



# Apricus Solar Hot Water Owner's Operating and Maintenance Manual

For Commercial Hot Water Systems

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Installation Manual for CHW Systems: MAN\_OWNER\_CHW(AA) | 1

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# CHAPTER 1: INTRODUCTION

## TERMINOLOGY

- Bank: Multiple collectors in series (one after the other).
- 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): Government body responsible for overseeing the implementation of the Large-scale Renewable Energy Target (LRET) and the Small-scale Renewable Energy Scheme (SRES).
- Collector: The Apricus solar collector includes the manifold with heat pipes and evacuated tubes inserted.
- Expansion Control Valve (ECV): Installed on the cold mains line to relieve excess pressure.
- Expansion Tank: Fitting an Expansion Tank to the system allows the water to move into the expansion tank and occupy its volume, rather than increasing the system pressure. This reduces the wastage of water through the PTRV and protects the system from high pressures and undue wear.
- Evacuated Tube: functions to harness the solar energy by capturing and retaining the heat due to the presence of the vacuum.
- Flow Line: The plumbing line running from tank solar flow port to the inlet of the collector. This line incorporates the circulation pump.
- 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.
- Header Pipes: The copper “heat exchanger pipes” in the manifold of the Apricus collector through which the water flows.
- Insolation: solar radiation level, expressed in kWh/m<sup>2</sup>/day.
- Manifold: Refers to the solar collector enclosure that contains the header pipes.
- Pressure Temperature Relief Valve (PTRV): installed on the hot water storage tank to relieve pressure, and excessive temperatures.
- Return Line: The plumbing line running from the solar collector to the solar return port on the tank.
- Stagnation: Stagnation is the maximum temperature a collector will reach, at which point the rate of heat gain and rate of heat loss is balanced.
- 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.

## UNDERSTANDING WATER HEATING

Before explaining the operation of your Apricus solar commercial hot water (CHW) system, it is important for you to understand how water heating works.

When you open a hot water tap, water pressure forces hot water out of the storage tank. When this happens cold water is actually entering the bottom of the hot water storage tank, gradually allowing the hot water in the tank to be pulled up and out.

The water is separated into hot and cold layers, this is primarily due to the fact that heat rises. See Figure 1. This is referred to as stratification and is very important as it allows us to use nearly all of the hot water available in the tank. You can experience this when having a shower when the water suddenly turns cold, this occurs when all of the hot water has been drawn out.

In order to prevent scalding due to excessively hot water, a tempering valve may be necessary depending on the commercial solar hot water application. This is an important safety device, as it limits the water supplied to the hot water taps to be no more than 50°C. Although this temperature is quite hot, it will not cause burns. Hot water leaves the storage tank and passes through the tempering valve which brings the temperature down to 50°C by mixing with cold water. At the shower most people will then cool it down further by mixing with more cold water.

It is possible to draw off the hot water before being tempered to specific fixtures such as kitchen dishwashers that may require high temperature water.

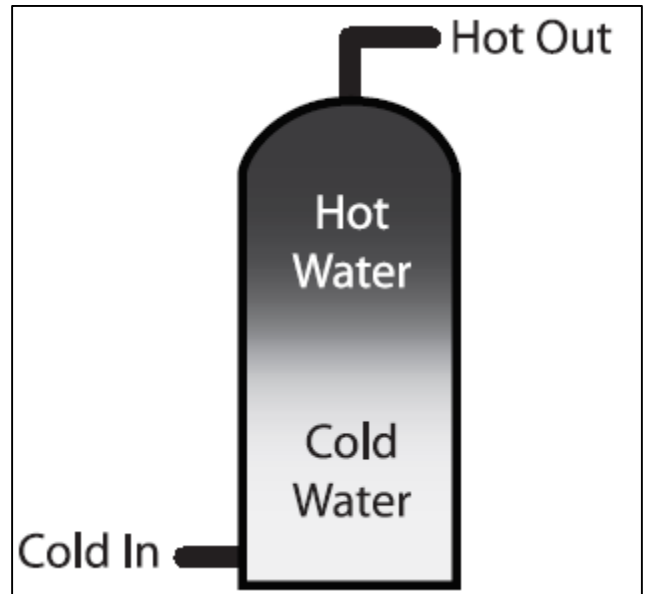


Figure 1 Diagram showing the stratification of hot and cold water within a storage tank.

