INSTALLATION MANUAL

SOLAR BUTLER 1.0
Solar Assisted Hot Water System
• Solar Wand Heat Exchanger
• “Sun Blocks” Modular Collectors
• Self Pressuring Unit for Glycol Loop
• Stagnation Over-Temp. Protection
• Automatic Trapped Air Purging
• Anti-Scald Valve
• Patents Issued & Pending
• SRCC OG-300 Certified Systems

BUTLER SUN SOLUTIONS
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### REVISION HISTORY

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[www.butlersunsolutions.com](http://www.butlersunsolutions.com)

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<tr>
<td>June 30, 2003</td>
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<td>February 11, 2004</td>
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<td>July 1, 2005</td>
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## ACRONYMS

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<th>Description</th>
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<tr>
<td>ABS</td>
<td>Acrylonitrile Butadiene Styrene – a tough, light, and water-resistant plastic, black in color, used for drain line pipes. (NOTE: ABS/PVC co-extruded pipe is sold in most parts of USA except the East coast, where they use PVC drain pipe)</td>
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<tr>
<td>PVC</td>
<td>Poly Vinyl Chloride – a plastic used to make drain and sprinkler pipes, white in color</td>
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<tr>
<td>ASTM</td>
<td>American Society for Testing Materials</td>
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<tr>
<td>AWG</td>
<td>American Wire Gauge</td>
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<tr>
<td>AWWA</td>
<td>American Water Works Association</td>
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<tr>
<td>GFCI</td>
<td>Ground Fault Circuit Interrupter – a device that detects and opens a circuit if electrical current is detected in the ground leg, indicating a ground fault or short-circuit</td>
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<tr>
<td>gpm</td>
<td>Gallons per Minute</td>
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<tr>
<td>GPS</td>
<td>Global Positioning System receiver, which can act as both compass and latitude measuring device.</td>
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<tr>
<td>Insolation</td>
<td>Power coming from the sun, 1,000 Watts/m(^2) at solar noon. May also be annual daily average which for San Diego is 6.5 kWh/m(^2)/day.</td>
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<tr>
<td>LCA</td>
<td>Linear Current Amplifier – electronic controller that improves performance of PV-powered pumps</td>
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<tr>
<td>NPT</td>
<td>United States National Pipe Thread Standard</td>
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<tr>
<td>pH</td>
<td>Log Scale of H(^+) ion activity, 1 to 6 is Acidic, 7 is neutral, 8 to 14 is Basic</td>
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<tr>
<td>psi</td>
<td>Pounds per Square Inch – a measure of pressure</td>
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<tr>
<td>psig</td>
<td>Pounds per Square Inch Gauge -- pressure measured above atmospheric pressure</td>
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<tr>
<td>PV</td>
<td>PhotoVoltaic panel – a flat panel containing solar cells that convert sunlight directly to electric power</td>
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<tr>
<td>SOF</td>
<td>Solar Orientation Factor shows solar system performance as a function of Tilt angle and East-West orientation</td>
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<tr>
<td>SRCC</td>
<td>Solar Rating and Certification Corporation</td>
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<tr>
<td>Stagnation</td>
<td>The condition where solar energy is being absorbed by the solar collectors and there is no fluid flow to remove the heat.</td>
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1.0 Solar Rating and Certification Corporation Compliance (SRCC) Information

The solar energy system described by this manual, when properly installed and maintained, meets the minimum standards established by the SRCC. This certification does not imply endorsement or warranty of this product by SRCC.

Butler Sun Solutions solar hot water systems are SRCC OG-300 certified systems. In the System Model Number column, the PV1 indicates that a Photovoltaic powered pump is used to circulate the Propylene Glycol antifreeze fluid in the solar collector loop. In the System Model Number column, the S1 indicates a 115 VAC Delta-T controller is used to power the pump to circulate the Propylene Glycol antifreeze fluid in the solar collector loop. Systems have been rated for ACR, Sun Earth and Thermomax solar collectors. Both single tank and dual tank systems have been rated by SRCC, see Table 1. For actual system performance ratings in your region go to www.solar-rating.org the SRCC web site.

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<th>SRCC Certification Number</th>
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<th>Solar Tank Vol. (gal)</th>
<th>Aux Tank Vol. (gal)</th>
<th>Solar Tank Heat</th>
<th>Aux Tank Heat</th>
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2.0 Tools and Skills Needed

Here is a suggested list of tools you may need to successfully complete the installation of your solar hot water system. Some installations will be easy and all of the suggested tools may not be required. We have tried to be as comprehensive as possible with the tool list; however, we do not guarantee that you will not need other tools or supplies, based on your specific installation situation. Roof installations can be dangerous since there are hazards such as ladders and slippery, sloped surfaces. If after reading this manual there is any doubt in your mind about self-installation, hire a professional. Be sure that your licensed professional has the appropriate liability and Workmen’s Compensation Insurance for your state. We will list qualified professionals on our web site as they become known to us. If we don’t list someone in your area, go to the Solar Energy Industries Association web site (www.seia.org) and look for a SEIA member company in your area. SEIA members subscribe to a strict code of ethics based on customer satisfaction. The American Solar Energy Society has a new website, www.findsolar.com, which lists qualified solar hot water installers by postal zip code. Murphy’s Law will come into play, but Do-It-Yourselfers are very resourceful and will be able to complete a professional installation and be happy with their new solar hot water system. A growing gallery of solar systems installed all over the USA is included on our website, www.butlersunsolutions.com.

2.1 Skills needed by Installer or Do-It-Yourself Handyman

- Basic carpentry, to route umbilical and cover with ABS/PVC pipe
- Basic roofing skills to secure the collector to the roof without creating water leaks.
- Basic plumbing using wrenches and pipe connections
- Basic soft solder pipe sweating, if umbilical must be extended or solar collector array is connected by sweat solder connections.
- Basic electrical to check outlet prior to plugging controller into outlet or connecting 12VDC for the PV powered system.

