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Hot Sun Solar Pool Heaters
GENERAL INSTALLATION MANUAL

see manual addendums for specific roof types

SUMMARY OF IMPORTANT NOTES:

Ensure all piping slopes downhill to drain and all plumbing drains are left open through freezing conditions. Note: Solar heaters are solar coolers at night. Air temperature only has to drop to 42F for water to freeze inside a solar cooler. The flexible fin-tubing can freeze full of water without concern. Plumbing and manifolds are not flexible and are vulnerable. Drains on flat rooftops should be closed once plumbing is emptied to prevent water getting back in and freezing. See repair manual if damage occurs.

Commission each installed system by checking start up pressure at typical vacuum breaker location. (less than 8psi) Check running pressure (less than 5 psi). Verify variable speed pump prime speed is turned down. Check pressure when pump runs through its starting cycle (less than 8psi). Verify vacuum breaker exhausts air fast enough to prevent fin tube collapse when solar turns off. If not add return line vacuum break. Verify all horizontal piping is supported every 36” inches max.

1.0 SAFETY:

Don't attempt this installation if you are not fully capable of working safely on the roof or hillside or wherever you will be working. Falls from roofs are a common and serious workplace accident. The use of safety equipment including body harnesses, lanyards and lifelines, ladders, and hazardous chemicals require training and certification. Hot Sun will not be held accountable for injuries. We require that you take all responsibility for learning how to use and for using correctly all safety equipment and chemicals and tools. Read all warning labels on all adhesives and cements used in this installation. Wear gloves and safety glasses and don’t work alone. PVC cements contain methyl ethyl ketone, a known carcinogen. Primer is especially dangerous. Use a respirator in confined spaces. Wear eye protection.

The rails used and the pvc piping can roll if you step on them. The same is true of pvc collars. This presents a safety hazard on a roof. Organize things carefully and bring these materials to the roof only as they are installed if possible.

2.0 POOL SYSTEM COMPATIBILITY

Before starting an installation you must check that the pressure where solar ties in (right after the filter usually) is lower than the height of the roof where the solar collector will be located. Beware of infloor

cleaning systems or special cleaning systems that require extra pump speed. Beware of solar collectors located at or below pool level. Beware of pools with older style more restrictive plumbing. If in doubt install a pressure gage at the solar tie in point and compare to roof height. 0.433 psi equals one foot of elevation difference. Make sure you can turn down the variable speed pump's priming speed. The default is full speed which usually will result in too much filtration system pressure. Recognize the possible need to schedule higher speed functions like vacuuming outside the hours of solar operation. The goal is no pressure, no stress BUT we can allow up to 8psi start up pressure and 5 psi normal operating pressure. Contact Hot Sun. There is usually a way but not always. Sometimes a site with adequate sun exposure is not solar compatible.

3.0 THE TIE IN:

Our recommended typical solar tie in uses a 3 valve bypass arrangement as shown below left. The reason for this scheme is that it allows anyone to bypass and isolate the solar system from the pool system without having to get into the controls to turn the motorized solar valve. Solar is fully isolated for winter drain down. If the pool is in a non freeze zone and if solar and the pool are not mismatched in size the diagram at the right can suffice. Here all the flow goes to solar so the pump speed must be low enough to not generate excessive collector pressure.