## HOW SOLAR WATER HEATING WORKS

Apricus solar water heating is done by using a solar collector, which is a thermal solar heating device. By gaining a basic understanding of your solar CHW system you can develop realistic expectations about the operation of the system, develop habits which maximize energy savings and most importantly, ensure safe and reliable operation.

An Apricus solar CHW system, captures solar energy directly and converts it to heat for use in your home.

1. The evacuated tubes ensure maximum absorption of 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 (head of collector) which contains a copper heat exchanger.
3. A controller measures the temperature of the water in the manifold and compares it to that 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.

## THE EVACUATED TUBE

1. Sunlight strikes the dark absorber coating inside the evacuated tube.
2. The heat pipe transfers the heat up to the copper header pipe location in the insulated manifold box.
3. The vacuum in the tube acts the same as a thermos flask, keeping the heat inside and ensuring it is delivered to the water, not lost to the air. Though the glass may be cool to the touch, inside, the system may be reaching temperatures up to 100.

Refer to Figure 2.

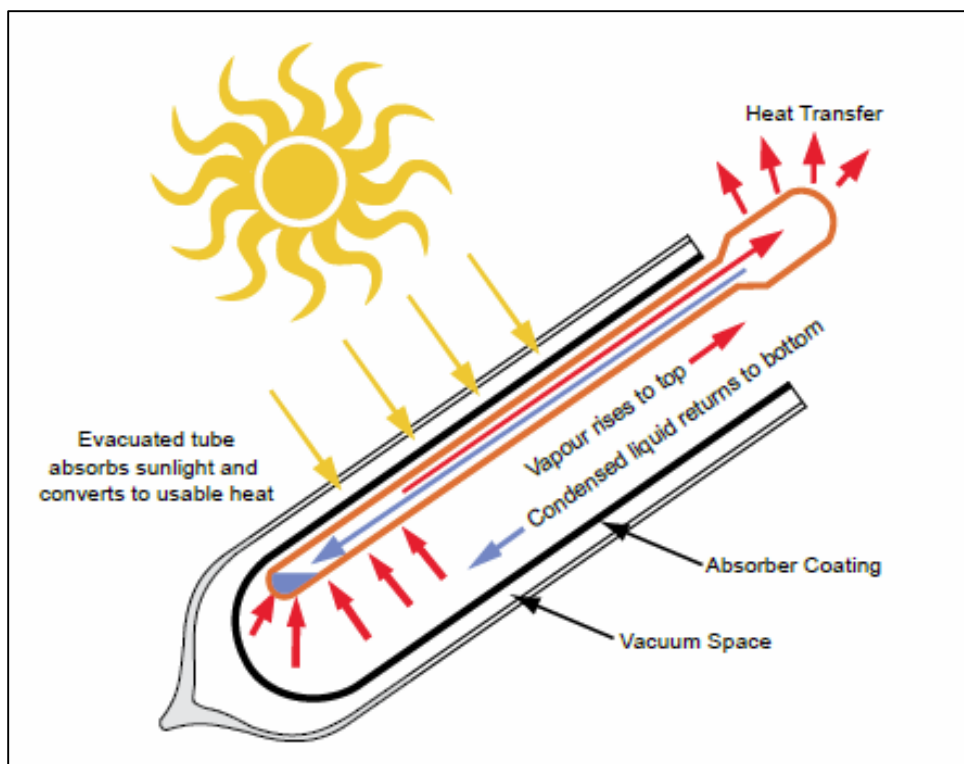


Figure 2 Evacuated Tube Function

## SYSTEM PERFORMANCE

The solar CHW system will begin acting immediately after installation to reduce your energy costs. System performance is dependent on the available sunlight that falls directly onto the collector. This means that during the months of winter when the sun is in the sky for fewer hours the solar contribution will fall. Conversely, the performance of the solar CHW system will increase significantly during summer to off-set the greater majority of your hot water usages all year round.

## UNDERSTANDING SOLAR CONTRIBUTION

Some solar CHW system owners make the mistake of thinking that once they install a system, they can turn their elements or gas boosters off whenever there is sunlight. This is incorrect for two reasons.

Firstly it is a requirement to heat the water on a regular basis to kill Legionella bacteria, see specific heating requirements in Chapter 3: System Operation. Secondly, solar radiation is only half or one third as strong in the winter months compared to summer, and therefore is not able to provide the same amount of hot water as in the summer.