2.2 Safety Equipment

- Rubber soled, lace-up shoes with good traction (no flip-flops or sandals on roofs)
- Leather gloves to protect your hands
- Safety glasses or a face shield to protect your eyes and face
- Electrical outlet polarity and fault detector
- Stud, wire and pipe finder
- Collector cover such as a tarpaulin, heavy blanket or craft paper
- Fire Extinguisher
- 100-foot, grounded, GFCI extension cord, or cordless tools for drilling, cutting and soldering
- Extension ladder
- 100 feet of ⅜-inch rope for pitched roofs.
2.3 Supplies You May Need To Provide

- One gallon of propylene glycol antifreeze (Peak Sierra carried by NAPA Auto Stores), **Not shippable, so you must provide.**
- Rubber stopper or cork with ¼-inch OD tubing attached for system filling and flushing, **Provided with System.**
- ¼-inch OD plastic tubing to go from flush or fill/drain valve to bucket, **Provided with System.**
- New flexible hot water tank inlet and or outlet lines of appropriate length
- Teflon® pipe tape for threaded fittings
- 2” ABS/PVC black drainpipe and fittings including elbows and angles; alternatively, standard plastic or metal down spouts including elbows and angles to hide the umbilical in outside wall installations
- Black electrical tape
- Assorted nails and screws
- Roof patching mesh
- Electrical solder or wire nuts
- Plumber’s “Lead-Free” solder and flux for copper tubing
- Sandpaper to clean copper surfaces
- Standard roof jack flashing for 2” roof penetration
- Collector supporting and elevating hardware if needed
- ¼-20 Hollow Wall Anchors to hold collector down on roof (Stainless Steel or corrosion resistant fasteners)
- Flange and pipe mounting hardware
- Caulking
  - Henry’s Roofing Tar in caulking tubes for roof penetration and fastener seals
  - GE Clear Silicone II or equivalent for caulking split pipe and fittings.

2.4 Tools

- Compass or GPS receiver to act as a compass and to obtain the site Latitude, Longitude and direction of true South.
- Level or level/inclinometer combination to measure the collector tilt angle.
- Thin stick or measuring tape
- Pipe wrenches, 12”, 14”, 16”.
- ¾-inch NPT pipe tap
- Adjustable wrenches, 8” and 14”.
- Wood hole saw, 2” diameter and 2.5” diameter
- Tubing expander to make soft solder tubing connections
- Tubing bender, Eastman type preferred
- Tubing cutter for ¼-inch OD copper refrigeration tubing, with reamer
- Compression nut removal tool for 5/8” nut for ½” tubing
- Indelible magic marker
- Gas torch and igniter
- Steel wool or emery cloth
• Hacksaw
• Wood and metal files
• Skill® Saw
• Sawzall® Saber Saw
• Electric drill ½-inch chuck capacity
• Twist drill bits up to ½-inch.
• Masonry/Tile drill bits
  o 1 inch hammer drill quality masonry bit or a 1 ⅛-inch Tungsten Carbide Core Drill (Remington Edge Grit) if you are removing the roof tile for flange mounting
  o ¾-inch Hammer drill quality masonry bit if you are leaving the roof tile in place and using hollow wall anchors
• Hammer
• Tin Snips
• Measuring tape, 20 to 50-foot length
• Chalk line
• Pliers, including Channel Locks® and Vice Grips®
• Screw drivers, straight blade and Phillips
• Caulking gun
• Matte knife and blades
• Pencils and paper
• Putty knife
• Wire cutter and stripper
• Volt-Ohm meter
• Calculator
• Dremel® tool with abrasive bits
• 12VDC, 2A power supply to power PV-powered circulation pump if sun is not shining during installation (PV-powered systems only)
• Plastic bottle, empty, 1 gallon (To mix antifreeze in. Note: dispose of properly after use)
• Rags for clean up
• Broom and dust pan
• Portable shop vacuum cleaner

### 2.5 Hazards of All Types

As a do-it-yourselfer, you must be comfortable assuming and mitigating the risks identified below. If you don’t feel qualified to assume these risks, we recommend that you hire a licensed contractor who is experienced with roof mounted solar installations.

#### 2.5.1 Drinking Water Contamination Hazard

The system is designed to prevent cross-contamination of the heat exchanger fluid with potable water. The solar wand has a double-walled heat exchanger.
**CAUTION:** If water or heat exchanger fluid begins leaking from the top of the heat exchanger wand, it means corrosion has breached a heat exchanger wall. Even though one wall is still intact, the heat exchanger should be removed immediately and replaced with a new one as soon as possible.

### 2.5.2 Hot Water Scalding Hazard

Hot water can scald you. Hot water can also be under pressure and squirt out. Wear leather gloves to protect your hands and Safety glasses or a face shield to protect your face when opening the Hot Water Tank Drain Valve and removing tank inlet or outlet fittings.

**CAUTION:** **BEFORE LOOSENING ANY PIPE CONNECTIONS NEAR THE HOT WATER TANK ALWAYS TURN OFF THE POWER AND/OR GAS TO THE HOT WATER TANK TO ALLOW THE WATER TO COOL DOWN AND TO RELIEVE THE TANK’S INTERNAL PRESSURE. ADDITIONALLY BE SURE TO ALWAYS ATTACH A HOSE TO THE DRAIN VALVE BEFORE OPENING IT.**

### 2.5.3 Ladder Hazard

Working on ladders is dangerous. Be sure that the ladder is properly placed and seated on the ground. Do not lean back while moving collectors from the ground to roof. Do not over-reach when running the fluid lines and umbilical. It is safest to have someone hold the ladder.

### 2.5.4 Falling Hazard

Working on roofs is extremely dangerous, and sure footing is required. Be sure to wear rubber-soled shoes that cover your entire foot and are laced snugly. **(Do not wear sandals or flip flops on roofs.)** Falling to the ground can be deadly. Be sure to stay a safe distance from the roof edge. Do not use collectors as a support, even if they are attached to the roof – the collectors were not designed to be handrails. Plan the installation to place the collector on the roof safely away from the roof edges. **Safety ropes and harnesses are required for steep roofs and can add safety on low pitch roofs.**

### 2.5.5 Electrical Shock and Fire Hazards

Do not drill into the roof or walls until you have looked or verified using a stud, wire & pipe finder that no pipes or electric lines are in your drill path. If you have any doubts about what is inside the wall or roof, drill a small pilot hole and look or probe to be sure that it is safe to drill. Drilling into electric lines, water pipes or gas pipes can be both dangerous and costly to repair.
2.5.6 **Electrocution Hazard**

Beware of electric shock hazards. Do not stand in water and touch electrical components. Test the 3-pronged polarized, electrical outlet you intend to use for the controller. Using an electrical outlet polarity and fault detector, check to be sure that the hot, neutral and ground are properly wired. A ground fault circuit interrupter (GFCI) outlet is recommended to reduce the possibility of electrical shock. Plug-in ground fault interrupters do not require an electrician and provide the same electrical shock protection.
3.0 STEP by STEP Installation Instructions

The following sections outline a recommended procedure-- those skilled in solar installation may have better or faster ways of achieving the same professional installation. The procedures are an effective way of installing the solar system without being exposed to excessive risks. Safety tips are included, but if there is any question of risk, hire a certified contractor with roof expertise. Always use caution when working around ladders, on roofs and near hot pressurized water. A professional installation will serve you well for years to come. Obtain necessary local permits and covenant approvals for your installation. Figures 1-a, 1-b, 1-c & 1-d provide an overview of the systems and details of the system for reference purposes. Figure 2 provides a cut away view of the Solar Wand, the double-walled heat exchanger which is the patented heart of the system.