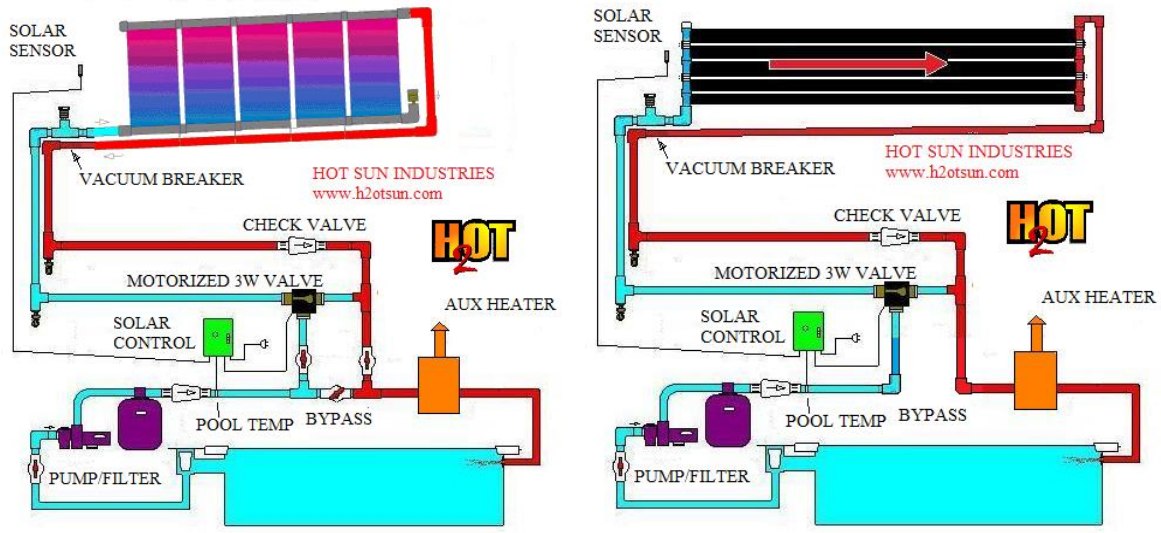


Fig. 1. General Schematics of Solar Pool Heater Tie-in.

The diagram above show a typical plumbing scheme. When the roof (solar) sensor gets warmer than the pool temperature sensor (plumbed right after the check valve, CV1) and the pool is colder than the set point you've set on the controller (the maximum pool temperature), the motorized valve will turn and divert flow to the bottom of the bank of solar collectors. The water rises up (or sideways) though the collectors flushing all the air out to the return pipe and back to the pool. When solar turns off after the pool is warm or the solar day is over, the 3 way solar valve turns another 180 degrees so that flow does not go to solar.

The check valve CV1 prevents the water from going backwards through the filter and pump when the pump is turned off. CV2 isolates solar when solar is off. This valve can be omitted if when solar is off the pressure is lower than the roof height such that the vacuum breaker allows some air to enter which breaks the path for reverse flow and loss of heat.

Note the bypass valve in Figure 1. It should always be assumed that we wouldn't be able to send all the flow from the pool pump through all the extra plumbing we add when we install a solar heater. The bypass

controls how much goes to solar when solar is on. It's adjustment is explained below under “Start Up”. Controlling solar panel pressure is NOT simply a matter of adjusting the bypass valve. In fact it has little to do with it. Bypassing some flow only eliminates the extra pressure caused by sending too much flow thru solar. Variable speed pumps running slow to minimize filtration cost will have no trouble at all with a 2” plumbed solar heater even if the plumbing run to the solar panels is 100 feet. In cases like this ,instead of the bypass valve the 3w valve can be plumbed directly as shown in the diagram to the right above. Consult Hot Sun.

If the solar heater is to be manually controlled (saving the cost of the automatic controls) the plumbing scheme will usually be identical except that the motorized valve will not be motorized.

Hot Sun systems can be plumbed with 1.5” or 2” pvc pipe. The correct choice depends on the length of plumbing run to the roof and the size of the pool plumbing being tied into and other factors. Consult Hot Sun if in doubt.

4.0 CONTROLS

Pool automation systems usually include the brain for solar. In these cases the pool temperature sensor is already in place. All you have to do is plug the actuator (the motor of the motorized valve) into the control panel as well as the wire from the solar sensor and assign the solar valve in the menus. Hot Sun solar sensors are made of a piece of solar panel material to perfectly mimic the temperature the solar panel would be if there was no water flowing through it. Locate the solar sensor in the same sun (shading angle direction) as the solar collector. Note this does not necessarily have to be on the roof next to the solar collector. The wire to the solar sensor can be a direct burial outdoor rated 18 GA wire or it can be inside a conduit. Secure the wire with UV rated black cable ties. Solder and heat shrink the connections. Hot Sun supplies these sensors with any wire length pre-attached.