## CHAPTER 2: SYSTEM COMPONENTS

The main system components that are a part of the electric and gas solar CHW systems are depicted and tabulated in Figure 3 and Table 1, and Figure 4 and Table 2, respectively.

### TYPICAL ELECTRIC BOOSTED SYSTEM

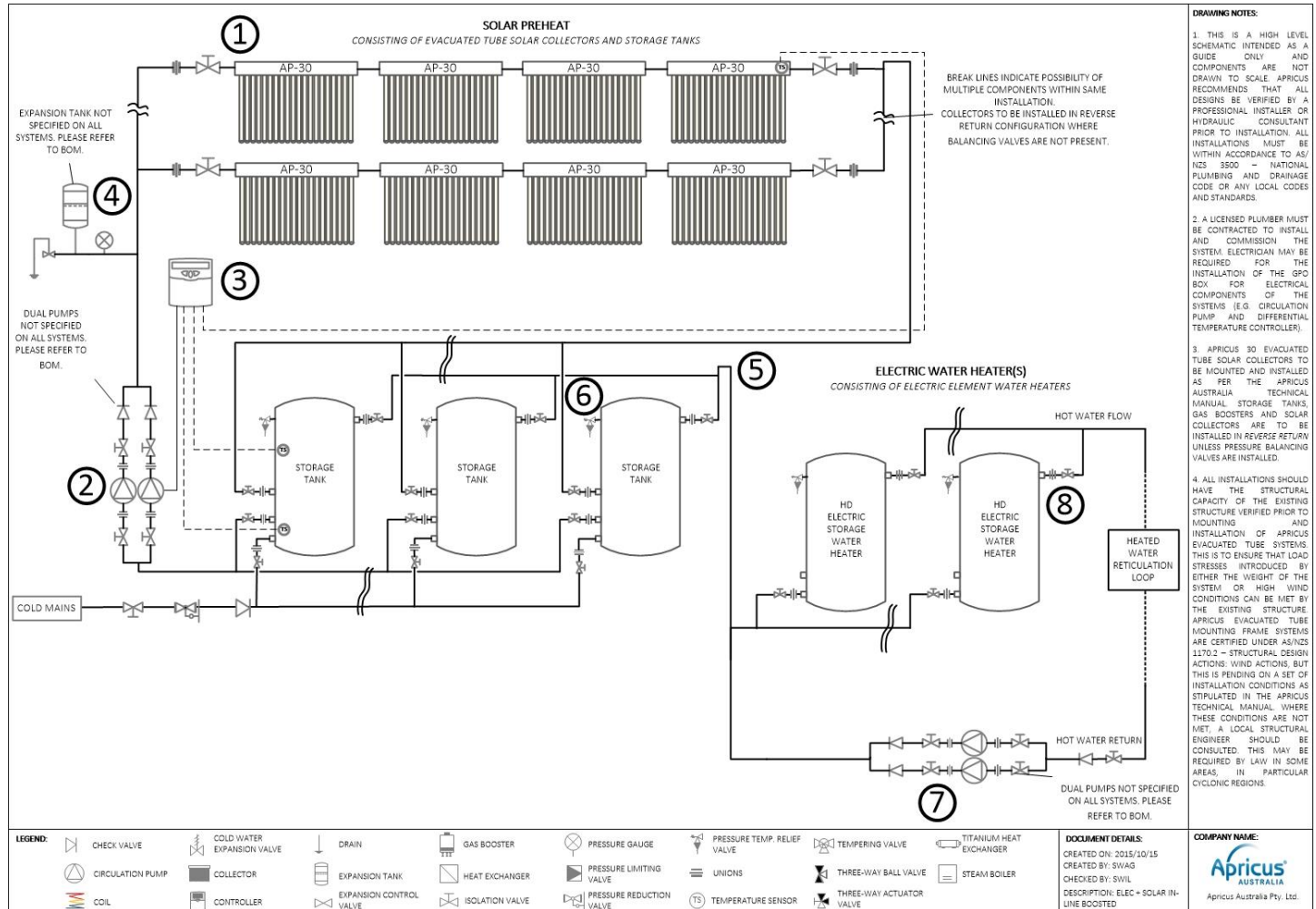


Figure 3 Typical Electric boosted solar CHW system.