![Solar Wand System](image)

Figure 1-a   Solar Wand System
Figure 1-b  Solar-Assisted Hot Water System Overview, Including Self Pressurization Unit, Stagnation over-temp. Protection and Solar Wand

**Self-Pressurized Closed-Loop Systems**

**Automatic Air-elimination, Pressure, Vacuum, Stagnation Temperature Control**

The system is flushed and filled using city water & pressure. Antifreeze fluid is either siphoned in from the radiator filler neck on the roof, or pumped in through valves near the water tank. As the fluid heats up & expands the pressure reaches 16 psig, overcoming the radiator cap spring seal so trapped air & fluid (about 2 oz.) can escape from the pressurized loop to the bottom of the overflow reservoir where the trapped air bubbles to the surface & escapes. Fluid cool down contraction causes the spring loaded vacuum relief in the radiator cap to open at -2 psi allowing fluid to be drawn from the bottom of the overflow reservoir into the closed loop. The liquid-to-air radiator limits the antifreeze temperature to 250°F, minimizing corrosive acid formation.
Solar Assisted Hot Water, Closed Loop Self Pressurized, 16 psi, “Screw-In-Wand” Heat Exchanger
The schematic shown in Figure 1-d is explained in detail in the companion Service Manual. The function and operation of each component is described to show how the Self-Pressurizing Unit functions to eliminate air from the fluid loop and to protect the solar collectors from stagnation. Stagnation is the condition where solar energy is being absorbed by the solar collectors, but the fluid loop is not circulating and removing the heat from the solar collectors. This will cause the glycol water solution in the solar collectors to boil. The liquid to air radiator, pressure relief valve and overflow reservoir work together to limit the glycol water mixture to a safe temperature, of 124°C (256°F), where acids will not form rapidly.
3.1 **STEP 1: Planning the Installation**

This STEP requires you to locate your hot water tank and determine the location where you want the solar collectors to be installed. The collector is supplied with a 25-foot umbilical length to reach from the hot water tank to the solar collector. More umbilical can be purchased if necessary. The collectors should be located as close to the hot water heater as possible. **NOTE: THE TOP OF THE COLLECTOR NEEDS TO BE ABOVE THE ROOF PENETRATION, SO THE TOP OF THE COLLECTOR IS THE HIGHEST POINT IN THE FLUID HEAT TRANSFER LOOP (SEE Figure 7-d).**
The collector should face approximately South (plus or minus 20°). Use a declination value from a map or declination table to determine the direction of true South from the compass reading. The collector should be tilted at the latitude angle plus 15° for best winter operation and latitude minus 15° for best summer performance. Tilt at latitude for best year round performance. A good GPS will also provide accurate compass headings and your exact latitude. If you do not have a compass or GPS, wait until solar noon and the shadow of a vertical stick or surface will point due North. True South is 180° from true North. **HINT: MANY SOLAR SYSTEMS ARE PLACED AT THE ROOF SLOPE WHICH IS LESS THAN LATITUDE MINUS 15°, BUT IS MORE AESTHETICALLY PLEASING, WITH ONLY A SMALL 10% PENALTY IN ANNUAL PERFORMANCE.**

The Solar Orientation Factor (SOF) is shown in **Figure 2-b**. This shows that with a SOF of 0.9 you experience a 10% reduction in system performance and have a wide range of tilt around the latitude and East-West azimuth orientation, around true South.

**Figure 2-b   Solar Orientation Factor for San Diego, CA**

The latitude of your location can be found on the Internet (e.g., [www.mapquest.com](http://www.mapquest.com)) or in your local paper. The latitudes of some selected U.S. cities are presented in **Table 2** for reference. (HINT: Look at other solar collectors in your area, see how they are oriented to South and elevated for latitude) Our website ([www.butlersunsolutions.com](http://www.butlersunsolutions.com)) includes the complete Department of Housing and Urban Development (HUD) Manual for solar system installation. The report includes a solar siting template to show the effects of shadowing from trees or nearby buildings, declination map and other useful information about system siting.
Table 2. Approximate Latitudes of Selected U.S. Cities

<table>
<thead>
<tr>
<th>City (arranged by increasing latitude)</th>
<th>Latitude (all North)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anchorage, AK</td>
<td>62°</td>
</tr>
<tr>
<td>Juneau, AK</td>
<td>58°</td>
</tr>
<tr>
<td>Seattle, WA</td>
<td>47.5°</td>
</tr>
<tr>
<td>Portland, OR; Minneapolis, MN; Bangor ME</td>
<td>45°</td>
</tr>
<tr>
<td>Buffalo, NY</td>
<td>43°</td>
</tr>
<tr>
<td>Chicago, IL; Boston, MA; Detroit, MI</td>
<td>42°</td>
</tr>
<tr>
<td>Denver, CO; Indianapolis, IN; Philadelphia, PA</td>
<td>40°</td>
</tr>
<tr>
<td>Kansas City, MO; St. Louis, MO; Washington, DC; Cincinnati, OH</td>
<td>39°</td>
</tr>
<tr>
<td>Reno, NV</td>
<td>39.5°</td>
</tr>
<tr>
<td>San Francisco, CA; Sacramento, CA</td>
<td>38°</td>
</tr>
<tr>
<td>Nashville, TN</td>
<td>36°</td>
</tr>
<tr>
<td>Albuquerque, NM; Memphis, TN</td>
<td>35°</td>
</tr>
<tr>
<td>Los Angeles, CA</td>
<td>34°</td>
</tr>
<tr>
<td>Phoenix, AZ; Charleston, SC</td>
<td>33°</td>
</tr>
<tr>
<td>San Diego, CA; Savannah, GA</td>
<td>32°</td>
</tr>
<tr>
<td>Houston, TX; New Orleans, LA; Jacksonville, FL</td>
<td>30°</td>
</tr>
<tr>
<td>Tampa, FL</td>
<td>28°</td>
</tr>
<tr>
<td>Brownsville, TX; Miami, FL</td>
<td>26°</td>
</tr>
<tr>
<td>Honolulu, HI</td>
<td>21°</td>
</tr>
<tr>
<td>Hilo, HI</td>
<td>20°</td>
</tr>
</tbody>
</table>

3.2 **STEP 2:** Picking the Collector Location.

Horizontal mounting will minimize the height the collector rises above the roof when it is tilted up above the roof slope. Look for a location on the roof which will not be shaded by trees, other parts of the building, or other buildings. The solar collector should not be shaded between the hours of 8AM to 4PM. For best year-round performance, the tilt should be equal to the latitude angle. Architecturally it may be desirable to place the collector flat on a South-facing roof slope. Placed flat on the roof it will look like a skylight and blend into the roof better. The appearance may be much improved and the performance loss will be minimal.

