Deemed to Comply status. We have done extensive physical load testing for this purpose and have already obtained a Section 40 - Certificate of Compliance for our flush-mounted frames. See section 8.4 Section 40 - Certificate of Compliance.

Check with local building authority to confirm whether or not this standard is a regulatory requirement.

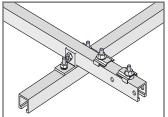
5.1.1 Installation Notes

The installer is to provide the fixings for the frame to the roof, ensure the fixings are applied in accordance with section 8.2 Conditional Requirements and section 5.1.3 Installation – Roof Fixing Guide. Holes can be easily drilled into the extruded aluminium components. They are to be no larger than Ø10 mm and not closer than 30mm centre to centre. Tighten frame bolts with spanners or short shafted socket wrenches only. DO NOT use power tools or long shafted tools that may over-torque the bolts (as stainless steel bolts are susceptible to galling/locking). Bolt assemblies come with spring washers to maintain long-term tension.

5.1.2 Installation – Assembly Guide

Apricus Australia's mounting frame systems come prepackaged to ensure the most streamlined and simple assembly process. Use the following steps as a guide to assembly.

- 1. Lay the first roof rail down horizontally (add L-brackets if using a 5 track system).
- 2. Attach all tracks to the L-brackets, finger tighten all nuts and bolts. Ensure that the track is placed in the right location based on batten/purlin spacing.



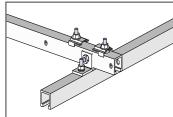


Figure 5. Flush mount 1500mm

Figure 6. Flush mount 1800mm

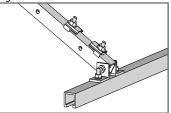


Figure 7. Tilt mount 1500mm or 1800mm

3. Slide the bottom track into the bottom attachment plates and finger tighten all nuts and bolts.

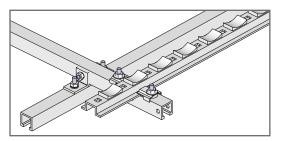


Figure 8. Bottom track and attachment plates

FLUSH MOUNT ONLY

4. For flush-mount frames attach the second roof rail. Continue onto Step 8.

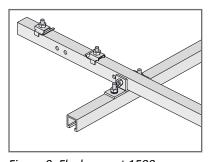


Figure 9. Flush mount 1500mm

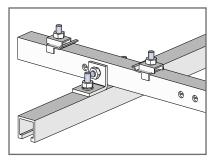


Figure 10. Flush mount 1800mm



TILT MOUNT ONLY

5. For tilt-mount frames, lay down the second bottom track, but attach the L-brackets to the rear legs. Fingertighten nuts and bolts.

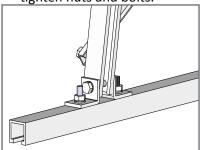


Figure 11. Rear leg connection

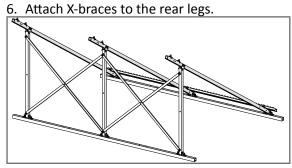
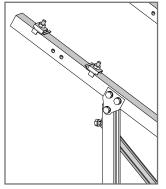


Figure 12. X-brace connection

7. Attach tri-attachment plates to the track



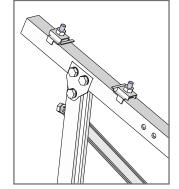


Figure 13. Tilt mount 1500mm Figure 14

Figure 14. Tilt mount 1800mm

8. Slide the manifold into the top attachment plates

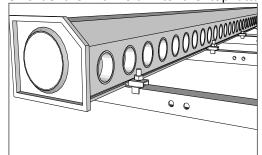


Figure 15. Manifold connection to frame

9. Using a spanner, tighten all nuts and bolts used for attachment.

5.1.3 Installation - Roof Fixing Guide

To proceed with attaching the mounting frame to the roof, follow all fixing rules as per section 8.2.2 Installation Conditions (for certification to apply). All fixings should be made equidistant from the front track and rear leg. This will ensure that the wind loads are equally distributed across the roof rail. Line up the roof rails with battens accordingly. For tilt-mount systems the batten/purlin spacing can be increased where the angle of the tilt decreases.

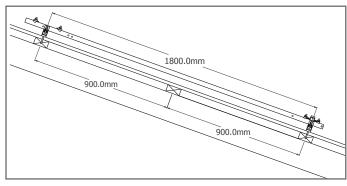


Figure 16. Roof fixing locations 1800mm

Ensure all roof penetrations are water tight. Use the following examples as a guide for installation for different roof types:

5.1.4 Tin Roof Installation Example:

For corrugated/tin roofs, place fixings on the peak of the roofing sheet material to minimize risk of leaks. Fixings are to be screwed into the batten with minimum 35mm embedment (for more details see section 8.2.2 Installation Conditions).

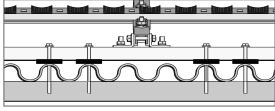


Figure 17. 35mm embedment into the batten/purlin [rear view]

5.1.5 Tiled Roof Installation Example:

For tiled roofs (where drilling is undesirable) use Apricus roof straps to attach the frame to the battens/purlins. Note: systems installed on tiled roofs are not certified under AS/NZS 1170.2. Roof straps can also be attached to roof rails by drilling through them.

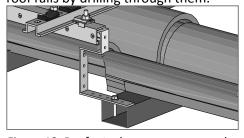


Figure 18. Roof attachment strap example



5.1.6 Adjusting Tilt Mount Angle:

When installing tilt-mount systems, the mounting frame can be modified to achieve a reduced tilt angle. This would be preferable where the optimum tilt angle is not achievable for the given roof pitch and tilt leg.

To reduce the installation angle of the collectors, the aluminium legs should be cut to a desired reduced length and a new hole should be drilled to allow for securing. By reducing the length of the aluminium tilt leg, the frame is brought closer to the roof and the tilt angle is reduced.

Note that decreasing the tilt angle will consequently decrease the wind loading on the system and as such will not impact the structural integrity of the system.

5.2 Collector Manifold Connection

5.2.1 Silver Soldering/Brazing

Soldering may be used to connect piping to the collector header pipe. Only use potable water grade brazing material. Care should be taken to avoid overheating the copper pipe and exposing the manifold casing to an open flame.

5.2.2 Compression Fittings

Apricus collectors come supplied with 20mm flare x 12mm Male Iron (MI) 90° Elbows.

5.2.3 Press Tools

Seek manufacturers advice before using all press tools. Press tools are not suitable for direct manifold connection, or connecting multiple collectors together.

5.3 Pump Station

5.3.1 Installation Guide

Use the following steps as a guideline for the installation of the pump station and connection to piping:

- 1. Remove the contents from the box.
- 2. Remove the Pump Station Cover from the base plate.
- 3. Position base plate on the wall making sure there is a clearance height of 1 to 1.5 metres on the vertical wall, either side of the pump.
- 4. With a spirit level and pen mark screw holes on the wall for base plate.
- 5. Drill holes for green plugs.
- 6. Insert Green plugs into the drilled holes.
- 7. Fix base plate to wall with the 4 screws and rubber isolators.
- 8. Plumb in flow lines to the circulation pump (with a flow meter and check valve above the pump).

5.3.2 Flow Meter Settings

AS 4234.2008 Heated Water Systems – Calculation of energy consumption, Clause 3.7.2 – Low Flow Criteria stipulates that the maximum flow rate is 0.75 L/min/m2 of collector aperture area. Table 5 shows the maximum flow rate settings for the various Apricus collectors.

Table 5. Maximum flow rate requirements

Collector Size	Maximum Flow Rate (L/min)
10 Tubes	0.7
20 Tubes	1
22 Tubes	1.5
30 Tubes	2
40 Tubes	2.5
44 Tubes	2.5

Note: Each tube is 0.094 m2 of aperture area

5.4 Solar Differential Controller

5.4.1 Controller Settings

The Apricus controller comes with temperature sensors and power leads already connected. For most installations there is no need to alter any of the settings.

The controller has 3 sensor cables. The longest cable is for the roof sensor for the solar collector.

The controller comes pre-set with suitable settings for most domestic applications:

- Pump On = 8°C (Temperature differential between tank and roof sensors)
- Pump Off = 1°C (Temperature differential between tank and roof sensors)
- Top out = 85°C (Maximum tank temperature)
- Frost Protection = 4°C (temperature for when pump is forced to cycle)

The controller provides a digital display providing the 3 sensor temperatures and also signs when faults occur within the controller readings. To cycle through the temperature display readings press the NEXT button, the current displayed sensor is indicated on the display board through a flashing icon. Refer to controller manual for detailed information.



5.4.2 Temperature Sensors

Apricus solar rated tanks come with two temperature sensor ports. The bottom port connects to the Sensor 2 (S2), the middle port connects to the Sensor 3 (S3) sensor.

The third temperature sensor port is located on both sides of the manifold. Sensor 1 (S1) must be connected to the outlet (the higher side).

Use a thin layer of thermal paste when inserting all sensors. Ensure insulation covers the opening of the collector sensor port to prevent water ingress. High temperature outdoor silicon sealant can be used to prevent water ingress to the manifold sensor port.

It is highly recommended that conduit be used to encapsulate the roof sensor and act as another protective layer as it is prone to physical damage by local fauna and extreme weather conditions. The sensor cable should run along the outside of the insulation and secured every 20cm with UV resistant nylon cable ties.

5.5 Insulation

- All insulation needs to be solar-rated. Any insulation exposed to sunlight must be UV stabilised.
- Insulate all pipe running to and from the manifold with insulation of at least 15mm thickness, or 25mm in cold climates.
- Ensure the insulation is tight against the manifold casing, thus minimising loss of heat from the inlet and outlet.
- All internal piping as well as external should be insulated. This includes at least 1m from the hot water outlet of the tank, as this copper pipe can be a significant point of passive heat losses.

5.6 System Filling and Air Purge

After all the plumbing connections to the solar collector have been made, the solar hot water system needs to be filled with water and the collector loop purged of air. This should be completed prior to insertion of evacuated tubes and connection of the tank to the hot water load.