Fig. 2. Hot Sun solar sensor. Don’t attach to pipe or solar panel.

Stand alone differential thermostats can be used if the pool automation does not have the solar feature built in. Differential thermostats compare the solar sensor temperature to the pool temperature sensor and the maximum pool temperature setpoint, turning the motorized valve to solar on or off accordingly.

5.0 INITIAL SYSTEM START-UP (COMMISSIONING)

It is very important to check system pressures on a new solar heater. Start with BV1 fully open. Close the drains, open the 2 isolation valves (BV2 and BV3) fully and turn the 3-way valve to direct flow to the solar panels. Slowly close the bypass valve BV1 until the air flushes out of the solar panels and into the

pool dramatically. The filter pressure will rise as the air flushes through and then settle back to a new lower level. Close BV1 further until you just start to see the pressure gage on the filter start to go up again. We want as much flow as possible without adding extra pressure. You can feel the solar panels when operating in Hot Sun. They should feel pool temp, not hot, and there shouldn't be any hot spots.

If this is the first time the system is started up you should install a pressure gauge on the roof at the level of the solar panels roughly (tee in a pressure gauge on the feed pipe into the solar panels) and check that there isn't any pressure in the solar panels when solar is off (but pump on). An easy way is to use the threaded hole for the vacuum breaker. Then turn solar on and verify the pressure is no more than 5 psi when solar is operating. Do the checks and then replace the vacuum breaker right away. **Do not purposely add pressure**. All you need is less than 1/10 psi to drive more than enough flow through solar. Contact us if there is a pressure situation. Watch the pressure spike as solar turns on and record how much. If it spikes to more than 8 psi it's too much. Contact Hot Sun. **The lower the pressure on the solar panels the better.** Note that if the vacuum breaker is sucking air, you can increase the flow. Close BV1 further but not so far that you add pressure. Make sure the normal operating pressure is less than 5 psi.

You can also control that bypass flow by setting cams on the motorized valve. Some installers prefer this method as it makes the plumbing easier and with variable speed pump running at low speed often we are sending all the flow to solar anyway.

Check vacuum breaker operation. Run solar and then turn the solar valve to solar off. Inspect the fin tubing to make sure it has not collapsed. If the fin tubes collapse every time solar shuts off then over the years it will experience thousands of cycles and eventually fail. If the fin tubes collapse the system needs an additional vacuum break. One will have to be added on the return side. The feed side vacuum breaker can sometimes be moved to the return side to resolve this issue. Then you have to check to make sure the vacuum breaker isn't opening constantly drawing air into the pool. Speed up the flow, use more restrictive return line piping, incorporate some bends in the return piping or add a restricted ball valve to get the vacuum breaker pressure above zero so there isn't a constant stream of air bubbles entering the pool. Vacuum breaker location with respect to return line elevations and plumbing characteristics can be a bit of an art form. Let Hot Sun help. Designing a solar heater to operate "smoothly" means minimal effect on the pool filtration and minimal pressure changes positive or negative as the system operates automatically through time.

Over a design 160 degree temperature swing 20F to 180F manifolds and pvc plumbing will change length by more than 1 inch over 30 feet. Make sure the plumbing can move freely enough to accommodate this kind of movement. Its huge. More than you would assume.

Commissioning Checklist

Max start up pressure less than 8 at feed side vacuum breaker location.
Normal operating pressure less than 5psi
Pump priming solar pressure less than 8 psi
Solar off pressure not negative (fin tubes are not collapsed).
Horizontal plumbing supported every 36 inches
All manifolds secured at ends and every 2 manifolds minimum
All piping and manifolds can move 1 inch for every 30 foot plumbing run. Pay attention to corners.
Paint all plumbing and pipe connections. UV will go through white PVC and attack glue joints.
System and piping can drain by gravity off the roof or manual drains points are located at all low points.