**CAUTION:** THE COLLECTOR MUST BE TILTED UP A MINIMUM OF 18.5° (4X12 PITCH) TO 26.5° (6X12 PITCH) ANGLE SO THE STEAM CAN MOVE THROUGH THE COLLECTOR FLOW PATH TO THE SELF-PRESSURIZING UNIT WITHOUT BEING TRAPPED.

EVACUATED TUBE COLLECTORS WITH HEAT PIPES, MUST BE TILTED AT LEAST 18.5° AND PREFERABLY 30° ABOVE HORIZONTAL TO ALLOW GRAVITY TO RETURN THE HEAT PIPE FLUID TO THE BOTTOM OF THE COLLECTOR.
3.3  **STEP 3: Configuring the “Sun Block” Modules into a Roof Mountable Solar Collector Array.**

3.3.1  **STEP 3A: Configuring the “Sun Block” Modules & Flow Paths**

The “Sun Block” module is unique to the solar industry. The 20” x 3” x 72” size and light weight allow the “Sun Blocks” to be shipped by UPS and FedEx. The internal plumbing configuration allows the 10 square foot building blocks to be assembled like paving bricks into arrays, since they can be stacked up or placed end to end. The shape of the row by column array can be matched to the area available on the roof. Larger water tanks need more modules, so the size of the solar collector array can be matched to the size of the hot water storage tank. The overview in Figure 3-a, shows the “Sun Block” collectors and how 4 collectors can be used to form a single column, a single row, or a 2 x 2 array.

The details of the fluid flow channels are shown in Figure 3-b. The A-end of the “Sun Block” modules can be connected together with U-Tube connecting pieces to form a single column. In this case the B-end is capped off. This arrangement forces the fluid to flow through all of the collectors in series. This fluid flow arrangement is shown for a four “Sun Block” array in Figure 3-c “Four Module Column Arrangement”. A photo of four modules arranged in a column is shown in Figure 3-d.
The A-end of a single “Sun Block” module can be connected to the fluid loop to form the beginning of a single row. Then the B-end of this single collector is available to connect to the A-end of the next collector to be added to the row and so on. The last “Sun Block” module in the row has its B-end capped off. In this case the fluid enters the first “Sun Block” module and then at the B-end some of the fluid goes through the first “Sun Block” module to the outlet. Some of the fluid goes from the first to the second “Sun Block” module. Each single row has a bottom inlet header and top outlet header connecting all “Sun Block” modules together. There are as many parallel flow paths as “Sun Block” modules in the row. In this arrangement the fluid flow in each “Sun Block” module is less going from the first in the row to the last. This fluid flow arrangement is shown for a four “Sun Block” array in Figure 3-c “Four Module Row Arrangement”. We do not recommend putting more than four “Sun Block” modules in any single row.

The 2 row by 2 column array arrangement is shown for a four “Sun Block” in Figure 3-c “Module Arrays of Rows/Columns”. This shows how the A and B-ends need to be arranged to get parallel flow in each two module row and series flow in the two high columns.

![Using This Modular Building Block](Image)

**Figure 3-b**  “Sun Block” Modular Building Blocks and Configurations
Figure 3-c   Fluid Flow Paths for Common Four “Sun Block” Arrays

These three arrays of solar collectors are typical of most installations and show all of the features needed to configure the plumbing connections for a long row, column, or a row/column array,
3.3.2 STEP 3B: Mounting the “Sun Block” Modules on Rails for Roof Mounting

The “Sun Block” module configuration should be determined prior to ordering the system, so the roof mounting rails provided will match the row/column array you have chosen. Mounting the rail supports to the roof is covered in STEP 4. The rails run vertically on the roof, so they can be lifted higher on top than on the bottom to achieve a tilt angle above roof line. The rails come in two shippable lengths, 24” and 48”. The 72” and 96” lengths are shipped as a (48” + 24”) or two 48” lengths with a coupling piece to join them together. The standard rails are shown in Figure 3-e.

![Figure 3-e](image)

**Figure 3-e** Standard “Sun Block” Module Mounting Rail System

The “Sun Block” modules are fastened to the rails by mounting clips. There are two types of mounting clips, one type for the free ends of the modules and one type for the modules that are placed A-end to B-end. These mounting are shown in Figure 3-f. Also note the left side of the collector in this figure is the A-end, the two collectors are joined in the middle, B-end to A-end, and then the right side of the second collector is the B-end which is capped. Note the “Hat Section” metal cover on the left side which covers the fluid connections and their insulation.
STEP 3C: Mounting the Evacuated Tube Systems

The picture in Figure 3-g shows a properly mounted Sunda™ evacuated tube system. Note that the Self-Pressurizing Unit is mounted above the manifold, where the heat pipes from the tubes transfer their heat to the antifreeze fluid. The tube heat pipes slide into the manifold and must be covered with a heat transfer grease to assure good thermal contact. Heat pipe evacuated tubes should not be tilted less than 20 degrees above horizontal. Note that the upper rear brackets have been lengthened to achieve a higher tilt angle than the roof, which was 18.5° (4 x 12 Pitch) degrees above horizontal.
Figure 3-g  Properly Mounted Evacuated Tube System

3.4  **STEP 4: Mounting Thermal and PV Collectors**

3.4.1  **STEP 4A: Mounting the Collector on the Roof (or other location).**

The key to roof mounting is to not create leaks in the roof. The collector can be flashed into the roof using standard flashing techniques, or mounted on collector racks made for this purpose. Our website (www.butlersunsolutions.com) includes the Department of Housing and Urban Development (HUD) manual for solar system installation. This report includes roof mounting procedures and illustrations about how to secure the solar collector to the roof. It also discusses wind loading and how to brace collectors to withstand 100 miles-per-hour sustained wind loads, with peak winds reaching 125 miles-per-hour. It is important to use corrosion resistant fasteners, such as stainless steel, if you are in a wet or salt air environment. Various roof mounting methods are shown in Table 3.