Note that an alternative system design to that displayed in Figure 3 can involve solar collectors feeding directly into the electric storage water heater tanks that feed into the heated water reticulation loop.

The design from Figure 3 works by allowing as much solar contribution to be added into the solar storage tanks as possible. When water is being used within the heated water reticulation loop (which if you can imagine, denotes hot water fixtures being in use) and when the HD electric tank hot water is being used up, the solar preheated water from solar storage tanks start re-filling the HD electric tanks, such that the electric elements can boost the water temperature up to the set temperature (e.g. 65°C). The electric water heaters end up using less energy than they would if there was no solar preheated water filling the tanks.

Table 1 Components that make up a typical Electric boosted solar hot water system.

No.	Component	Function
1	Evacuated tube collector(s)	Solar energy collection
2	Circulation Pump(s)	Circulates water from the solar storage tank(s) to the collectors(s)
3	Controller	Monitors temperatures and controls the system
4	Expansion Tank(s)	Allows the system to “breathe” when pressure increases in the system (Optional)
5	Solar Storage Tank(s)	Stores solar hot water
6	PTRV	Pressure Temperature Relief Valve
7	Ring Main Pump(s)	Recirculates water back from the ring main into the auxiliary heater.
8	Heavy duty (HD) electric storage water heater(s)	Provides the auxiliary backup energy source for cloudy days and legionella protection.