6.0 PLANNING THE JOB

Always plan collector lengths to standard sizes. Custom sizes available by special order. Standard sizes measured outside to outside of manifolds at room temperature are . 29’8”, 22’ 18’, 15’ 12’, 10’, and 8’.

The manifolds are 13” long so allow 13” for each collector section. The high point is where water comes out of the collectors and the low corner is where it goes in. This ensures air can rise up and out of the system naturally avoiding any air pockets trapping flow.

Hot Sun is available for planning consultation.

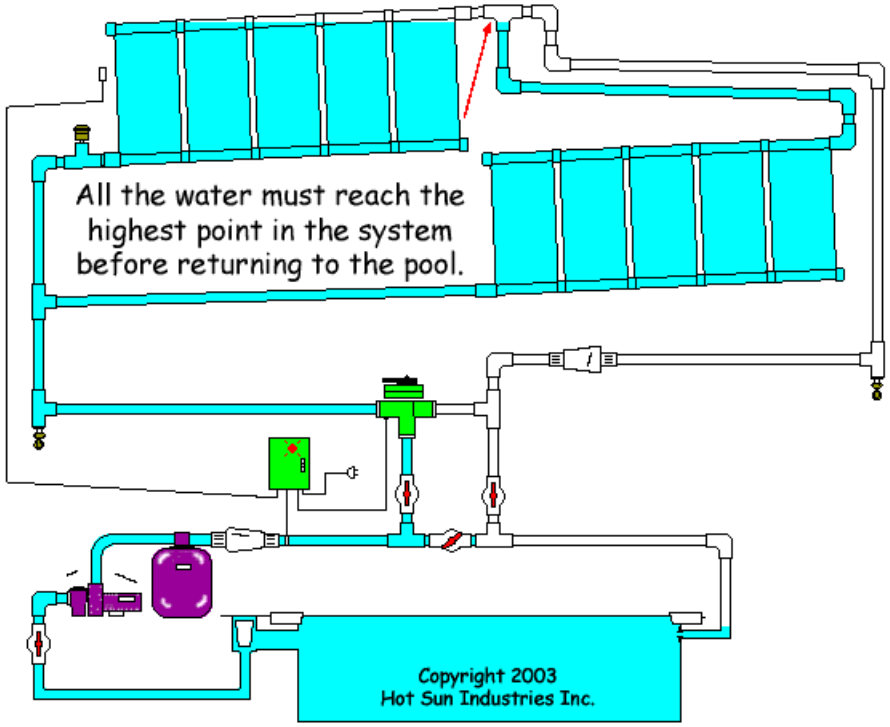


Figure 3: Typical Multiple Panel Bank Assembly

In order to flush all the air out it must be allowed to rise to the highest point in the system as shown in the diagram.

7.0 INSTALLATION

For specifics to each roof type see manual addendums.

7.1 CONVENTIONAL

Conventional means the flow of water goes up the roof. Water enters at one bottom corner and exits diagonally opposite at the top.