**IMPORTANT:** BE SURE TO CONSULT YOUR LOCAL CITY OR COUNTY BUILDING DEPARTMENT TO ASSURE YOU ARE IN COMPLIANCE WITH ALL PERMITS, REQUIREMENTS, AND STATE AND LOCAL CODES AND PRACTICES.
### Table 3. Roof Mounting Options for Solar Collectors

<table>
<thead>
<tr>
<th>Fastening the Collector to the Roof, Flashing, Rails</th>
<th>COMPOSITION</th>
<th>CLAY OR CEMENT TILE ROOFING</th>
<th>SHAKE SHINGLES</th>
<th>TAR PAPER, TAR AND ROCK ROOF, USUALLY FLAT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flashing Collector into Roof Line (for pitched roofs only)</strong></td>
<td>100 MPH winds cause 25 pounds per square foot loads which can lift the collector off of the roof. Hold-down bolts and fasteners, usually ¼-inch to 5/16-inch diameter bolts, should carry this load, even after they have been severely corroded.</td>
<td>Tar and Metal Flashing</td>
<td>Remove Tile, Flash to Tar Paper, Seal with roofing tar, Recement to finish</td>
<td>Remove Shakes, Flash to Tar Paper, Seal with roofing tar, Finish Shake Edge</td>
</tr>
<tr>
<td><strong>Rack Mounting on Aluminum Rails</strong></td>
<td>Seal rail supports to roof</td>
<td>Drill tiles, remove tiles, mount flanges to roof and seal. Install tile and stand-off, and caulk stand-off to tile.</td>
<td>Seal rail supports to pads placed on shingles.</td>
<td>Seal rail hold-down bolts to roof</td>
</tr>
<tr>
<td><strong>Tilting Collector at an angle greater than the roof pitch</strong></td>
<td>Cross-bracing must be used; usually ¼-inch x 1” aluminum flat will suffice. 100 MPH winds cause 25 pounds per square foot load which can lift the collector off of the roof. Hold-down bolts and fasteners, usually ¼-inch to 5/16-inch diameter bolts should carry this load, even after they have been severely corroded.</td>
<td>Use a commercial roof rail mounting system. Seal all penetrations in the roof needed for mechanical fastening to the roof.</td>
<td>Install a stand-off that is sealed and attached to the roof and which comes above the roof tile and is cement sealed to the tile. Then use a commercial roof rail mounting system.</td>
<td>Use a commercial riser, see Figures 4-a,b&amp;c, sealed and attached to the roof, which comes above the shake roof and is cement sealed to the shakes using silicone sealer. Then use a commercial roof rail mounting system.</td>
</tr>
</tbody>
</table>
Figure 4-a  Roof Mounting Using Flange and Pipe Method

STEP 1. Mark location & drill through roof tile with core or carbide tipped drill

STEP 2. Seal flange with roof tar

STEP 3. Fasten flange to plywood roof deck

STEP 4. Slide tile back over mounted flange

STEP 5. Screw pipe into flange, cap & seal pipe to tile

Installing Flanges To The Roof Deck & Vertical Pipes To Support The Solar Collector Rails
For roofs where the collectors can be closely mounted to the roof, i.e. 6” or less, a simple plate with a threaded stud is used. This arrangement is shown in Figure 4-c.
Figure 4-c  Mounting of Rails and Collectors of Composition Shingle Roof

Figure 4-d  Rail Mounted Collectors on a Tilted Rack
3.4.2 **STEP 4B: Mounting a Photovoltaic Panel on the Roof**

If a photovoltaic powered pump is used, it requires a PV panel of the appropriate Wattage (i.e., 20 Watts), that must be mounted on the roof along with the solar thermal collector. The wires in the umbilical in **STEP 7** must include at least three 16 AWG wires to power the pump and overflow level sensor. The PV panel should be tilted up at the solar collector angle and facing South or slightly Southwest. The PV panel should be mounted so it is not shaded during the day by any part of the thermal solar collector or vents raised above roof line. The PV panel can be mounted to the thermal solar collectors and tied to the roof through them, as shown in **Figures 3-d, 3-g and 4-d**, or be mounted separately. Separate PV collector mounting requires additional roof penetrations similar to those used for the thermal solar collectors.

3.5 **STEP 5: Installing the Solar Wand Heat Exchanger**

1. The solar wand is inserted in the HOT WATER OUTLET of the existing hot water tank. The water tank must be depressurized first. This is accomplished by turning off the water supply to the tank. This valve should be inside the house at the water service entrance, or at the cold-water inlet to the hot water tank. If no cold water shut-off exists in the house, the water must be shut off at the street and a shut-off valve added at the cold water inlet line to the hot water tank. Once the supply valve has been located and turned off, open a water faucet in the house and let it run until there is no pressure. Leave the faucet on.

   **CAUTION: THE HOT WATER MAY CAUSE SCALDING. TO PREVENT INJURY PROCEED WITH EXTREME CAUTION.**

2. Shut the gas valve if you are installing in a gas hot water heater. If you are installing in an electric hot water heater, shut off the electric circuit breaker supplying the water heater.

   **CAUTION: TURN OFF THE SOURCE OF FUEL OR POWER BEFORE BEGINNING TO WORK ON THE HOT WATER TANK. DOUBLE-CHECK, IF NECESSARY, TO BE CERTAIN THAT THE FUEL OR POWER HAS BEEN SHUT OFF!!!**

3. Allow the water in the tank to cool off BEFORE draining the tank using either the drain valve at the bottom of the tank or a siphon or pump to lower the tank level from the top.

   **NOTE: ON OLDER TANKS WHERE PROPER ANNUAL DRAINING HAS NOT BEEN DONE, SOLID MATERIAL ACCUMULATES AROUND THE INSIDE OF THE DRAIN VALVE OPENING. OPENING THE VALVE MAY ALLOW THESE SOLIDS TO JAM IN THE VALVE AND KEEP IT FROM CLOSING, REQUIRING REPLACEMENT. OPENING THE VALVE MAY NOT ALLOW WATER TO DRAIN FROM THE TANK, BECAUSE THE SOLID MATERIALS COMPLETELY**
BLOCK THE INLET TO THE VALVE. TO AVOID PROBLEMS
WITH THE VALVE, SIPHONING OR PUMPING SOME WATER
OUT OF THE TOP OF THE TANK ALLOWS YOU TO LEAVE
THE DRAIN VALVE ALONE, AND SHUT, JUST AS YOU FOUND
IT.

Remove the hot-water outlet and cold-water inlet connections using pipe and or
adjustable wrenches and check and clean the threads with a ¾-inch NPT pipe tap if
needed.

NOTE: IT HAS COME TO OUR ATTENTION THAT HOT
WATER TANKS MANUFACTURED BY BRADFORD/WHITE
UNDER THEIR OWN LABEL OR FOR SEARS ROEBUCK HAVE
THE SACRIFICIAL ANODE ATTACHED TO THE BOTTOM OF
THE NIPPLE IN THE HOT WATER OUTLET PORT. IF THIS IS
THE ONLY SACRIFICIAL ANODE IN THE TANK REMOVING
IT WILL SIGNIFICANTLY REDUCE THE TANK’S LIFE. TO
CIRCUMVENT THIS CHALLENGE, THE COLD WATER MUST
BE REPLUMBLED TO THE BOTTOM OF THE TANK, BY TEEING
INTO THE DRAIN VALVE PORT, THE HOT WATER OUTLET
PORT CAPPED AND THE WAND INSERTED INTO THE
ORIGINAL COLD WATER PORT ON TOP OF THE TANK, TO
WITHDRAW THE HOT WATER. SEE FIGURE 5-a.

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Figure 5-a Special Instructions for Bradford White Hot Water Tanks With
Sacrificial Anode on the Hot Water Outlet Nipple.