To fill the system:

- 1. Open the cold mains line and fill up the tank.
- 2. Turn the pump dial to speed 3 and connect it directly to the electricity mains rather than the controller.
- 3. Open up a drain on the solar return line.
- 4. Where an air-relief valve has been installed, air will be automatically released from the collector loop. This should be shut once the line is filled.
- 5. Filling is completed once there is a constant stream of water exiting from the solar return line drain.
- 6. Reconnect the pump to the controller.

5.7 Evacuated Tubes and Heat Pipes

The Apricus evacuated tube solar collector is a simple "plug and play" system. See section 4.3.2 Unpacking of Components for details regarding the unpacking of the evacuated tubes. Use the following section as a guide to installing evacuated tubes.

5.7.1 Installation Notes

- The powder content of the heat paste may have settled during freight and storage. To ensure optimal thermal conductivity of the paste, place the heat paste tube in a glass of warm water for several minutes.
- If weather conditions are dusty, take care to ensure heat paste is not contaminated with impurities, as this may reduce thermal conductivity and efficiency of the heat paste.
- If weather conditions are wet, take care to ensure water does not enter the inside of the evacuated tube.

5.7.2 Installation Guide

- 1. Open the evacuated tube box on the side with the heat pipes.
- 2. Pull the heat pipe out ~10cm and ensure to keep the rest of the tube shaded.
- 3. Coat each heat pipe bulb with heat transfer paste, this can be applied using a piece of foam insulation.
- 4. Take out the evacuated tube and turn it upside-down (heat pipe down) before turning it back upright (heat pipe up). Repeat this several times to disperse the copper powder within the heat pipes.
- 5. Guide the heat pipe into the inside of the header port. Push the heat pipe in full depth.
- 6. Use a damp cloth, to lubricate the outer surface of the evacuated tube and the rubber ring in the manifold to minimize friction during insertion.
- 7. Insert the evacuated tube using a slight twist and pushing action.
- 8. Repeat steps 3-7 for the remainder of the tubes.
- 9. Using provided tube clips, secure the evacuated tubes into the bottom track.
- 10. Wipe down each evacuated tube with a damp cloth to ensure a polished and clean installation.



5.8 Auxiliary Boosting Components

5.8.1 Electric Booster, Thermostat and Element Setup

⚠ WARNING

WARNING: All electrical connections must be completed by a qualified electrician.

- The thermostat should be set to 60°C or above as per AS/NZS 3498.
- To adjust the temperature setting:
 - » Disconnect the electrical power supply to the tank
 - » Remove the element cover
 - » Using a screw driver, rotate the thermostat dial to the desired temperature.
- Where off-peak periods are unavailable it is advisable that a timer be installed to heat the system up to 60°C at least: i) once per week (bottom element tanks), or; ii) once per day (middle element tanks) to prevent legionella formation. See section 2.5 Legionella Control.

5.8.2 Gas Booster Setup

- All gas boosters come pre-set to heat up to 70°C as per AS/NZS 3500, see section 2.5 Legionella Control for more information.
- Installations must be compliant with AS/NZS 5601.
- Larger gas systems require adequate flueing and ventilation, this should also be done in accordance with AS/NZS 5601.
- To customize settings please refer to relevant manufacturer's installation manual.

6. Post Installation

6.1 Commissioning

To ensure optimal operation and to maintain the integrity of Apricus solar hot water systems, commissioning is an essential process. Ensure that each of the following processes is carried out prior to leaving the site.

6.1.1 System Operation Check

Given good sunlight, the evacuated tubes will begin to produce heat after a 5-10 minute "warm up" period. There should be an observable increase in the temperature reading at the roof sensor on the controller.

When there is an 8°C temperature differential between ROOF and TANK sensors the circulation pump should turn on.

After initial completed installation of collector, watch the operation of the pump and controller for at least 5 ON/ OFF cycles or 15 minutes as the system stabilises. This process may take longer on overcast or cold conditions.

6.1.2 Photo Records

Take several photos of the installed product including: plumbing lines to/from the tank and collector and sensor port connections. These will serve as an important record for future servicing or warranty issues.

6.1.3 Installation Record Form

Complete the installation record form that is supplied, This will ensure that the customer is registered on the Apricus database and increase the speed with which warranty and service issues can be dealt with. The installation record forms can be returned via:

- a) Fax a copy to: 02 9475 0092;
- b) E-mail a copy to: warranty@apricus.com.au;
- c) Mail a copy to: Apricus Warranty, PO Box 6109, Silverwater, NSW, 1811; OR,
- d) Installation/record forms can also be submitted electronically online at: http://www.apricus.com.au/

6.1.4 Rebate Forms

Complete any applicable rebate forms that require an installers signature prior to leaving the site.

6.2 Maintenance

Under normal conditions the solar collector is maintenance free. Please refer to the documentation provided by the manufacturer of other components for maintenance guidelines.

Maintenance and servicing should only be completed by a certified plumber, with experience in solar hot water systems.



6.2.1 Damaged Tubes

⚠ WARNING

WARNING: When replacing damaged tubes follow all relevant OH&S policies. Protective clothing is to be worn at all time.

WEAR thick leather gloves if handling the heat pipe. WEAR safety glasses at ALL times when handling the glass tubes.

- If a tube is broken it should be replaced as soon as possible to maintain maximum collector performance.
 However, the system will continue to operate safely even with a damaged tube.
- Any broken glass should be cleared away to prevent injury.
- To replace a tube:
 - 1. Remove the tube clip, slide broken tube out and carefully pick up any glass pieces and dispose of appropriately.
 - 2. Avoid touching the glass wool insulation inside the manifold with bare hands, as it can cause mild skin irritation.
 - 3. If the heat pipe is not damaged, 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.

6.2.3 Draining the System

Draining of the collector may be required when servicing or performing maintenance on the system. Periodic flushing of the system is not required unless in areas with hard water resulting in scale formation in the bottom of the tank.

Follow the steps below to drain the collector:

- 1. Turn off the mains water supply to the solar storage tank.
- 2. If the storage tank is being drained,
 - a) Disconnect all power supply to water heater (for electric boosted tanks).
 - b) Release pressure in the tank by carefully operating the PTRV release lever.
 - c) Undo the cold inlet and attach a drain hose.
 - d) Operate the PTRV release lever allowing air into the heater and water to drain via the hose.
- 3. If the storage tank is not being drained,
 - a) Isolate piping to and from the solar collector and immediately undo fittings to open drain lines.

⚠ WARNING

WARNING: Allowing the collector to sit pressured with the isolation valves closed may lead to dangerously high pressure.

- b) Open an air vent or drain cock, on the manifold outlet to allow air to enter the system.
- c) Allow the manifold to sit in a vented state for 5-10min to allow the manifold to boil dry (may need longer in poor weather).
- d) Close the air vent or drain cock.
- 4. Re-fill the system by following the same procedure outlined in section 5.6 System Filling and Air Purge.

6.2.4 Over Pressure Protection Maintenance

The lever on the PTRV should be carefully lifted and placed down once every 6 months, this will help prevent any debris or scale build up in the valve. Ensure the drain pipe from the PTRV is clear.

This should be similarly done for the expansion control valve on the cold mains line (if there is one installed).

6.2.5 Magnesium Anode Replacement

Glass-lined storage tanks have a magnesium anode inserted into the tank. This anode prevents internal corrosion that will otherwise drastically shorten storage tank life. Apricus recommend the anode be inspected at least every three (3) years, and serviced as required.



7. Custom System Design Guidelines

7.1 Introduction

This chapter is intended as a guide to assist in designing commercial or custom-sized solar thermal systems using Apricus collectors. In conjunction with this guide, Apricus Australia offers a free service, whereby the system can be sized and designed by a group of trained engineers to ensure that the system best meets the application. If you are interested in taking up this free service please contact your local Apricus agent or email engineering@apricus. com.au.

7.1.1 Associated Work

All designs and installations created using this guide or by Apricus Australia, must be verified by a professional installer or hydraulic consultant, prior to installation. All installations must be within accordance to AS/NZS 3500 – National Plumbing and Drainage Code and any local authorities. A licensed plumber must be contracted to install and commission the system. An electrician may be required for the installation of the GPO box for electrical components of the system (e.g. circulation pump and differential temperature controller).

Apricus Australia advises that all assumptions are correct at date of release. Derived values are conservative approximations based on a combination of provided data and field experience. Information presented in this manual shall not be misused or misconstrued in any way.

7.2 Calculating Load

7.2.1 Calculating Water Usage

In most cases the hot water requirements for a building are given in fixture counts or peak demand. These numbers are not always the most accurate for sizing solar thermal systems. In order to properly size a system, an analysis of the actual or estimated hot water usage is required.

Method A (Metering): If the building already exists and is occupied, it is recommended that the system be metered during normal operation to accurately gauge the hot water usage of the building. Data obtained through metering should include daily volume usage and peak flow rate or energy demand.

Method B (Utility Bill): It may be possible to use past utility bills to estimate the usage. If the hot water is on its own meter, multiply the summer energy consumption required to heat the water by the estimated system

efficiency. When estimating the efficiency, take into account any losses from recirculation and subtract from the usage. The resulting number can be divided by the number of days in the month to achieve a daily energy requirement.

Method C (Estimation): If methods A or B are not applicable, or feasible, an estimation of the amount of hot water consumption will need to be made. There are many published water heating standards or guidelines that can be used to estimate consumption values, such as ASHRAE (American Society of Heating and Air-Conditioning Engineers). Table 6 shows field data of water usage values for a range of applications.

Table 6. Field data for water usage for various applications

Building Use	Water Usage*
Apartment Block	130-160 L/Unit
Nursing Home	70 L/Bed
Hotel	57 L/unit
Dormitory	49 L/Student
Restaurants	6 L/Meal

Note: Figures normalised for 60°C outlet temperature, data obtained from ASHRAE.

7.2.2 Calculating Energy Requirements

The equations below detail how to calculate the energy requirement using Method C Estimation as discussed in section 7.2.1

In order to calculate the energy required, calculate the differential temperature in the summer:

Differential Temperature (°C)

- = Desired Temperature (°C)
- Minimum summer temperature (°C)

The daily energy requirement can then be calculated:

Daily Energy Requirement (kJ)

= Volume of water used daily (kg) \times 4.18 (kJ/kg°C) \times differential temperature (°C)

This calculation will change if water is not the chosen medium for the system design.