Slope exaggerated

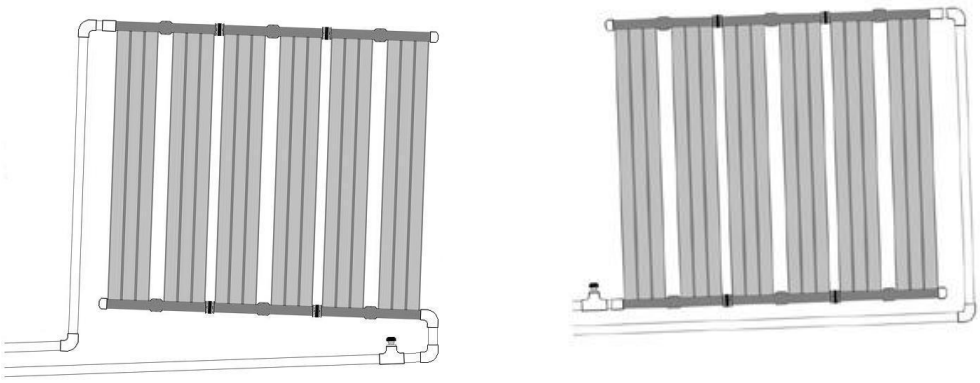
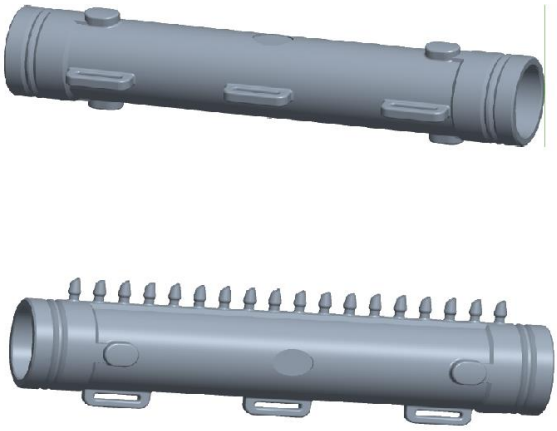


Fig. 2: Sloping panel banks and roof piping

In conventional orientation you have to provide a tilt to the top manifolds so the air doesn't get trapped. A corresponding slope on the bottom manifolds ensures the bottom manifolds drain. Note in the diagrams above, the diagram to the right is preferred so plan your piping to the roof accordingly. The vacuum breaker is teed off the pipe going into the solar collectors. Water feeds the bottom and rises up releasing the air to the return and back to the pool. If the flow is sideways, air is not trapped, and sloping like this is not necessary.

Do not use removable couplings on sch 40 pvc pipe. The pipe will neck down under the heat and stress. Hot Sun supplies adapters.

Adapter



Hot Sun 2" manifolds

Hot Sun manifolds join together several different ways. Our standard 2" MJ coupling joins manifold to manifold. Alternatively, manifolds can be glued together via a piece of 1.5" pvc pipe cut 2" long. You can vary that pipe stub length to work around roof obstructions. This will effectively make it a 1.5" system. If there are two banks, then 1.5" is appropriate. Also, if the pool plumbing is all 1.5" and the run of piping to solar not too long.

We recommend a slope of at least 1 to 120 (1"in 10' or 8mm in 1m) for horizontal manifolds and horizontal plumbing piping and that all piping be painted where exposed to sun. Manifolds and plumbing on flat roof systems do not need to be sloped but means to remove trapped water (for winterizing) must be provided.

7.2 PAINTING

Paint the exposed side of the pipe after installation with gloss black paint, not from a spray can. Acrylic paint works best with pvc. Use a brush and small roller. Slide a piece of cardboard between the pipe and the roof as you go. Painting is best done before the piping is attached to the roof but after its plumbed in. Gloss black resists fading better. Black paint allows the piping to collect solar energy. Piping on the side of the house can be painted to match the house. Keep the pipes next to each other for a neat appearance.

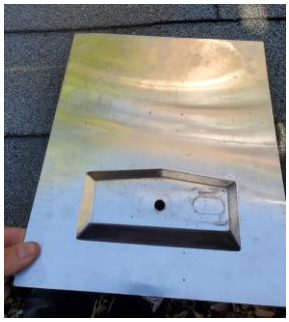
7.3 COLLECTOR MOUNTINGS

Hot Sun solar panels are secured at the both manifolds, top and bottom, or right and left. Securing both manifold runs satisfies the structural requirement. Additional strapping under the collectors glued or tied to the collectors is intended primarily to keep the fin tubes organized and in position. See drawings for positions.