## TYPICAL GAS BOOSTED SYSTEM

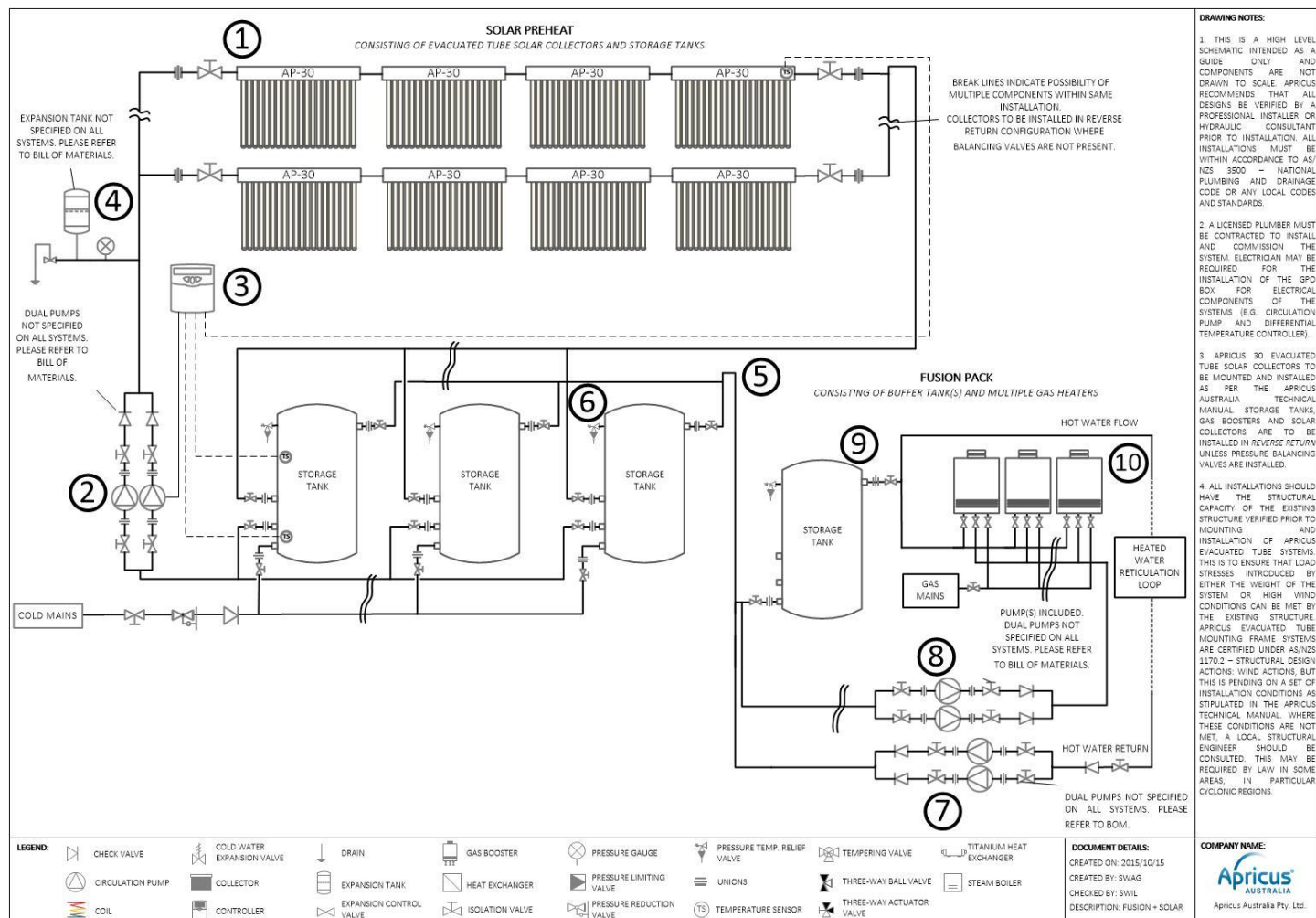


Figure 4 Typical Gas boosted solar CHW system.

Note that an alternative system design to that displayed in Figure 4 can involve solar collectors feeding into the solar storage tanks, with gas heater(s) set up in-line (i.e. no buffer tanks set up in recirculation with gas heaters), and allowing hot water to be fed directly into the heated water reticulation loop.

The design from Figure 4 works by allowing as much solar contribution to be added into the solar storage tanks as possible, and when water is being used within the heated water reticulation loop and when the tank hot water is being used up, the gas recirculation pumps switch on to draw solar preheated water from solar storage tanks, and feeds that into the gas heaters. Solar preheated water that is fed into gas heaters now is fed directly to the load.

Consider the other scenario where no hot water is being used within the reticulation loop, but the buffer tank falls below a certain temperature, so the gas recirculation pumps switch on to pull cold water from bottom of the tank into the gas heaters, which feed this back into the tank until it is sufficiently heated.



Table 2 Components that make up a typical Gas boosted solar hot water system.

No.	Component	Function
1	Evacuated tube collector(s)	Solar energy collection
2	Circulation Pump(s)	Circulates water from the tank to the manifold
3	Controller	Monitors temperatures and controls the system
4	Expansion Tank(s)	Allows the system to “breathe” when pressure increases in the system (Optional)
5	Solar Storage Tank(s)	Stores solar hot water
6	PTRV on each tank	Pressure Temperature Relief Valve
7	Ring Main Pump(s)	Recirculates water back from the ring main into the auxiliary heater.
8	Gas Recirculation Pump(s)	Circulates water from the inlet of the buffer tank into the auxiliary heater.
9	Buffer tank(s)	Provides storage to increase the first hour delivery litres.
10	Gas Heater(s)	Provides a backup energy source for cloudy days and legionella protection

## CHAPTER 3: SYSTEM OPERATION

### PUMP OPERATION

The Apricus solar CHW system involves a solar circulation pump that is generally installed beside the tank. The pump may be a three-speed pump or may be an auto-adapting pump that finds optimum setting and continues to adjust its operation to changes in demand. In either case, the pump turns on and off at varying intervals that are determined by the controller and its temperature sensors. When the temperature difference between the tank and the collector are at just the right temperatures the pump will extract the optimum amount of energy from the collectors and transfer it into the solar storage tanks.

On cold nights the circulation pump may turn on to cycle water from the hot water tank into the collector to prevent the components on your roof from freezing.

### AUXILIARY BOOSTING OPERATION

The auxiliary heating boost acts as a back up to ensure you always have hot water ready to go, so even when there is intermittency with sunlight, the solar CHW system is still able to meet the commercial application's hot water needs. Secondly, it provides protection against the growth of legionella bacteria that can lead to legionnaire's disease. The temperature requirements and frequencies of heating required are in Table 3 below.

*Table 3 Minimum heating requirements of different system types.*

Type of Apricus solar CHW installed	Minimum heating requirements
Electric boosted system	Once per week to 60°C for 32 minutes
Gas boosted system	Minimum 55°C each time water is used

### ELECTRIC ELEMENTS

Electric element tanks have an element inside them located near either the bottom, or the middle of the tank. Generally with electric HD water heaters that contain multiple elements, these are located near the bottom of the tank. Elements operates just like a stand-alone electric hot water heater, only the amount of work is reduced due to the solar input from your collectors.