7.3 System Sizing

7.3.1 Collector Size Requirement

Using summer time values of daily energy requirement as determined in Section 7.2.2, the number of collectors required can be determined. Summer time values have been selected to ensure that the size of the solar thermal system will meet the majority of the hot water demands during the summer period (this is approximately 90-95% solar contribution), and ensure that overheating will not be a problem.

Number of AP30 collectors

=Daily Energy Requirement (kJ)×3600(kWh/kJ)/11kWh

7.3.2 Roof Space and Collector Shading

When designing commercial solar thermal systems, it is very common for the roof space to be the limiting factor that determines the number of collectors that can be placed on the roof. If this is the case, it is necessary to determine the available area for the solar thermal collectors and calculate the number of collectors that can fit within the design envelope.

The roof space and dimensions required for a single AP-30 at common install angles are listed below in Table 7.

Table 7. Roof Coverage of a single AP-30 Collector

	Pitch (°) Roof Batten Spacing	Width (mm)	Depth (mm)	Total roof Coverage (m2)
1500mm	0	2240	2025	4.54
	30		1753	3.92
	45		1431	3.2
1800mm	0	2240	2025	4.54
	28		1787	4
	43		1480	3.31

Shading is another factor that needs to be taken into account for tilted collectors, as it is possible that banks of collectors can shade each other. Shading can add 41.8m2 to the roof surface area that the collector occupies.

As a result, spacing between banks of collectors needs to be considered, especially when installing frames at tilts. This can result in significant shading during winter and performance loss if not assessed properly. Contact engineering@apricus.com.au for advice on complex array installations.

Systems that require certification to cyclonic standards should also take into account edge zones and other site

specific factors. For more detail please refer to section 8 - Appendix.

7.3.3 Storage Tank Sizing

The storage tank sizing is directly related to the load profile of the building. Section 7.2.1 details methods of determining the load profile for a site.

The storage tank acts as a thermal battery and should be sized to provide, as a minimum enough energy capacity to match the summer time production of the system.

To calculate the storage tank energy capacity, follow the equation below:

Tank Volume (kg)

=(Energy Capacity (kJ)
/[(Max Storage Temperature
- Summer Water Temperature) (°C)
× 4.18 (kJ/kg°C)]

Storage tank sizing can only be lowered if there is extreme confidence in the load profile and a careful analysis has been undertaken.

The storage tanks should be sized to hold the energy from the solar array without any load. For example, buildings that are not used during the weekend require a storage tank size that is two to three times larger than an equivalent building using hot water seven days a week.

7.3.4 Pipe Material

collector loop can get very hot and therefore the recommended material choice for pipes are copper (hard or soft coiled) or corrugated, flexible stainless steel pipe.

7.3.5 Pipe Size

a) Pipe Selection: When selecting the size of the pipe for the solar loop or any plumbing, there are two main concerns; flow rate and pressure drop.

These two factors are closely related; a higher pressure drop will reduce the flow rate. Pressure drop is increased with a smaller diameter pipe, as well as the presence of bends, elbows and other components that will restrict the flow. Corrugated pipes will also increase the pressure drop.

b) Pipe Diameter: See Table 8 for basic pipe sizing (based on type L copper):



Table 8. Recommended Pipe Sizing for Number of Tubes

Number of Tubes	Pipe Size (inches)	Pipe Size (mm)
10-20	1/2"	12.7
30-90	3/4"	19.05
90-240	1"	25.4
240-750	1.5"	38.1
750-1700	2"	50.8

c) Temperature Rise: Table 9 provides estimated temperature rise at various flow rates:

Table 9. Approximate Temperature rise given flow rate and Solar irradiation

Flow Rate per 30 Tubes (L/min)	Temp Rise (°C) @ 0.47 kWh/m2 (Clear Winter's Day)	Temp Rise @ 1.0 kWh/m2 (Clear Summer's Day)
0.75	16.4	35
1.5	8.2	17.5
2.3	5.5	11.7
3	4.1	8.7
3.8	3.3	7

7.4 System Type

The system type (direct, closed, drainback) is directly related to the building function and usage. Typical usage patterns are listed below along with design considerations. When all types of systems are acceptable for the application, freeze protection methods must still be taken into consideration.

7.4.1 Closed loop

In a closed loop system, the heat transfer fluid is pumped through the collectors and a heat exchanger is used to transfer heat from the collector loop to the water in the tank. Closed loop systems are used in areas where freezing conditions are common and the transfer fluid in the manifold is generally glycol or an antifreeze fluid. These systems are more expensive to construct and install, and require maintenance.

7.4.2 Open Loop or Direct Flow

Open loop active systems circulate water directly from the tank, through the collectors. This design is efficient and lowers operating costs, but is not appropriate if the water supply is hard, as deposits of calcium will quickly build up in the bottom header of the collector. Open loop systems have limited freeze protection usually achieved through controller functions; by running the pump and forcing warm water from the tank to the collector, when the collector temperature approaches zero.

7.4.3 Drainback

Drainback systems use water as the heat transfer fluid in the collector loop. The water drains by gravity back to the storage tank or an auxiliary (header) tank when the circulation pump stops, thus preventing overheating and freezing. This system provides a high level of protection as it does not rely on valves or controllers that could fail under adverse freezing conditions. The disadvantage of the system is that it requires a pump with a high static lift to fill the collector when the system starts up, it is also important that all plumbing slopes, ensuring that the collector is at the top and the tank at the bottom, u-bends are strictly not allowed.

7.4.4 Constant Use, 7 Days a Week

Example: Industrial applications

In applications where the usage is constant throughout the day any of the three system types can be utilized. Since the load is constant and usually known, minimal storage is required as all the energy will be used as soon as it enters the system. The booster will need to be sized to be able to maintain this constant draw off.

7.4.5 Constant Use, 5 Days a Week

Example: Manufacturing facility

In this type of application there is a large constant load during the week, however the weekend load may be minimal. Hence although all the energy produced by solar is used during the week, it is advisable to install the largest amount of storage possible. The ideal scenario is to size the tanks such, that stagnation, and thus energy waste is minimized. Where sufficient storage is available any of the three configurations are suitable.

If enough storage isn't installed it is advisable to use either a drainback system to minimize the impact of stagnation, or a closed loop system with a heat dump mechanism or separate energy application. Alternatively, the number of collectors can be scaled down to meet the amount of storage feasible.

7.4.6 Daily Peaks, 7 Days a Week

Example: Apartment Building, Brewery, Dairy Farm Applications where water usage peaks at points during the day require standard storage capacity. Ideally enough energy can be stored to offset the daily energy requirement. If the system is sized to contribute a small amount (<50%) the amount of storage can be reduced to 150-200 litres per AP-30 and any type of system can be used.

If a high solar contribution is required it is recommended that larger storage be used or that a drainback design is employed.



7.4.7 Constant Use, with Extended Periods of Non-Use

Example: School, Colleges

Since many learning facilities have extended holiday periods a drainback system is the best choice. Storage can be minimized since the collectors will not be in operation during the summer months. During this period, collectors should be covered to prevent extended periods of dry stagnation as this may damage the collectors. Collector fields for schools are often oversized to provide more contribution in the shoulder months.

If the facilities are opened year round, follow Section 7.3.1. If the facilities are opened year round and a pool exists, it can be used as a form of heat dump over the weekend.

7.5 System Design and Configuration

7.5.1 Multiple Collector Connection

a) Connecting Collectors in Series: It is highly recommended that the flow rate through any Apricus collector should not exceed 18L/min. If the ideal flow rate is designed using this value in mind it results in a maximum of 150 tubes in series. This is for four main reasons:

- Excessive high flow rates can scrub the walls of the copper header wearing it away.
- High flow rates greatly increase the pressure drop, requiring a much larger circulation pump, and consuming more power.
- The peak 30 tube collector output is about 1.9kW, therefore the maximum temperature rise per pass through the collectors will be 8.6°C at the ideal flow rate specified above. A faster flow rate provides no major benefit and may result in the pump dropping below the pump cycling on and off due to controller settings.
- Thermal expansion of more collectors in series could cause buckling of the copper header during periods of stagnation.
- b) Isolation and drain valves: Each bank of collectors (up to five 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 build up.

⚠ WARNING

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.

7.5.2 Balanced Flow

When connecting multiple banks of collectors in parallel, the flow rate through each bank must be equal. Failure to ensure equal flow will result in some collectors running "cold" due to higher flow rate while others will run hot, due to the lower flow rates. This will mean that the cold collectors will cool the hot collectors down when the water returns to the same pipe, reducing the overall effectiveness of the solar heating. This is not an issue for a single bank of 150 tubes connected in series (5 x AP-30). There are two main methods of achieving balanced flow; reverse return and flow setters.

a) Reverse Return: To ensure balanced flow through the collectors, piping configuration can be used following a method of "first in - last out" as illustrated in Figure 19. This method is less precise flow balancing, as well as increased cost and heat loss due to extra piping.

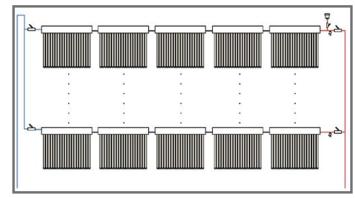


Figure 19. Collector Piping Arrangement - Reverse Return



b) Flow Setters: This is a more precise method of balancing flow. Each bank is measured and directly adjusted, see Figure 20. It is generally more cost effective than reverse return as it eliminates pipe run length and associated increased cost and heat loss. Although involves extra componentry.

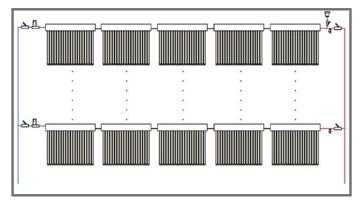


Figure 20. Collector Piping Arrangement - Reverse Return

7.5.3 Multiple Tank Piping

a) Parallel Tank Piping: To allow balanced flow through multiple parallel tanks, the reverse return, or "first in - last out" theory can also be used for tank piping, as evident in Figure 21. The design allows the multiple tanks to act as a single large tank. It means the stratification will be the same through all tanks.