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NOTE: IT HAS COME TO OUR ATTENTION THAT SOME HOT WATER TANKS ARE MADE WITH THE HOT WATER OUTLET NECKED DOWN ON THE INSIDE, LIKE THE COLD WATER INLET, WHICH IS NECKED DOWN TO HOLD THE DIP TUBE, WHICH DELIVERS COLD WATER TO THE BOTTOM OF THE TANK. IF THE HOT WATER OUTLET FITTING IS NECKED DOWN, YOU WILL HAVE TO FILE OFF THE NECKED-DOWN REGION TO ALLOW THE WAND TO BE PUT INTO THE TANK. THIS CAN BE DONE WITH A SMALL HALF ROUND FILE AND SHOULD TAKE LESS THAN 30 MINUTES (See Figure 5-b).

You may save time during the filing process by using a Dremel® tool and abrasive grinding bit. Although metal filings will not harm the tank, the number of filings that go into the tank can be minimized by using a vacuum cleaner or a small magnet, or by turning the tank so filings fall out of the tank during the process. Of the filings that do remain in the tank, some will dissolve in the water, and the rest will settle harmlessly to the bottom of the tank and oxidize to iron oxide.

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**Solar Wand Installation Note**

If you have any questions, call or e-mail us (858)-259-8895 or www.butlersunsolutions.com

- Install Wand in Hot Water Tank Outlet
- If Wand Will Not Fit Through ¾ NPT Thread
- Then Carefully File the Bottom Edges of the Outlet Threads As Shown

---

**Figure 5-b**  Notes On Getting Wand Into Tank.
4. Take a thin stick or measuring tape and measure the depth inside the tank, under the hot water outlet port to be sure that the wand is not too long. Long wands need 46.5” from the bottom of the tank to the top of the threads; short wands need 36.5” from the bottom of the tank to the top of the threads. Sometimes scale will build up and reduce the tank depth. If this has happened the tank must be flushed out to remove the scale build up. If the tank depth is not enough to allow the wand to be inserted and screwed in to seal, then a shorter wand must be used.

5. Wrap the male ¾-inch pipe threads on the wand with at least 3 wraps of plumber’s Teflon® tape.

6. If the water tank has sufficient space above it to allow the wand to be inserted, then skip to **SUB-STEP 8**. The proper installation of the solar wand and the Anti-Scald valve are shown in Figure 6-a.

**HINT: CUTTING THE HOLE FOR THE UMBILICAL IMMEDIATELY ABOVE THE HOT WATER OUTLET PORT ON THE HOT WATER TANK OR FOR GAS HOT WATER HEATERS REMOVING THE VENT PIPE, MAY ALLOW THE TOP OF THE WAND TO PASS THROUGH THIS HOLE TO THE ATTIC OR ROOF AND AVOID THE NEXT SUB-STEP 7, TILTING THE TANK.**

7. If the tank needs to be leaned over to insert the wand, the following procedure must be followed:
   - Disconnect the pressure/temperature relief outlet piping if it prevents tipping the tank.
   - If the tank has anti-earthquake restraints, disconnect them.
   - Disconnect the cold-water inlet to the tank, and move piping out of the way.
   - Make sure the electrical or gas is turned off, then disconnect the electrical or gas connections to the tank, so the tank can be tilted.
   - Drain the water from the tank, so hot water will not spill out when the tank is tilted to a 45 degree angle and so the tank will weigh less.

8. Insert the wand carefully, and be sure it goes in straight and does not touch the electric heating elements or central gas heating tube.

9. Screw in the wand and tighten with a pipe wrench to ensure that the pipe threads seal.

10. Return the tank to upright position if it has been tilted. Secure the tank with anti-earthquake restraints if needed.

11. Reconnect the gas or electric lines and pressure/temperature-relief piping.
### 3.6 STEP 6: Installing Anti-Scald Valve and Repressurizing the Hot Water Tank

1. Install the Anti-Scald valve between the hot water outlet of the solar wand and the house hot water line and the house cold water line, using proper plumbing fittings, piping and techniques, which meet local and national codes, see Figure 6-a. **NOTE:** APPROVED ANTI-SCALD VALVES ARE AVAILABLE FROM BUTLER SUN SOLUTIONS, OR HONEYWELL’S SPARCO DIVISION. THE PLUMBING CONNECTIONS AND FITTINGS NEEDED FOR STANDARD WATER HEATERS ARE SUPPLIED WITH THE SOLAR COLLECTOR KIT. SPECIAL CONNECTORS SHOULD BE AVAILABLE FROM YOUR LOCAL HARDWARE OR PLUMBING STORE.

2. Connect the cold water piping to the tank with a T-fitting, so cold water can be routed to the cold water inlet of the Anti-Scald valve. Use fresh Teflon® tape on all of the threaded joints.

3. Connect the T-fitting in the cold water line to the cold input on the Anti-Scald valve and set to the desired maximum temperature, usually 120°F (49°C).

4. Check to be sure that the drain valve is closed and the hot and cold-water connections are tight.

5. Open the cold water shut off valve and refill and pressurize the hot water tank.

6. Check for leaks and tighten any leaking connections.

7. Close the water faucet opened in **STEP 5, SUB-STEP 1**, after all of the air has been purged from the system.

8. Turn on gas and relight pilot light if necessary, or turn on the electric circuit breaker.

9. Set tank thermostat to warm or 120°F (49°C).

10. Insulate the last 5 feet of cold water line coming into the hot water tank, and the hot water outlet lines exiting the tank.

11. The tank is now back in operation and ready to have the solar heating system connected to it.

12. A thermal insulating blanket should be installed now, if the tank is not a newer well insulated model.
Figure 6-a  Proper Installation of the Anti-Scald Tempering Valve
Figure 6-b  Anti-Scald Valve Blow Up Diagram Needed for Disassembly and Cleaning
3.7 **STEP 7: Installing Roof to Tank Umbilical of Insulated Fluid Tubing & Electrical Wires**

3.7.1 **STEP 7A: Running the Flexible \(\frac{3}{8}\)-inch Copper Tubing from the Solar Collector to the Hot Water Tank, Including Sweated Solder Joints if the Tubing is not Continuous.**

The supplied umbilical comes in 25 foot lengths, one of which is supplied and should be sufficient for most installations. If the umbilical must be extended it should be coupled using sweated solder joints, not compression unions that can leak in inaccessible locations. A tubing expander can be used to make a slip-in fit swage joint, like in refrigeration systems, or a sweat coupling can be used, where both tube ends slide in and are sweated at one time, see **Figure 7-a.**

![Umbilical With Coupling (Top) and Swaged Joint (Bottom)](image)