Electric elements have a safety energy cut-out device that will operate to turn the element(s) off in the event of failure of the normal temperature control device before hot water is discharged from the Pressure Temperature Relief Valve (PTRV) as a result of the water temperature exceeding the temperature setting of the safety devices.

### GAS BOOSTERS

Gas boosters are typically located either in-line with the solar storage tanks or in recirculation with buffer tank(s). For a typical 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 load. Under normal operations the gas booster may fire-up on the first instance because there may be cold water in the pipes between the storage tank and itself.

## CHAPTER 4: IMPORTANT FEATURES & CHARACTERISTICS

### **PTRV**

A PTRV is installed on all hot water storage tanks including electric storage tanks, to relieve pressure and excessive temperatures in the system. The PTRV discharges 3-6% of the water heaters capacity during normal heating cycles with a hot water system.

### **EXPANSION CONTROL VALVE (ECV)**

An ECV is recommended to be installed, it is located on the cold water mains line to relieve pressure within the system. The ECV may discharge a small quantity of cold water rather than the PTRV discharging hot water from the tank. This conserves hot water within the hot water or electric storage tanks, as the discharged water from the ECV is much cooler than the PTRV.

### **SYSTEM FROST PROTECTION**

The controller has a safety mechanism that operates the solar circulation pump when the temperature in the collector falls below 4°C. Cycling water from the tank increases the temperature of the collectors to prevent the water in the collectors from freezing.

### **HOLIDAY MODE**

If the commercial application is shut down for a long period of time, the solar CHW system is capable of protecting itself with the existing safety devices (i.e. ECV, PTRV, Frost Protection mechanism). It is recommended that power to all components remains on.

### **SHUT DOWN MODE**

During the months of summer you may experience days of hot weather and the solar CHW system may have the potential to generate more hot water than the hot water fixtures application would be using. When this is the case, the controller will detect that your solar storage tanks are full of hot water and request the system to shut down. During these times the circulation pump will be inactive until you use a substantial amount of hot water from the storage tank.

## CHAPTER 5: TROUBLESHOOTING

You may encounter abnormal characteristics with your solar CHW system and would like to understand the issue before calling your local plumber/installer.

### PTRV

The PTRV relieves 3-6% of the water heaters capacity during normal heating cycles with a hot water system. If the storage tank is discharging more than a bucket full of water in 24 hours, it may be due to the incoming water pressure being too high. Request for your plumber/installer to fit a pressure limiting valve.

There could be some debris or thread seal tape trapped in the valve mechanism. You can try lifting the valve gently and try to dislodge anything that could be causing that valve not to be re-seating properly. Please refer to Maintenance Procedures provided in Chapter 6: System Maintenance.

### THERE IS NOT ENOUGH HOT WATER

Solar collectors work based on weather, when the sun is not shining as bright in the sky the solar CHW system will require the auxiliary heater(s) to operate to provide the hot water (ensure that this is functioning correctly). Installing a solar CHW system doesn't mean you get more hot water; it harnesses the sun's energy to offset the load from your conventional heat source (electricity/gas) as much as possible.

The commercial application may be using more hot water than they may realise. Look more closely into how the commercial loads are being used as the solar CHW system design needs to match the hot water daily loads and peak hourly loads of the application. Adjusting the hot water usage patterns at the commercial application to maximize the energy that the system can generate during the day will benefit energy bills.

### CIRCULATION PUMP

Table 4 Circulation pump related issues

Symptom	Potential Cause	Solution
Pump is not operating even during sunny weather.	Storage tanks are already full of hot water.	This is normal operation. Controller switches pump off once maximum temperature is reached to prevent over-heating.
	Collectors are at a very high temperature.	This is normal operation. Pump will not circulate until the collector temperature is safe.
	Controller/pump power is OFF.	Connect power to controller/pump.
Pump appears to be running but collectors not cooling down.	Air lock in system	Ensure system pressure is 2-6 bar. Drain and refill the system.
	Flow rate is too small. Pump is undersized for given pipe length.	Solar pumps are sized suitably for the pipe length that is prescribed by the client. May require a larger pump to get higher flow rates.
Pump is running overnight.	Frost protection is operating.	This is normal operation. Pump will be activated to circulate tank water to the collectors to prevent collectors from freezing.
	System reverse thermos-siphoning.	Check with the plumber that a U-shaped heat trap on the solar return line piping has been made and if it has not then it is advised to have a non-return valve on the solar return line installed.