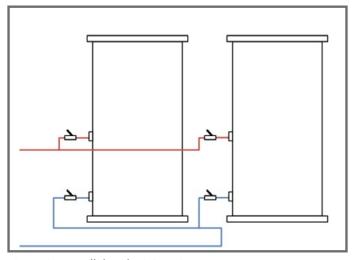


Figure 21. Parallel tank piping - in reverse setup

b) Prioritisation Tank Piping: Prioritisation pipe design has an ordering system that forces the first tank in the line to be heated fully before the next tank in the line, through controller logic, see Figure 22. This process keeps working down the chain of tanks until all are full of the set point temperature. This method would be used in constant load applications where it is more important to reduce inefficient auxiliary heating/high energy costs rather than consider solar efficiency. Tanks in this setup will run hotter and have a potential for increased heat loss. All tanks and piping must be well insulated to minimise heat loss.

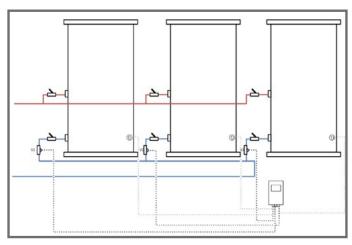


Figure 22. Parallel tank piping - in reverse setup

Please contact engineering@apricus.com.au for advice on complex tank priority control.

7.6 Design Considerations

7.6.1 Stagnation

Stagnation is a term used to describe the scenario where the collectors are producing energy while the circulation pump is turned off. This can occur in a number of circumstances:

- During a power outage when the electricity is out.
- During servicing when the controller and pump are shut down.
- When the water store has reached maximum temperature and the controller does not allow the pump to turn on.

In both direct and closed loop systems, stagnation results in excessive heat energy being transferred to the fluid inside the collectors. When this occurs, the temperature and pressure of the system will increase. In a flooded system, the collectors and plumbing in close proximity may reach temperatures of up to 170°C. Therefore components which are exposed to such high temperatures, such as valves, piping or insulation, should be suitably rated.

The system designs listed in the 'CER' Register must meet the No-Load system requirements detailed in AS/ NZS 2712:2007. This means that they will not dump large volumes of water from the PTRV and do not require an auto air-vent.

Under stagnation conditions, when water is turned on, condensation pressure shocks may occur in the tank. This is often associated with a loud, rumbling noise in the tank. This occurs, when high pressure, high temperature steam in the solar return, experiences a rapid pressure and temperature decrease as it enters the tank meeting



mains pressure water. This results in rapid condensation, where the surrounding fluid collapses on itself or tank chamber walls.

Although the tank will not be damaged by the such pressure shocks, if the noise becomes an issue an expansion tank can be fitted on the mains line after the non-return check valve to prevent the high pressures being met. See section 7.7.2 Expansion Tank for more information.

7.6.2 Excessive System Pressure and Temperature Control

Many solar thermal applications face a fundamental supply and demand mismatch. I.e. when it is hottest in the year, solar produces the most, but required load is smaller. By contrast, when it is the coldest in the year, solar produces the least but the load is often greater. This means that in some applications such as pool heating and under-floor hydronic heating, the system needs to be oversized for summer. This can result in prolonged periods of stagnation.

Steamback is a passive method of controlling system stagnation. The mechanism of steamback is described in four parts:

- Part 1 Expansion of fluid. The fluid expands as it is heated.
- Part 2 Pushing liquid out of the collector. As the boiling point is approached, fluid begins to turn to steam (evaporates). Because steam occupies a much larger volume then liquid, it pushes liquid out of the collector.
- Part 3 Emptying of the collector by boiling. The residual fluid from part 2, continues to evaporate and form steam. Eventually there is little to no liquid and the collector reaches a state similar to dry stagnation.
- Part 4 Refilling of the collector, when solar irradiation falls, the collector temperature drops causing steam to condensate. This acts as a vacuum and leads to passive refilling of the collector.

To enable effective steamback design:

- 1. System pressure should be set at 1.5-2.5 bar (lower boiling point of water).
- Oversize expansion tank to include volume for expansion of water and also all the volume in the collectors.
- 3. Check valve must be placed before the expansion tank so as not to prevent emptying of the collector from the flow side, see figure 23.

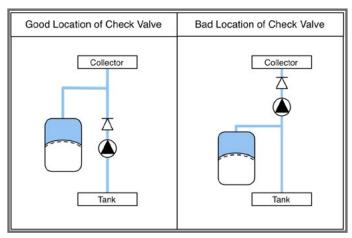


Figure 23. Check valve location in steam back system

7.6.3 Freeze Protection

In areas that experience freezing conditions at any time of the year, a method of freeze protection must be considered.

- a. For areas with temperature that does not fall below -5°C, simple low temperature controller based freeze protection may be used. That is, the pump circulates if the manifold temperature approaches freezing. If possible, backup protection in the form of an uninterrupted power supply (UPS) or a power outage drain valve should also be installed. A power outage drain valve installed on the return line (back from the collector to tank) opens to allow water to slowly run through the collector if the power supply is cut. A check valve between the tank and drain valve must be installed, to ensure flow is through the collector.
- b. For areas with temperatures below -5°C, a closed loop filled with freeze resistant heat transfer fluid should be used. The installer would need to refer to the specific heat transfer manufacturer's specifications about the temperature ranges that the fluid can withstand. The pH and freeze fluid level of the fluid should be tested every year before cold weather occurs. Always follow the manufacturer's guidelines when testing the pH and freeze protection of the heat transfer fluid.
- Drainback systems are permissible in all climates, but recommended as an option for freeze prone areas.
 Refer to Section 7.4.3 Drainback for more details.



7.7 Additional Components

7.7.1 Thermostatic Mixing Valve

Thermostatic Mixing Valve (TMV): The TMV is similar to a tempering valve, as it blends hot and cold water to a set temperature required at the outlet. TMVs continually maintain the outlet water temperature to a preset value, further preventing scalding. It allows water to be stored at a higher temperature, and further not inhibit the growth of legionella bacteria.

7.7.2 Expansion Tank

Expansion tanks allow the system to breath and control pressure fluctuations. The tank is designed to absorb any extra pressure within a system caused by water expansion from stagnation and water hammer. The tank itself contains air, which is somewhat compressible; it is this characteristic that will absorb the shock from water pressure.

When heat energy is added to a fluid it's molecules will vibrate with greater energy. This results in the fluid expanding. In a closed environment the volume is fixed, hence as expansion increases, this leads to the pressure of the system and boiling point of water rising. In domestic systems an expansion control valve fitted on the cold mains line (fitted in between the non-return valve and tank) may be enough to mitigate the effects of expansion and pressure increase.

For larger direct flow systems and closed loop systems, an expansion tank needs to be used to absorb the pressure caused by the expansion of water.

An expansion tank contains a bladder, this separates the gas chamber from the fluid (see figure 24). When the system is commissioned the fill pressure of the expansion tank is set to the desired system pressure. Proper sizing of the expansion tank is important to take the full expanded volume of the fluid in the hydraulic system.

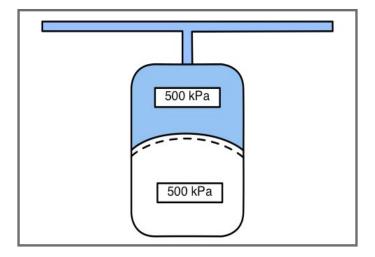


Figure 24. Expansion tank operation

As temperature increases, the fluid expands and pressure increases. Since a gas can be compressed and a fluid can not, the bladder pushes into the gas chamber (see figure 25).

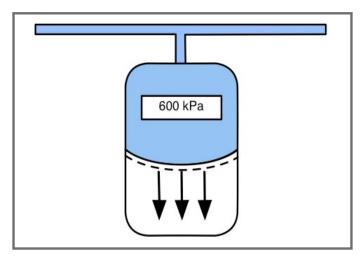


Figure 25. Pressure tank working as water is heated

By pushing on the bladder, the volume of the fluid increases, and thus pressure in the hydraulic system is decreased. Conversely, the gas chamber decreases in volume and thus pressure is increased (see figure 26).

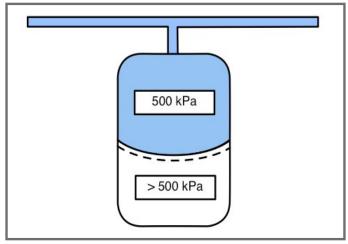


Figure 26. Pressure tank working as water is heated

If the expansion tank is undersized, when the tank's maximum pressure intake capacity is met, the hydraulic system will continue to increase in pressure which will eventually lead to the PTRV opening.

Table 10 shows how the expansion is greater at higher temperatures



Table 10. Expansion coefficient of water at various temperatures

Temperature of Water (°C)	Expansion Coefficient (10 ⁻⁶ K ⁻¹)
4	0
10	88
20	207
30	303
40	385
50	457
60	522
70	582
80	640
90	695

7.7.4 Adjustable Pressure Reducing Valve

Pressure reducing valves (PRV) should be used connected on the mains-line after the ball valve and before a nonreturn duo valve. They will automatically fill the closed solar loop back to the set pressure if air is released from the expansion control valve.

A pressure gauge should be installed on the PRV to provide a clear indication of line pressure upstream of the valve. During commissioning, a flat head screw can be used to adjust the pressure setting on the PRV.