Refer to manual addendums for each roof mounting type. On flat roofs we employ a ballasted system so there are no roof penetrations. On tile roofs we employ an all adhesive mounting so there are no roof penetrations. On a ground mount we usually build a bed of gravel and install a ballasted flat roof system on that. On a shingle roof we must penetrate the roof because the surface of the shingle has no strength

Our standard tool kit includes vinyl coated stainless steel strapping, strap brackets, strap clamps, plus proper flashed roof brackets all manufactured and supplied by Hot Sun.

Roof bracket



Flashing

pvc coated ss strap

Four #10 stainless steel screws grab the roof sheathing under the shingles. We don't need to hit the rafters. We start with the idea that we want a proper secure flashed roof connection every 6 feet very similar to what we see with a PV system (photovoltaic solar electric). The supplied #10 stainless steel screws can be installed without pilot drilling. Beware ss screws are soft. Its easy to strip the head so use a good bit and be sure to apply accurate force as the screw goes in.

PL roof and flashing sealant

strap clamp

strap bracket

Follow the roof mounting methodology outlined in the appropriate manual addendum for the roof type. Consult Hot Sun for variations and other roof types not covered like metal roofing and wood shingles.

Chain link fence top rail

strapping fin tubes

PL3x construction mastic

When using the vinyl (PVC) coated ss strap to strap down the fin tubes we run the strapping under the fin tubes. This is easier than going over because it can be done before the fin tubes are laid out.
Glue the fin tubes to the strapping beneath with PL construction adhesive (shown above). Alternatively we use a one tube wide piece of the fin tubing over the top and then sandwich the fin tubes to the strapping every 6 tube wide strip using UV rated black nylon zip ties.

8.0 PLUMBING

Glue connections are done using P70 primer and 2711 heavy body PVC cement. Don't use primer on the manifold itself. The manifolds are not PVC. They are a styrene material which reacts more aggressively with the active ingredient in PVC cement and primer, MEK. Fully wet the inside of the fitting and the outside of the pipe using the daubers inside the cans. Check to make sure you don't miss a spot and make sure everything is dry first. Twist ¼ turn as you assemble and wipe off excess. Paint all connections after the glue has dried. UV will go right thru white PVC and attack the glue joints. Take the sharp edge off the end of a cut piece of PVC pipe before gluing. Let the glue dry 24 hrs before sealing the system up. Let it breathe with the drains open and the vacuum breaker removed.

Vacuum breaker- mount vertically

You need to be able to drain water from the piping and header pipes at any low points to prevent damage from freezing (assuming you are in a climate where it does freeze). Slope all the plumbing down to these drains. Mount the unit vertically relative to the center of the earth not the roof surface.

Install the vacuum breaker on the free low corner of the bank of solar panels or preferably on the pipe entering the solar panels. If there is more than one bank of panels the vacuum breaker should be on the bank of panels that is highest on the roof

The vacuum breaker lets air in when the pressure goes below zero to prevent plumbing and solar panels from collapsing. It doesn't vent air or release pressure. The solar system is open to the pool. Air flushes to the pool upon start up. The vacuum breaker also allows air in so water can drain out when solar or the pool pump is off. Without the vacuum breaker the system would go under negative pressure and there would be a risk of collapsed plumbing if temperatures get high enough.

Install 1-1/2" PVC end caps or drain points as needed on the remaining corner(s)

All piping is schedule 40 pvc. Horizontal runs of piping along a wall should be supported every 3' (1m) Underground piping can be buried deep enough that it can stay full of water all winter. Check with a plumber or city hall for the depth required in your area. Alternatively underground piping can be shallow and sloped one way or the other to a drain. A drain pit can be constructed where a large hole is dug (about a

foot deeper than the piping), partially filled with gravel. If you bury the pipe below the frost level you can get away with drains at ground level where the pipes come up. There will be a small column of water that will freeze but it can expand up the pipe.

Remember pvc pipe needs to be able to change length with temperature. A piece of 2" pvc pipe fits over 1.5" perfectly allowing the 1.5" to slide freely while the 2" collar is secured positively. Similarly, 2.5" sch 40 pvc pipe makes a perfect slip collar for 2" pipe.