## CONTROLLER

The controller provides indicators that can assist you in understanding what the system is doing. Refer to Table 5 below for symbols that may appear on the controller display related to Chapter 6: Solving Problems.

Do not change any controller default settings.

Table 5 Apricus BS4/V2 Controller Troubleshooting Symbols





BS4/V2 Symbols	Description	Action required?
	Maximum store temperature exceeded: TST Bottom tank temperature will read 75°C. Pump will not be active until hot water is drawn or tank cools down.	Normal operation.
 (flashing)	Collector emergency shutdown active: COL will read $\geq 110^{\circ}\text{C}$ . Pump will not be active until collector cools down.	Normal operation.
 (flashing)	Frost protection is operating. Pump will be activated to circulate tank water to the collector to prevent collectors from freezing.	Normal operation.
 (flashing)	Sensor defect: 888.8 indicates the fault is a broken cable, -88.8 indicates that there is a short circuit.	Contact Apricus Aftersales Team.
Display off	Controller may be in standby, press main circular button to see if display illuminates. Controller power may be off.	Connect power supply to controller if it is off. Call Apricus Aftersales Team if still not on.

Table 6 MX Controller Troubleshooting

MX Error Codes	Indication	Monitoring function	Error Cause	Action required?
0001	!Sensor fault!	Sensor cable broken	Sensor cable broken	Contact Apricus Aftersales Team.
0002	!Sensor fault!	Sensor cable short-circuited	Sensor cable short-circuited	Contact Apricus Aftersales Team.
0011	!ΔT too high!	ΔT too high	Collector $50^{\circ}\text{C}$ > than store to be Loaded for 20 minutes or more. System will not be shut down. Possible causes are pump power too weak, blocked system components, faulty flow through collector field, air inside pipework or defective valve and/or pump.	Contact Apricus Aftersales Team.
0021	!Night circulation!	Night circulation	Between 11pm-5am collector temperature $> 40^{\circ}\text{C}$ for at least 1 minute, temperature difference exceeds ΔTon. Possible causes are defective non-return valves, defective valve or wrongly adjusted time.	Contact Apricus Aftersales Team.
0031	!FL/RE interchanged!	Flow or return pipe interchanged or a badly placed collector sensor	Collector temperature does not rise after switching on	Contact Apricus Aftersales Team.
0041	!Flow r. monit.!	Flow rate monitoring	No flow rate at sensor	Contact Apricus Aftersales Team.
0051	!Overpressure!	Overpressure monitoring	Overpressure reached	Contact Apricus Aftersales Team.
0052	!Low pressure!	Low pressure monitoring	Low pressure reached	Contact Apricus Aftersales Team.
0061	Data storage!	Storing and changing values		Contact Apricus Aftersales Team.

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		not possible		
0071	!RTC!	Time-controlled functions (e.g. night correction) not possible		Contact Apricus Aftersales Team.
0081	!Store max. temp.!	Maximum store temperature	Storage max has been exceeded. Possible cause may be a defective valve.	Contact Apricus Aftersales Team.
	Restarts	Restart counter (non-adjustable)	Number of restarts since commissioning	Contact Apricus Aftersales Team.
Display off			Controller may be in standby, press main circular button to see if display illuminates. Controller power may be off.	Connect power supply to controller if it is off. Call Apricus Aftersales Team if still not on.

Note that during normal operation, the message Everything OK is indicated.

IF YOU HAVE READ ALL THE INFORMATION WITHIN THIS MANUAL AND BELIEVE THAT YOU NEED ASSISTANCE, CALL APRICUS AUSTRALIA'S AFTERSALES TEAM.

## CHAPTER 6: SYSTEM MAINTENANCE

### MAINTENANCE SCHEDULE

Apricus recommends that maintenance must be carried out accordingly with but not limited to the maintenance schedule in Table 7. Please refer to the manufacturer's documentation for any non-Apricus components for maintenance guidelines. Maintenance and servicing should only be completed by a certified plumber, with experience in solar hot water systems.