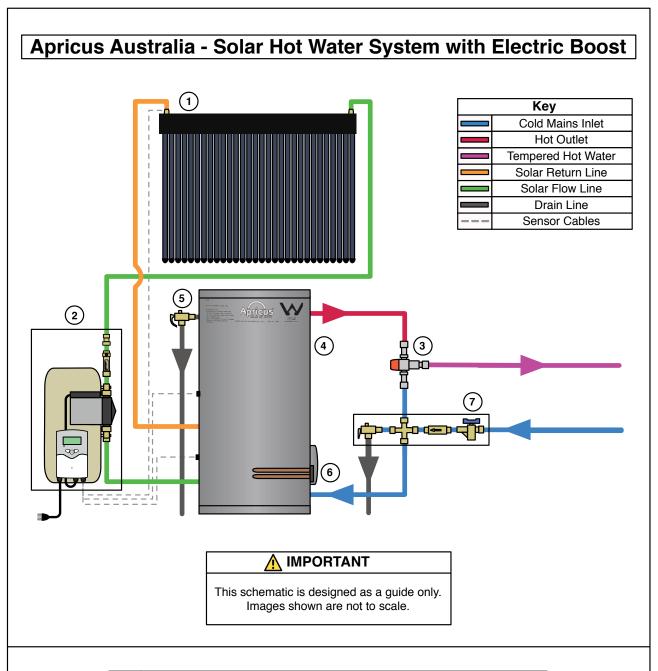
Figure 27. Pressure tank working as water is heated



8. Appendix

8.1 Apricus System Schematics

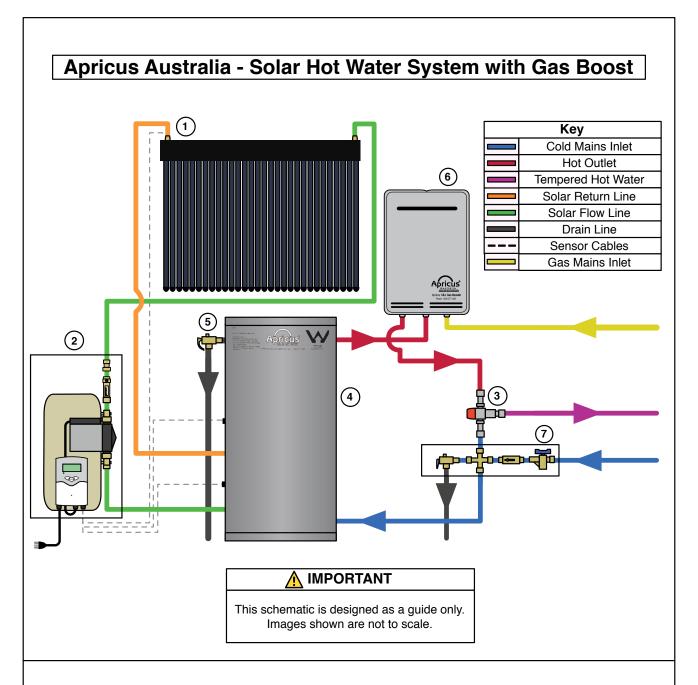
8.1.1 Apricus Electric Boosted Solar Hot Water System



No	COMPONENT NAME
1	Apricus Solar Evacuated Tube Collector (10/20/22/30 Tubes)
2	Apricus Pump Station Kit
3	(includes tempering valve, flow meter, check valve, circulation pump, controller)
4	Apricus Storage Tank (Stainless Steel or Glass-Lined)
5	Pressure Temperature Relief Valve
6	Electric Element and Thermostat (Bot or Mid Element)
7	Apricus Valve Kit (Optional Extra) (includes duo valve, pressure limiting valve, 4-way cross, expansion control valve)



8.1.2 Apricus Gas Boosted Solar Hot Water System



No	COMPONENT NAME
1	Apricus Solar Evacuated Tube Collector (10/20/22/30 Tubes)
2	Apricus Pump Station Kit
3	(includes tempering valve, flow meter, check valve, circulation pump, controller)
4	Apricus Storage Tank (Stainless Steel or Glass-Lined)
5	Pressure Temperature Relief Valve
6	In-Line Gas Booster (NG/LPG)
7	Apricus Valve Kit (Optional Extra) (includes duo valve, pressure limiting valve, 4-way cross, expansion control valve)



8.2 Conditional Requirements

8.2.1 Wind Loading Conditions

The localised wind loading conditions can differ depending on a number of factors. These factors can vary greatly depending on location. What may be correct in one street or suburb, may be different in the next. The Wind loading parameters include: wind region, topography and terrain category. Figure 28 illustrates how Australia has been categorized. For more information on how to classify wind-loading parameters see AS/NZS 1170.2 – Wind Actions or consult a local structural engineer.

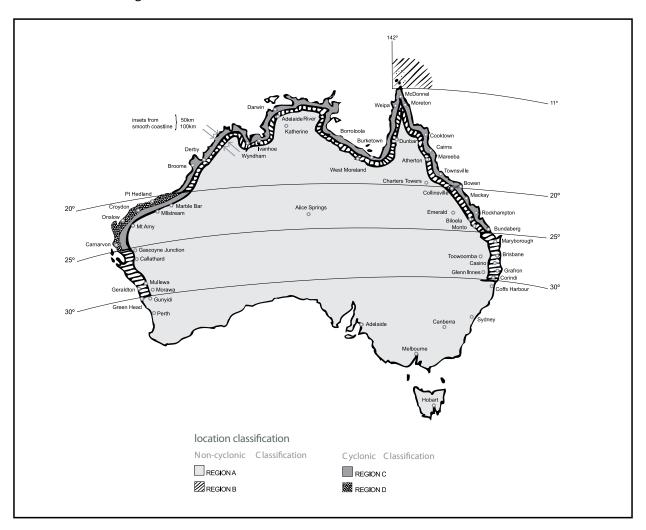


Figure 28. Wind Region Map of Australia

Source: STEGBAR Architectural Design Manual Section 3, Version 2 (Issued March 2009)

Wind Gust Speed: The Apricus mounting frame is certified to different wind speeds and this is determined by the region it is located in. The regional wind speeds are shown below:

- Region A (Non-Cyclonic): 162 km/h.
- Region B (Non-Cyclonic): 205 km/h.
- Region C (Cyclonic): 249km/h.
- Region D (Cyclonic): 316km/h.

Terrain Category: 2, 3 and 4. Terrain Category 2 (TC2) is characterized as an open terrain with only a few scattered obstructions to wind. Calculations of wind load have assumed TC2.

Topography: Flat topography. This means that the intended install site can not be located on a hill or escarpment unless subjected to prior additional engineering approval.



8.2.2 Installation Conditions

For mounting frame certification to apply, the following installation conditions must be met.

Batten/Purlin¹ Spacing: 600, 900, 1500 or 1800mm.

Batten/Purlin Screws:

- Timber Battens/Purlins: 14G Ø6.3mm timber screw, with minimum 35 mm embedment into battens. Minimum joint group J4.
- Steel Battens/Purlins: 14G Ø6.3mm tek screw. Minimum steel thickness 0.75 mm, Grade G550.
- There is an even number of screws per roof rail, so fixing points should be equidistant from the roof rail. E.g. A tilt-mounted AP-30 system in Region C will require, 20 screws for the rear roof rail. Since there are 5 rear legs, this is 4 screws per rear leg. The screws should installed at 60 mm at 120 mm away from the rear leg and on each side.
- Table 11, 12a and 12b show the number of screws required per track for a flush-mounted and a tilt-mounted system respectively.

Maximum height of install: 10 m above ground.

Flush Mount: roof pitch needs to be 20-45° to the horizontal.

• Existing Roof Check: the structural adequacy of supporting roof members must be confirmed by a practicing structural engineer prior to installation, unless a roof rail is used for every batten location.

Tilt Mount: roof pitch needs to be 0-10° to the horizontal.

- Region A and B: Maximum tilt angle 45° to the horizontal.
- Region C: Maximum tilt angle 30° to the horizontal.
- Existing Roof Check: a practicing structural engineer prior to all installations must confirm the structural adequacy of supporting roof members.

Edge Exclusion Zones – As per AS/NZS 1170.2:2011, the flush mounted and tilt-mounted frame systems need to be installed within the internal roof zone. The edge exclusion zones is calculated from the minimum of 0.2x'D' (width of the building), 0.2x'B' (length of the building) and 'H' (average height of the building).

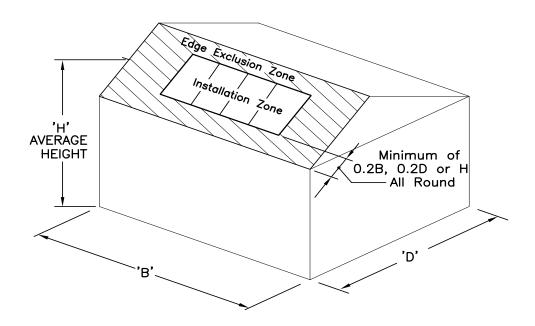


Figure 29. Edge exclusion zone

¹Battens and purlins are the same components and are usually located horizontal, or perpendicular to the roof pitch. This differs from rafters which are situated parallel to the roof pitch.



Table 11. Screw Fixing and Frame Configurations for Flush Mounted Systems

Number of Screw Fixings Required for the Front and Rear Roof Rail												
Wind Region	Wind Region A Number No of Fixings per Roof of Front Rail		Wind Region B			Wind Region C			Wind Region D			
			gs per Roof	Number Total Fixings per Roof of Front Rail		Number No of Fixings per Roof Front Rail		Number No of Fixings per Roc of Front Rail		gs per Roof		
	Track	T i m b e r Batten	S t e e l Batten	Track	T i m b e r Batten	S t e e l Batten	Track	T i m b e r Batten	S t e e l Batten	Track	T i m b e r Batten	S t e e l Batten
30 Tubes	3	6	6	3	6	6	5	10	20	5	10	20
22 Tubes	3	6	6	3	6	6	3	6	20	5	10	20
20 Tubes	3	6	6	3	6	6	3	6	20	5	10	20
10 Tubes	2	4	4	2	4	4	2	4	4	3	10	12

Table 12a. Screw Fixing and Frame Configurations for Front Roof Rail on Tilt Mounted Systems

Number of Screw Fixings Required for the Front Roof Rail										
Wind Region	on Wind Region A			Wind Region B			Wind Region C			Wind Region D
	Number of Front	No of Fixings for Front Roof Rail		Number of Front	No of Fixings for Front Roof Rail		Number of Front	No of Fixings for Front Roof Rail		
	Track	T i m b e r Batten	S t e e l Batten	Track	T i m b e r Batten	S t e e l Batten	Track	T i m b e r Batten	S t e e l Batten	Th
30 Tubes	3	6	6	5	10	10	5	10	10	Tilt mount frames cannot be installed in wind region D.
22 Tubes	3	6	6	3	6	6	5	10	10	
20 Tubes	3	6	6	3	6	6	5	10	10	
10 Tubes	2	4	4	2	4	4	3	6	6	