**Figure 7-a  Solder Coupling for Umbilical Copper Tubing**

1. Determine the shortest, smoothest, and easiest route for the tubing, and determine where the piping will come from inside the roof to the outside. **NOTE: THE BOTTOM OF THE COLLECTOR NEEDS TO BE ABOVE THE ROOF PENETRATION, SO THE TOP OF THE COLLECTOR IS THE HIGHEST POINT IN THE FLUID HEAT TRANSFER LOOP.**

2. Drill a 2 ½-inch diameter hole in the roof to accommodate the insulated tubing umbilical and electrical cable(s) cased in 2” ABS/PVC pipe. Be careful not to weaken critical structural members with the holes. The ABS/PVC pipe will be held in place by the top of the roof flashing, see **Figures 7-b and 7-c.**

3. The roof penetration must be placed so the umbilical comes onto the roof below the bottom of the solar collector. This is necessary so the Self-Pressurizing Unit will be located at the highest point in the fluid loop. This will ensure that any trapped air will be pushed out of the fluid loop and replaced with water/antifreeze mixture from the overflow recovery tank during operation.
At the location where the umbilical goes from inside to outside of the house make certain that the opening is sealed properly, to be sure water, insects, and rodents cannot enter (see Figures 7-b, 7-c and 7-d). Also see Figures 3-d and 3-g.

![Diagram](image)

**Figure 7-b**  Standard Water-Tight Roof Penetration for 2” ABS/PVC Pipe

**Figure 7-c**  Collector to Roof Jack Penetration Using Split Pipe to Cover Umbilical on Roof, Umbilical under Roof Jack to Water Tank
Roof Positions of Self-Pressurizing Unit and Roof Penetration

NOTE: THE SELF-PRESSURIZING UNIT MUST BE THE HIGHEST POINT IN SYSTEM & ABOVE ROOF PENETRATION.

4. In routing the umbilical, sweeping bends can be made carefully by hand. For sharper bends, use a tubing bender to make neat bends without kinking the tubing. **HINT: IF THE UMBILICAL YOU HAVE IS ALREADY INSULATED, CUT THE INSULATION AND PUSH IT BACK FROM THE BEND SO THE TUBING CAN BE BENT WITHOUT KINKING.**

5. You will need to know which tube is which later on. The pre-made umbilical comes with one tube marked over its entire length. If you are making your own umbilical or extending a pre-made umbilical, mark the tubes so you can tell them apart. The marked tube should be the collector return line. **HINT: PUT A PIECE OF ELECTRICAL TAPE ON EACH END OF ONE OF THE TUBES, OR USE A MAGIC MARKER AND PUT A STRIPE ALONG THE LENGTH OF ONE OF THE TUBES, OR AT LEAST THE LAST SEVERAL FEET ON EACH END.**

6. For best performance, the supply and return tubes should be kept from touching in the insulation. The pre-made umbilical comes with the tubes separated with clips and insulated. If you are making or extended an umbilical yourself, you can order a plastic spacer kit composed of plastic S-clips see **Figures 7-a and 7-e.** Spacers should be placed about every six inches along the length of the tubing.

7. To install an umbilical, the tubing can be laid out side-by-side along the chosen path. Then S-clips can be added at six-inch intervals, the split insulation applied along its length, and finally the electrical cable can be attached in place. Alternatively, the
umbilical can be assembled with the spacers, insulation, and electrical cable, and fed from one end along the path chosen from the hot water tank to the collector.

**IMPORTANT:** BE SURE TO ATTACH THE WIRES TO THE INSULATED TUBE UMBILICAL, BEFORE YOU RUN IT BETWEEN THE WATER TANK & COLLECTORS ON THE ROOF.

![Figure 7-e Water Tank To Solar Collector Umbilical](image)

Leave enough tubing at each end to connect to the collector and the wand. Route the umbilical neatly inside the attic with the foam insulation as the outer surface and secure to the structure using plastic pipe straps to make it look professional. Allow for limited motion to accommodate thermal expansion of umbilical. Cover exposed umbilical on roof, in closets and shelving areas with 2” ABS/PVC split pipe so it looks good and will not be damaged by sun or objects placed against it.

### 3.7.2 STEP 7B: Running the Temperature Sensor & PV Power Cable & Protecting the Umbilical

1. Run both a three-wire AWG #18 temperature signal cable and a three-wire AWG #18 PV power cable parallel to the insulated copper tubing fluid umbilical. Once the tubing has been insulated, the wire can be taped onto the outside of the insulation with electrical tape at 0.5 m (20”) intervals (see **Figure 7-e**). The pre-made umbilical comes in coils with the copper tubes clipped together and insulated, but without the wire attached. One three-wire cable can be used to connect the PV panel power source to the circulation pump and connect the overflow reservoir fluid level switch.
to the low fluid LED on the hot water tank. See Figure 7-f. HINT: A 25 FOOT POWER AND SIGNAL CABLE CAN BE MADE FROM A SINGLE 50 FOOT AWG 3-18 OUTDOOR RATED (ORANGE) EXTENSION CORD FROM THE HARDWARE STORE. INSTALLING BOTH SIDE BY SIDE NOW GIVES THE OPTIONS OF COLLECTOR TEMPERATURE MEASUREMENT FOR CONTROL AND PHOTOVOLTAIC POWER FOR THE CIRCULATION PUMP.

![Butler Sun Solutions Wiring Diagram for PV Powered Pump with Snap Switch High Limit And Float Level Minder LED System](image)

**Figure 7-f** Single Power Cable for PV Pump and Fluid Level Light
2. Any sections of the umbilical that are exposed to sunlight and weather need to be protected. This is done using 2" ABS/PVC, black/white drain pipe and fittings to cover the affected areas (see Figures 7-c and 7-e). NOTE: 2"ABS/PVC PIPE AND ELBOWS, SPLIT IN HALF SO THEY SNAP EASILY BACK TOGETHER, ARE SUPPLIED WITH THE COLLECTOR KIT. IF YOU CHOOSE NOT TO USE THE SPLIT 2" PIPE FROM BUTLER SUN SOLUTIONS, ABS/PVC PIPE AND ELBOWS ARE AVAILABLE FROM YOUR LOCAL HARDWARE OR PLUMBING STORE.

Straight lengths of un-split pipe can be slipped over the umbilical during installation. Angle fittings may be cut in half so they can be placed around the corners and cemented back in place. Once the fittings are in place, they can be glued back together and secured using stainless steel screw-hose clamps to clamp the pieces together while the glue sets.

| IMPORTANT: DRAIN HOLES MUST BE DRILLED IN LOW SPOTS OF THE ABS/PVC PIPE TO PREVENT RAINWATER FROM ACCUMULATING IN THE PIPE. |

3.8 STEP 8: Installing the Self-Pressurizing Unit

The Self-Pressurizing Unit assembly shown in Figure 8-a, usually has mounting brackets on both ends and in the middle. The mounting hardware is shown in Figure 8-b. The radiator end mounting plate is attached to the collector support rail for “Sun Block” modules. For other collector an optional support is used, see Figure 8-b. The center and fill (float level) end are attached to the solar collector via a bracket that attaches to the solar collector edge and allows the Self-Pressurizing Unit to be leveled. Once leveled the single top screw are used to hold the sliding plastic T-brackets in place it in place. Then secure sliding plastic T-brackets with the 4 bottom screws in each one.