Table 7 Suggested Maintenance Schedule

MAINTENANCE SCHEDULE	MAINTENANCE PERIODS			
	EVERY 6 MONTHS	EVERY 12 MONTHS	EVERY 2 YEARS	PER PRODUCT GUIDE
<b>SOLAR COLLECTOR</b>				
All tube clips are present and secure		X		
All tube caps are present		X		
All tubes have vacuum. Check tubes are intact and bottom is silver. Replace if broken. If dirty, clean with glass cleaner (if safe)	X			
Manifold and frame are free of rust			X	
Inspect manifold			X	
Descale collector loop or install scale inhibitor			X	
Check that there is no shading on collector.		X		
<b>EXTERIOR PIPING</b>				
All piping is insulated, with no exposed pipe	X			
All insulation is free from defects	X			
All insulation is UV and weather protected		X		
Insulation jacketing is free of degradation		X		
Check pipe hangers are in good condition		X		
Piping is labelled clearly			X	
Inspect brass fittings		X		
<b>INTERIOR PIPING</b>				
All solar piping is insulated			X	
All hot water piping is insulated			X	
All piping is labelled clearly			X	
Check pipe hangers are in good condition			X	
All valves are clearly labelled			X	
Inspect brass fittings		X		
<b>SYSTEM</b>				
Check that the pump is operational				X
Check that the differential control is operational		X		
Check instrumentation				X
Check expansion tank (if applicable)				X
Check analog gauges			X	
<b>STORAGE TANK</b>				
Drain and flush tank				X
Inspect anode rod (if glass-lined tank)				X
Inspect tank		X		
<b>HEAT EXCHANGERS</b>				
Check performance		X		
Descale heat exchanger (if possible)			X	

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VALVES				
Check automatic valve operation (if applicable)		X		
Check PTRV operation		X		
Release PTRV lever to prevent debris build up.	X			
Check tempering valve operation, that the line strainers are clear and that the pressure across tempering valve is balanced.		X		
Cycle manual valves	X			
GAS BOOSTER				
Inspect gas unit for insect infestations and plant growth, remove	X			
ELECTRIC ELEMENT				
Inspect element for leaks. Check fuse, replace if required	X			

## MAINTENANCE PROCEDURES

### SOLAR COLLECTOR

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 with a damaged tube. Any broken glass should be cleared away to prevent injury.

To replace a tube:

1. Remove the tube clip, slide the 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 film.

### DRAINING THE SYSTEM

Draining of the collector and/or tank 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.

#### WARNING

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

Follow the steps below to drain the collector:

1. Turn off the mains water supply to solar storage tank.
2. If the storage tank is being drained,
  - a. Disconnect all power supply to water heater.
  - 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 line
  - b. Open the manifold outlet to allow air to enter the system.

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- 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 manifold outlet.
4. Re-fill the system by following the procedure outlined in the Apricus Installation manual, Chapter 6: Commissioning.

## AIR LOCKS

If the pump is running but flow is not being achieved in the solar loop, the system may have an air lock. This can be rectified by following the filling procedure outlined in the Apricus Installation manual, Chapter 6: Commissioning.

## 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 of 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).

## MAGNESIUM ANODE REPLACEMENT

Glass lined storage tanks have a magnesium anode inserted into the tank. The 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. Inspect the anode on a yearly basis if tank uses hard water.

It is recommended that the manufacturer be consulted regarding suitable replacement anodes.

### WARNING

If the hot water system is not used for two weeks or more, a quantity of highly flammable hydrogen gas may accumulate in the water heater. To dissipate this gas safely, it is recommended that a hot tap be turned on for several minutes or until discharge of gas ceases. Use a sink, basin, or bath outlet, but not a dishwasher, clothes washer, or other appliance. During this procedure, there must be no smoking, open flame, or any electrical appliance operating nearby. If hydrogen is discharged through the tap, it will probably make an unusual sound as with air escaping.

## CHAPTER 7: GENERAL INFORMATION

### WARRANTY/SERVICE CALL

If you have an issue with your Apricus solar CHW system please contact our head office on: 1300 APRICUS (1300 277 428)  
Any enquiries regarding the solar CHW system can be sent to [commercial@apricus.com.au](mailto:commercial@apricus.com.au).

### STAY IN THE LOOP

To stay up to date with the latest Apricus news, product updates, announcements, and specials. Sign up to our Apricus e-newsletter and connect with us on social media by visiting our website: [www.apricus.com.au](http://www.apricus.com.au)