Table 12b. Screw Fixing and Frame Configurations for Rear Roof Rail on Tilt Mounted Systems

Number of Screw Fixings Required for the Rear Roof Rail										
Wind Region	Wind Region A			Wind Region B			Wind Region C			Wind Region D
	Number of Front	No of Fixings for Rear Roof Rail		Number of Front	No of Fixings for Rear Roof Rail		Number of Front	No of Fixings for Rear Roof Rail		
	Track	T i m b e r Batten	S t e e l Batten	Track	T i m b e r Batten	S t e e l Batten	Track	T i m b e r Batten	S t e e l Batten	
30 Tubes	3	12	12	5	20	20	5	20	40	Tilt mount frames cannot be
22 Tubes	3	6	12	3	12	12	5	20	40	installed in wind region D.
20 Tubes	3	6	12	3	12	12	5	20	30	
10 Tubes	2	4	4	2	4	4	3	6	18	
Max. Pitch	45 degrees			45 degrees			30 degrees			



8.3 Mounting Frame Certification



November 18th 2011

Apricus Australia PO Box 6109 Silverwater NSW 1811

Attention: Mr Christopher Nheu

STRUCTURAL DESIGN CERTIFICATE

Project Description: Certification of Aluminium Mounting Frames and

Fixing Requirements for Apricus Australia for

30/22/20/10 Tube Manifolds

We, Partridge Partners Pty Limited, being professional Structural Engineers within the meaning of the Building Code of Australia, hereby certify that we have reviewed the structural design of the aluminium framing and fixing specifications for the Apricus Aluminium Mounting Frames for 30/22/20/10 evacuated tube manifolds as detailed in the Apricus Australia document "Aluminium Frame Certification Requirements" and that the design is in accordance with the relevant provisions of the Standard Building Codes, in particular AS/NZS1170.2:2011, and in accordance with accepted engineering practice and principles.

Certified Document: AA-8.3.8.1-Al Frame Cert.-v1.2 Issue 1.1

"Aluminium Frame Certification Requirements" dated 12.11.12

by Apricus Australia

This certification is subject to the limitations imposed on the system by the manufacturer and as detailed in the Certification Requirements. This document does not constitute structural certification of the existing roof structure to which the mounting system is to be fixed.

This certificate shall not be construed as relieving the system manufacturer or installer of their responsibilities, liabilities or contractual obligations

Rob O'Reilly

BE(Hons) MIEAust CPEng NPER(Structural) RPEQ

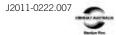
For and on behalf of:

Partridge Structural Pty Ltd

Level 5, 1 Chandos Street, St Leonards NSW 2065 Australia 1612 9460 9000 1612 9460 9090 partridge@partridge.com.au

www.partridge.com.au

Partridge Structural Pty Ltd – 73 002 451 925 Partridge Event Pty Ltd – 50 139 601 433 Partridge Remedial Pty Ltd – 89 145 990 521





8.4 Section 40 - Certificate of Compliance

NORTHERN TERRITORY OF AUSTRALIA BUILDING ACT SECTION 40 – CERTIFICATE OF COMPLIANCE – STRUCTURAL DESIGN

PROPERTY / PROJECT DETAILS						JOB NO: 130814		
Location: Various	3							
Description of works: Apricus Evacuated Tube Mounting System Flush and Tilted								
DOCUMENTS	S ATTACH	ED						
Drawing Nos: 20	11. 02 22 Sheet	1 1 to 6						
DESIGN BAS	BIS (please li	st relevant Stand	ards use	ed in the desig	gn)	AC4700 AC4004		
AS1170.0, AS11	70.1, AS1170.	2, AS1170.4, AS	2870, A		00, AS3700, AS4100, AS4600			
Class of Building	(BCA):				nstruction (BCA volume 1 §C1. \[\text{fire-resisting construction} \]	et.		
Building importar	nce Level (BC/	A Table B1.2a): 2		Annual Pro	bability of Exceedance for Win	d (BCA Table 1.2b): 1 in 500		
Region: C	Regional ulti	mate wind speed	Reference height (m): 10					
M _{z,cat} : 1.0	M _s : 1.0	Mt: 1.0			V _{des9} Design Wind Speed at	/ind Speed at reference height (m/s): 69		
Internal Pressure (C ₈₄):		N/A						
External Pressure Coefficients (C _{p,e}	External Pressure Walls		N/A					
, ,	, <u>-</u>	Roof	N/A	N/A				
Net Pressure Co (C _{p,n})	Net Pressure Coefficients: Roof / Walls		As Pe	As Per CPP Wind Assessment Report No 6979 Dated 15.02.2013				
Imposed Loads,	kPa	Floor / Roof	N/A					
Earthquake Desi Annual Probabilit Importance Leve Safe Foundation	ty of Exceedar I (BCA):	nce for Earthquak	f AS 117 e Action	ns (BCA Table Hazard Fac	e 1.2b): 1 in ctor, Z (Section 3):	Class of Sub-Soil (Section 4): — to be confirmed prior to construction.		
COMMENTS	/ EXCLUSI	ONS (Exclusion	ons to	this Certifica	ate must be clearly identified	i).		
The following iter	ms are exclude	ed and shall be o	ertified s	separately:				
-								
Comments:								
- This cert	tification is bas	sed on the existin	g constr	ruction being	fully certified.			

	CERTIFICATION BY	STRUCTURAL ENGINEE	<u>ER</u>				
Company Name Rodeghiero Fong & Partners trading as Wallbridge and Gi	•	Company NT Registre	Company NT Registration Number 43460ES				
We certify that reasonable car been designed in accordance v	re has been taken to ensure that the with the requirements of the Building	ne structural engineering aspect	ts of the works as described above have hern Territory Building Regulations.				
Name (print clearly)	Individual NT Registration Number	Signature	Date				
Adam James	26968ES	new /	09.10.2013				



SCHEDULE OF STRUCTURAL INSPECTIONS REQUIRED (Shown by 🗵)						
Inspection of construction is required at all stages indicated below.						
1. Completion of site preparation/site filling/excavations for footings prior to placement of any reinforcement or concrete.						
2. Completion of preparations for placing of concrete strip footings including placement of reinforcement.						
3. Completion of preparations for placing concrete slabs including compaction of fill and sand blinding, placement of formwork, reinforcement, starter bars and cast in items.						
4. Completion of preparations for placing of concrete pier footings including reinforcement (if any).						
5. Starter bars and cast in items after placing of concrete and prior to any covering up work.						
6. Reinforcement to walls completed prior to core filling (inspection holes and cleanout cores to be completed).						
7. Structural steelwork and cold formed steelwork completed and prior to any covering up work. Floor framing system completed before floors and laid or underside is lined.						
8. Suspended concrete floor slabs with formwork, reinforcement and cast in items completed, prior to placing of concrete.						
9. Wall framing or blockwork wall core filling completed (with windows fixed in place) and roof framing with connections completed and prior to sheeting or lining.						
Note: Prior lodgement of truss manufacturer's drawings, details and certification required. Prior lodgement of windows manufacturer's drawings including fixings and certification required.						
10. Structural wall linings completed and prior to any covering up work.						
11. Final inspection upon completion of all structural work including fixings of external roof and wall claddings, flashings, barges & vents.						
☐ 12. Other Inspections as required by the building permit						

Important Information:

- 1) The above inspections are required to be carried out by either the certifying engineer or the building certifier who issued the building permit for the work. (If no inspections are indicated refer to the certifying engineer for advice).
- 2) Where works are prescribed building works under the NT Building Act, the building certifier must be provided with a copy of the inspection record and no further works must be carried out by the builder until the building certifier issues a release to proceed with further works.
- Additional non structural inspections may be required during the course of construction before the issue of a Permit to Occupy (refer to building certifier for requirements).
- 4) Failure to obtain inspections may prevent the issue of a Permit to Occupy upon completion of the building works.

E-mail: engineering@apricus.com.au for associated data sheets.



8.5 Mounting Frame Configurations

8.5.1 10 Tube Flush Mount

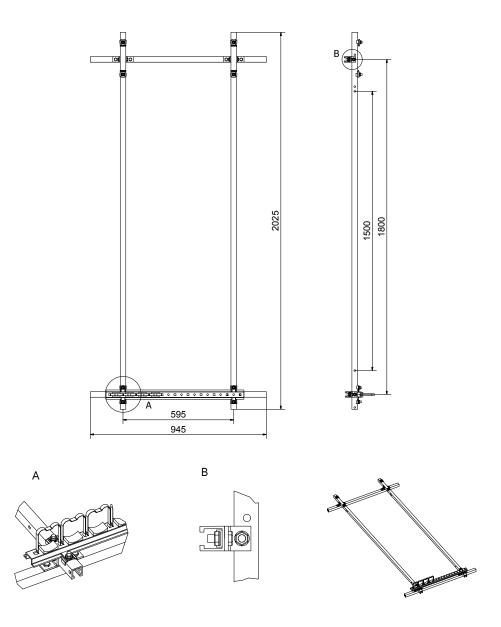


Table 13. 10 Tube Flush Mount Components

Frame Component	Qty (10 Tube - 2 Track)
10 Roof Rail	2
AL-L Bracket	8
Top Attachment Plate	4
AL-Front Track	2
Clip Fastener	10
Tube Clip	10
AL-Bottom Track	1
Bottom Attachment Plate	4