Slip collars glued to ballasts (flat roofs)

slip collars supporting a plumbing run on a shingle Roof – 2 strap brackets, one screw

9.0 TROUBLESHOOTING and REPAIR

Air Bubbles:

You should see a big flush of air when the solar heater starts up in the morning. It should stop after a few minutes. If air is entering the pool inlets constantly after the system has started up then the vacuum breaker is probably opening and allowing air to enter. Safely, listen to it. You will hear air entering the vacuum breaker if it is the source of the air. If it isn't, then you have a leak on the pool plumbing before the pump or near the top of the solar panels. Check the pump lid seal. The vacuum breaker is mounted to the bottom header of the bank of solar panels to try and keep some pressure on it so it stays closed. One remedy is to just live with some air bubbles. Another remedy is to increase the pump speed (assuming variable speed). Perhaps the filter just needs to be cleaned or backwashed. That's why the vacuum breaker started sucking air. That's our most common inquiry. You can increase the flow thru the collectors if BV1 isn't closed all the way already. Close it until you see the pressure gage on the filter react. Closing BV1 to send more flow to solar is the same effect as increasing the pump speed. Your pump speed is set for filtering and unless it is set pointlessly too low you shouldn't have to change it to accommodate solar.

Poor performance:

If you suspect the system is not heating as well as it should be, check the solar panels on a sunny day. When operating (water flowing through them) solar panels will be cool to the touch (pool temperature) across their entire width. Near the bottom of the collector (or feed side) the collector will be close to the swimming pool temperature. Near the top of the collector the temperature will be a little higher (depends on flow rate) but for efficient operation will only be about 5-10 degrees F higher than pool temperature at solar noon. If there is a hot spot, then water is not flowing through this area. Make sure the panels are draining down some when solar shuts down to ensure you aren't losing heat at night.. Without turning the pump off, turn solar off, wait, then on again and make sure you see air bubbles flushing into the pool. This confirms the panels drained down when off. If they don't drain down you could be losing heat if the pump is on at night due to an induced backwards cooling circulation. Install check valve CV2 in Fig 1.

SERVICE: You can splice the tubing with ¼" pvc drip irrigation tubing – see repair manual. Beware of polypropylene drip irrigation tubing. Make sure its pvc which is the same as "vinyl". You can always test it by seeing if it glues to itself with PVC cement or CA adhesive. Gorilla brand superglue- see repair manual (under manuals at www.h2otsun.com) is an alternative to buying the CA from Hot Sun . If you have a leak, seal the vacuum breaker location with a plug, run solar, then shut off the pump. Air will be drawn in at the leak location. You can use this method to get 2711 pvc cement to flow into the joint.

Auto Controls: If its not coming on or off automatically the first thing to do is check to make sure the little switch on the actuator is set correctly. It is a 3 position switch. In one position the system operates in reverse so if you change it make sure you remember which position is correct. The middle position prevents the actuator from turning. You can also check the sensors. The two sensors (one on the roof and one in the pool plumbing) are 10,000 ohm thermistors. They measure 10,000 ohms at room temperature. Lower when hotter, higher when colder. If solar isn't coming on when it should, short out the roof sensor at the control panel . If that makes solar turn on then it's a broken wire to the roof sensor or a bad roof sensor. If that doesn't work disconnect the pool temp sensor. If solar comes on (when it should) then it's the pool temp sensor. Parts for these control systems are universal and available worldwide. The motorized valves are pool industry standard parts. Any pool service man has access to all the parts through his local pool equipment distributor.

BROKEN MANIFOLDS

To replace a manifold it is important to understand that the fin tubing can be cut short and stretched. It will become the new length over time. The fin tubes are plastic not rubber. The word plastic means it deforms plastically to become the new size. The new manifold must be glued properly to the fin tubes. Hot Sun can supply the parts needed and instructions.

Addendum manuals covering all the specifics of collector mounting on all the different mounting surfaces are under " DOCUMENTS AND MANUALS" at www.h2otsun.com