8.5.2 10 Tube Tilt Mount

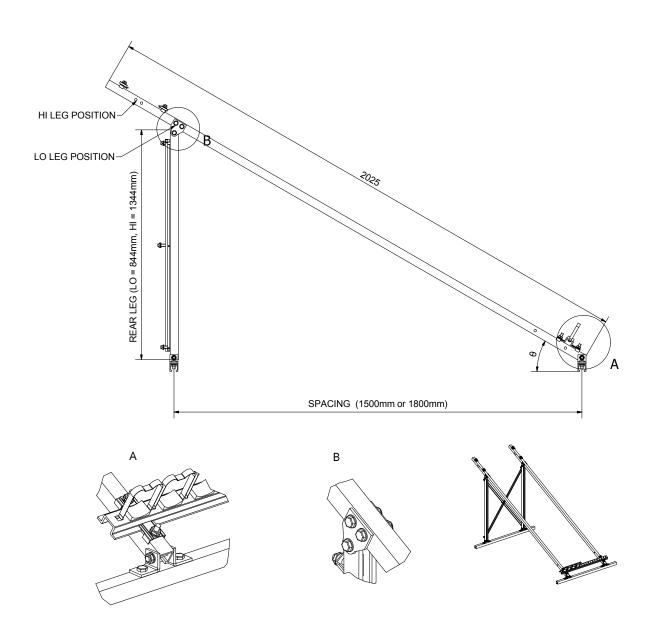


Table 14. 10 Tube Tilt Mount Components

Frame Component	Qty (10 Tube - 2 Track)
10 Roof Rail	2
AL-L Bracket	8
30° or 45° Rear Leg	2
AL-Rear X Brace	2
Top Attachment Plate	4
AL Tri-Plate	4
AL-Front Track	2
AL-Bottom Track	1
Clip Fastener	10
Tube Clip	10
Bottom Attachment Plate	4



8.5.3 20/22 Tube Flush Mount

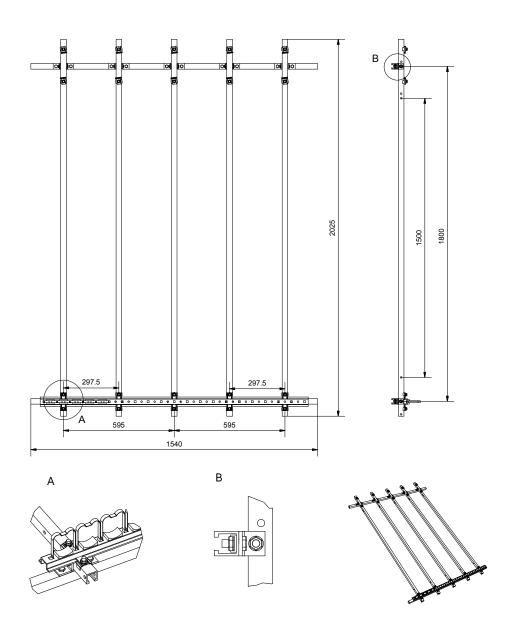


Table 15. 20/22 Tube Flush Mount Components

Frame Component	Qty (20 Tube - 3 Track)	Qty (22 Tube - 3 Track)	Qty (20 Tube - 5 Track)	Qty (22 Tube - 5 Track)
20/22 Roof Rail	2	2	2	2
AL-L Bracket	12	12	20	20
Top Attachment Plate	6	6	10	10
AL-Front Track	3	3	5	5
Clip Fastener	20	22	20	22
Tube Clip	20	22	20	22
AL-Bottom Track	1	1	1	1
Bottom Attachment Plate	6	6	10	10



8.5.4 20/22 Tube Tilt Mount

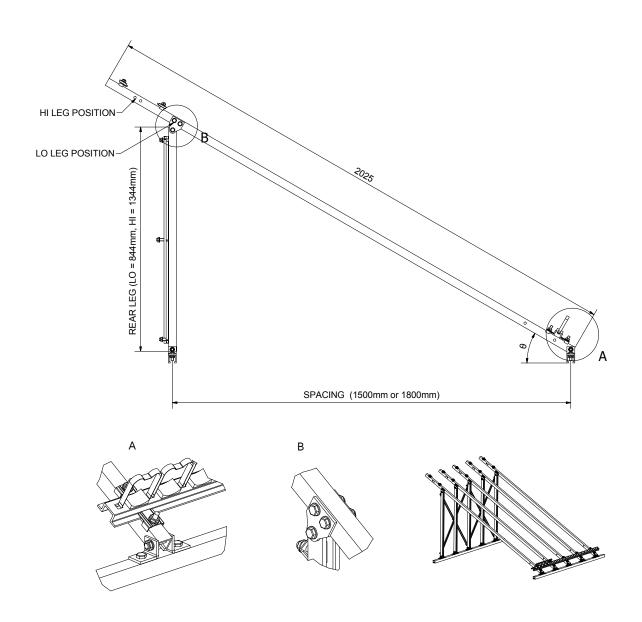


Table 16. 20/22 Tube Tilt Mount Components

Frame Component	Qty (20 Tube - 3 Track)	Qty (22 Tube - 3 Track)	Qty (20 Tube - 5 Track)	Qty (22 Tube - 5 Track)
20/22 Roof Rail	2	2	2	2
AL-L Bracket	12	12	20	20
30° or 45° Rear Leg	3	3	5	5
AL-Rear X Brace	4	4	4	4
Top Attachment Plate	6	6	10	10
AL Tri-Plate	6	6	10	10
AL-Front Track	3	3	5	5
AL-Bottom Track	1	1	1	1
Clip Fastener	20	22	20	22
Tube Clip	20	22	20	22
Bottom Attachment Plate	6	6	10	10



8.5.5 30 Tube Flush Mount

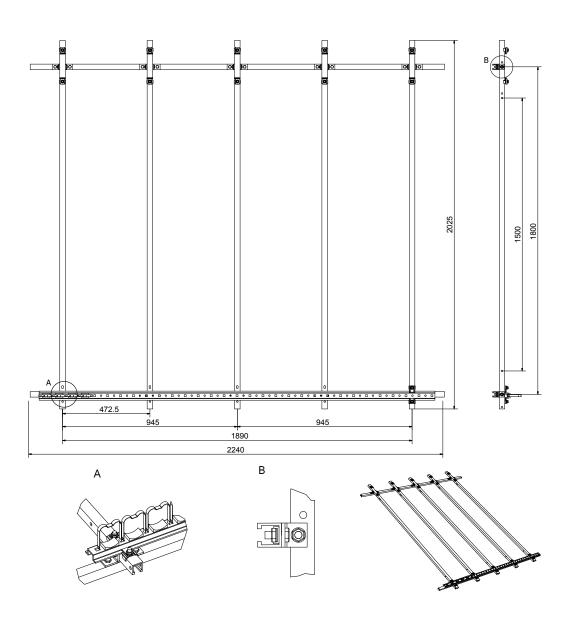


Table 17. 30 Tube Flush Mount Components

Frame Component	Qty (30 Tube - 3 Track)	Qty (30 Tube - 5 Track)
30 Roof Rail	2	2
AL-L Bracket	12	20
Top Attachment Plate	6	10
AL-Front Track	3	5
Clip Fastener	30	30
Tube Clip	30	30
AL-Bottom Track	1	1
Bottom Attachment Plate	6	10



8.5.6 30 Tube Tilt Mount

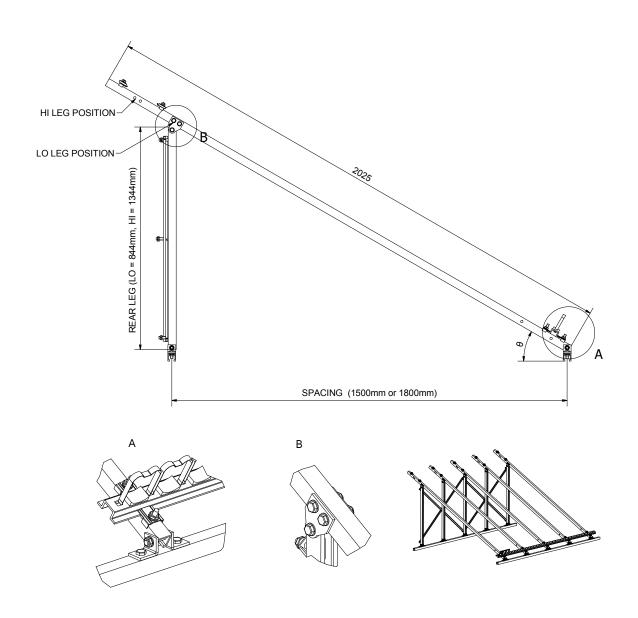


Table 18. 30 Tube Tilt Mount Components

Frame Component	Qty (30 Tube - 3 Track)	Qty (30 Tube - 5 Track)
30 Roof Rail	2	2
AL-L Bracket	12	20
30° or 45° Rear Leg	3	5
AL-Rear X Brace	4	4
Top Attachment Plate	6	10
AL Tri-Plate	6	10
AL-Front Track	3	5
AL-Bottom Track	1	1
Clip Fastener	30	30
Tube Clip	30	30
Bottom Attachment Plate	6	10



8.6 Apricus Component Information

8.6.1 Glass Lined Storage Tank Specifications

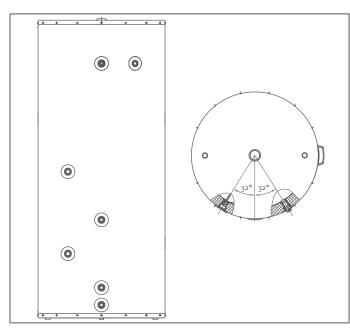


Figure 30. Glass lined tank layout

Table 19. Glass lined tank specifications

Model	250 L	315 L	400 L	
Rated Capacity (L)	250	315	400	
Physical Volume (L)	274	343	445	
Dry weight	84	102	150	
Port Size		3/4"		
Max. Thermostat Setting	75°C			
Dead Band	8°C			
Element Rating	3.6 kW			
Cylinder Warranty	10 Years			
Safety Valve Setting	850 kPa			
Max. Supply pressure	600 kPa			
Anode Material	Magnesium			
Construction Material	Vi	treous Enam	iel	

Table 20. Glass lined electric tank dimensions

Measurements (mm)	250L BOT	250L MID	315L BOT	315L MID	400L BOT	400L MID
Diameter	648	648	648	648	731	731
Height	1388	1388	1682	1682	1731	1731
HW outlet	1167	1167	1470	1470	1474	1474
PTRV port	1167	1167	1470	1470	1474	1474
Top sensor	759	759	841	841	841	841
Solar return	564	432	564	509	564	564
Bottom sensor	369	303	369	342	369	369
Solar Flow	174	174	174	174	174	174
Cold Water Inlet	74	74	74	74	74	74
Element Height	170	454	170	553	190	691

Table 21. Glass lined gas tank dimensions

Measurements (mm)	250L GAS	315L GAS	400L GAS
Diameter	648	648	731
Height	1388	1682	1731
HW outlet	1167	1470	1474
PTRV port	1167	1470	1474
Top sensor	759	841	841
Solar return	564	564	564
Bottom sensor	369	369	369
Solar Flow	174	174	174
Cold Water Inlet	74	74	74



8.6.2 Stainless Steel Storage Tank Specifications

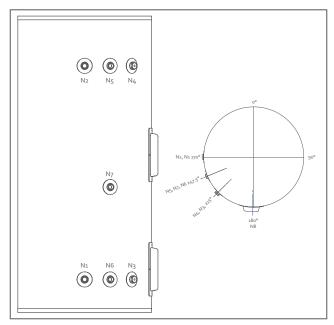


Figure 31. Stainless steel tank layout

Table 22. Stainless steel tank specifications

Model	250 L	315 L	400 L	
Rated Capacity (L)	250	315	400	
Physical Volume (L)	275	358	420	
Dry weight	60	75	87	
Port Size		3/4"		
Max. Thermostat Setting	80°C			
Dead Band	8°C			
Element Rating	3.6 kW			
Cylinder Warranty	15 Years			
Safety Valve Setting	850 kPa			
Max. Supply pressure	550 kPa			
Anode Material	N/A			
Construction Material	Stainless 316 (2mm)			

Table 23. Stainless steel electric tank dimensions

Measurements (mm)	250L BOT	250L MID	315L BOT	315L MID	400L BOT	400L MID
Diameter	700	700	700	700	700	700
Height	1232	1232	1551	1551	1832	1832
HW outlet	972	972	1291	1291	1543	1543
PTRV port	972	972	1291	1291	1543	1543
Top sensor	972	972	1291	1291	1543	1543
Solar return	399	449	519	656	629	629
Bottom sensor	172	172	172	172	163	163
Solar Flow	172	172	172	172	163	163
Cold Water Inlet	172	172	172	172	163	163
Element Height	412	642	535	752	649	786

Table 24. Stainless steel gas tank dimensions

Measurements (mm)	250L GAS	315L GAS	400L GAS
Diameter	700	700	700
Height	1232	1551	1832
HW outlet	972	1291	1543
PTRV port	972	1291	1543
Top sensor port	972	1291	1543
Solar return port	449	656	629
Bottom sensor	172	172	163
Solar flow	172	172	163
Cold water inlet	172	172	163



8.6.3 Apricus Pump Station Dimensions

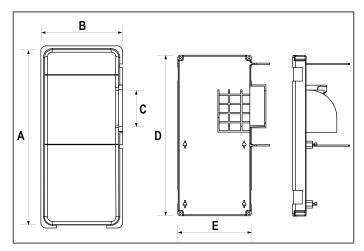


Figure 32. Pump station cover layout

Table 25. Pump station dimensions

Measurements	Label	mm
Lid Height	Α	398
Lid Width	В	178
Lid	С	96
Base Plate Height	D	350
Base Plate Width	E	160

8.6.4 Apricus Gas Booster Dimensions

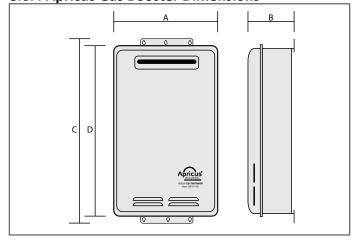


Figure 33. Gas booster layout

Table 26. Gas booster dimensions

Measurements (mm)	Label	20L/min	26L/min	32L/min
Width	Α	350	350	470
Depth	В	194	180	244
Height - Inc. Brackets	С	571	623	644
Height - Unit	D	530	575	600

8.6.5 Collector Technical Specifications:

Technical data on Apricus solar collector construction, performance and physical specifications.

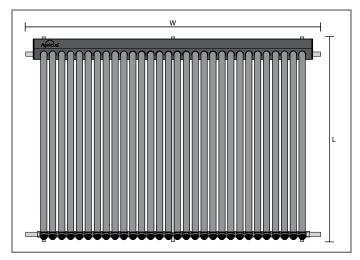


Figure 34. Collector layout

Table 27. Collector dimensions

Measurements		Dry Weight		
Collector	Width	Length	WO/Tubes	W/Tubes
10 Tube	945 mm	2025 mm	11 kg	40 kg
20 Tube	1540 mm	2025 mm	18 kg	77 kg
22 Tube	1636 mm	2025 mm	20 kg	85 kg
30 Tube	2240 mm	2025 mm	24 kg	112 kg

Note: Dry weights based on 3 track flush mount frame.



Table 28. Apricus AP-10 Collector Specifications



Materials of Co	Materials of Construction			
Evacuated tubes:	1.8mm Borosilicate 3.3 glass			
Absorber:	AI-N on AI on glass			
Heat pipes:	High purity copper			
Heat transfer fins:	Aluminium			
Rubber components:	HTV Silicone rubber			
Stainless mounting frame:	439 Stainless steel			
Aluminium mounting frame:	6005-T5 Anodised AL			
Manifold casing:	5005-H16 Anodised AL			
Performan	ce Data:			
Ideal flow rate:	<1 L/min			
Max flow rate:	15 L/min			
Peak power output:	648W *			
Eta0:	0.687 *			
a1 (W/m²K):	1.505 *			
a2 (W/m²K):	0.0111 *			
*Data from ITW report 09COL805. Calculated at midday.				
Dhysical Specifications				

Physical Specifications		
Aperture area:	0.94m²	
Gross area:	1.57m ²	
Gross dry weight:	34.8kg	
Fluid capacity:	500ml	
Max pressure:	800kPa	
Stagnation temperature:	220°C	

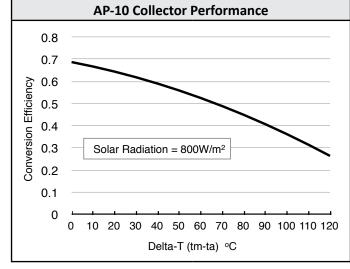


Table 29. Apricus AP-20 Collector Specifications



	**		
Materials of Construction			
Evacuated tubes:	1.8mm Borosilicate 3.3 glass		
Absorber:	AI-N on AI on glass		
Heat pipes:	High purity copper		
Heat transfer fins:	Aluminium		
Rubber components:	HTV Silicone rubber		
Stainless mounting frame:	439 Stainless steel		
Aluminium mounting frame:	6005-T5 Anodised AL		
Manifold casing:	5005-H16 Anodised AL		
Performan	ce Data:		
Ideal flow rate:	<1.5 L/min		
Max flow rate:	15 L/min		
Peak power output:	1296W *		
Eta0:	0.687 *		
a1 (W/m²K):	1.505 *		
a2 (W/m²K):	0.0111 *		
* Data from ITW report 09COL805. Calculated at midday			
Physical Specifications			
Aperture area:	1.88m²		
Gross area:	3m²		
Gross dry weight:	63.5kg		

Stagnation temperature: 220°C **AP-20 Collector Performance** 8.0 0.7 0.6 Conversion Efficiency 0.5 0.4 0.3 Solar Radiation = 800W/m² 0.2 0.1 0 10 20 30 40 50 60 70 80 90 100 110 120 Delta-T (tm-ta) °C

500ml

800kPa

Fluid capacity:

Max pressure:



Table 30. Apricus AP-22 Collector Specifications



The second second			
Materials of Construction			
Evacuated tubes:	1.8mm Borosilicate 3.3 glass		
Absorber:	AI-N on AI on glass		
Heat pipes:	High purity copper		
Heat transfer fins:	Aluminium		
Rubber components:	HTV Silicone rubber		
Stainless mounting frame:	439 Stainless steel		
Aluminium mounting frame:	6005-T5 Anodised AL		
Manifold casing:	5005-H16 Anodised AL		
Performance Data:			
Ideal flow rate:	<1.5 L/min		
Max flow rate:	15 L/min		
Peak power output:	1422W *		
Eta0:	0.687 *		
a1 (W/m²K):	1.505 *		

* Data from ITW report 09COL805. Cal	culated at midday
--------------------------------------	-------------------

0.0111 *

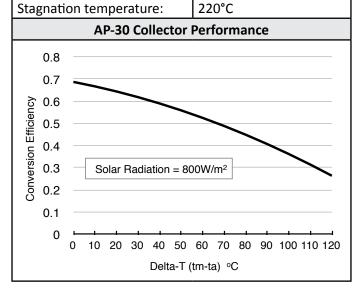
Physical Specifications			
Aperture area:	2.07m ²		
Gross area:	3.28m ²		
Gross dry weight:	71.3kg		
Fluid capacity:	550ml		
Max pressure:	800kPa		
Stagnation temperature:	220°C		

AP-22 Collector Performance			
0.8			
0.7			
වු 0.6			
Conversion Efficiency 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0			
0.4			
0.3	Solar Radiation = 800W/m ²		
§ 0.2			
0.1			
0	0 10 20 30 40 50 60 70 80 90 100 110 120		
	Delta-T (tm-ta) °C		

Table 31. Apricus AP-30 Collector Specifications



Materials of Construction			
Evacuated tubes:	1.8mm Borosilicate 3.3 glass		
Absorber:	AI-N on AI on glass		
Heat pipes:	High purity copper		
Heat transfer fins:	Aluminium		
Rubber components:	HTV Silicone rubber		
Stainless mounting frame:	439 Stainless steel		
Aluminium mounting frame:	6005-T5 Anodised AL		
Manifold casing:	5005-H16 Anodised AL		
Performance Data:			
Ideal flow rate:	2 L/min		
Max flow rate:	15 L/min		
Peak power output:	1944W *		
Eta0:	0.687 *		
a1 (W/m²K):	1.505 *		
a2 (W/m²K):	0.0111 *		
* Data from ITW report 09COL805. Calculated at midday			
Physical Specifications			
Aperture area:	2.83m ²		
Gross area:	4.4m ²		
Gross dry weight:	95kg		
Fluid capacity:	710ml		



800kPa

Max pressure:

a2 (W/m²K):



8.7 Apricus Warranty Information

Visit www.apricus.com.au for the most up-to-date version of the Apricus Warranty Policy.

For all warranty service requests or issues, please call Apricus Australia on 1300 277 428 or email warranty@apricus.com.au





Thank You For Choosing Apricus Australia

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