Determine the angle of the solar collector, and then use the set of holes in the ABS plastic mounting plates that brings the radiator cap closest to horizontal. The mounting plates should be bonded to the Self-Pressurizing Unit using ABS cement. After the ABS cement has set, about 20 minutes, attach the mounting plate to the collector rail, so the radiator end faces the A-end of the solar collector, the fluid inlet and outlet side. Properly position and attach the aluminum brackets to the solar collector for the middle and far ends. Loosely attach the hardware, so the middle and far end sliding supports can be moved to level the Self-Pressurizing Unit, so that the far end is about ½ inch above the radiator end. It should be nearly parallel with the top of the solar collector. Tighten all bolts and screws.

Attach and partly tighten the ¾-inch, 90-degree bent tubing coming from the radiator assembly to the upper T-connector of the collector. A tubing cutter and deburring tool are needed to cut the copper tubing to length and debur it so it will fit into the T-connector. (See Figure 8-c). NOTE: BE SURE THAT THE OVERFLOW RESERVOIR FLOAT LEVEL SWITCH MOVES FREELY UP AND DOWN TO MEASURE ACCURATELY.
The wires from the float switch need to be connected to the umbilical wires. The float switch connections are shown in Figures 7-f, 14-a and 14-b. Solder and weather protect these connections to prevent false readings.
3.9 **STEP 9:** Connecting the \( \frac{3}{8} \)-inch Copper Tubing to the Solar Collector Inlet and Outlet.

**HINT: BE SURE TO NOTE THE SOLAR COLLECTOR INLET AND OUTLET ON THE WATER TANK END OF THE TUBING.** If you did not label the pipes in **STEP 7A, SUB-STEP 5**, you will need to use a plastic cap or tape to seal the end of one of the copper tubes at the water tank. Before you connect the collector inlet tube, the lower one, blow into it. **Note on paper if it is free flowing or capped.** Do the same for the collector outlet and you will know if the capped pipe at the water tank is collector inlet or outlet.

The collector inlet on the bottom of the collector is fitted with a \( \frac{3}{8} \)-inch compression right-angle fitting. Using the tubing cutter and deburring tool, cut and debur the \( \frac{3}{8} \)-inch tube from the hot water tank, slide it into the compression fitting and tighten. Be sure to tighten both sides of the right angle fitting (see **Figure 8-C**).

![Solar Collector Fluid Connections and Interconnections](image-url)
The collector outlet on the top of the collector is fitted with a \( \frac{3}{8} \)-inch tee compression fitting. Using the tubing cutter and deburring tool, cut and debur the \( \frac{3}{8} \)-inch tube to the hot water tank, slide it into the compression fitting and tighten. Be sure to tighten all three sides of the tee (see Figure 8-c). Insulate with rubber foam insulation and cover the collector connections with the sheet metal “hat section” cover provided. This cover is shown in Figure 3-f, top left and Figure 8-c sitting over the collectors. Specific instructions are provided with each solar collector option, and although the procedures are similar, different fittings may be used.

If your solar system uses a Delta-T controller, you will need to install a temperature sensor on the solar collector outlet. The sensors should be hose clamped to make solid physical contact with the solar collector outlet line as shown in Figure 8-d.

#### Figure 8-d  Solar Collector Temperature Sensor For Delta-T Controllers Only

**3.10 STEP 10: Connecting the Pump Assembly Inlet, (including: Pump; Pump Isolation Valve; Flush Valve; Fill/Drain Valve), to the Union on the Outlet of the Wand (Lower Connector)**

The pump is supplied with the pressure gauge, flush, fill/drain and pump isolation valves attached to it. A union is used to connect the Wand’s outlet (the lower of two wand connections) and the pump inlet. The pump outlet includes a set of three valves which are needed to flush and fill a system with antifreeze. The three valves are a fill/drain valve, a quarter turn pump isolation valve and a flush valve. The isolation valve is normally open and shuts off flow from the pump to the solar collector. The fill/drain valve and flush valves are used to connect the fluid loop to the antifreeze charging system. Once the system is charged a pressure gauge is added to the fill/drain valve and it is opened so the gauge can read pressure at the pump outlet. The operation of these valves to flush and then fill the system will be explained in STEP 16.
Hot water tank replacement and pump replacement are the two most common large system maintenance items. Ease of system maintenance is provided by two quarter turn ball valves for system isolation. These valves are located on the pump outlet and the wand inlet. Each of these valves has two compression unions, one on each end. Closing these valves isolates the solar collector fluid loop from the solar wand. The pump can then be removed and repaired or replaced without draining the entire system and without losing too much fluid. The isolation valve unions closest to the wand can both be disconnected, keeping the fluid in the solar collectors, while the tank is removed and the
wand moved from the leaking hot water tank to a new one. If the wand is poured full of fluid after it is in the new tank, the valve connections can be remade, the valves opened and the system will circulate normally. The system will then refill itself from the overflow reservoir which should then be topped off with antifreeze mixture.

Figure 10-b  Horizontal & Vertical Solar Umbilical Connections

The quarter turn ball valves come in two styles, straight through and side outlet. By reversing their positions on the pump and wand, you can go from horizontal umbilical connections to vertical umbilical connections. The positions of the valves for horizontal or vertical umbilical connections are shown in Figure 10-b.

3.11  STEP 11:  Connecting the ⅜-inch Solar Collector Inlet Tube to the Pump Assembly Outlet (Including: Pump Isolation Valve; Flush Valve; Detachable Pressure Gauge)

In STEP 9 you noted which copper tube was the collector inlet line (bottom of the collector). Using the tubing cutter and deburring tool, cut and debur the ⅜-inch tube from the collector inlet, slide it into the compression fitting on the flush valve on the pump assembly outlet and tighten (see Figures 10-a & b).

Figure 10-b shows the arrangement for vertical and horizontal connection to the umbilical. This is accomplished simply by reversing the positions of the straight-through and right-angle (side outlet) ¼-turn isolation valves (chrome-plated).
3.12 **STEP 12: Connecting the ¾-inch Solar Collector Outlet Tube to the Wand’s Inlet (Upper Connection) and Install Temperature Gauge plus Level Minder LED.**

In **STEP 9** you noted which copper tube was the collector outlet line (top of the collector). Using the tubing cutter and deburring tool, cut and debur the ¾-inch tube from the collector outlet, slide it into the upper compression fitting on the wand isolation valve and tighten. Be sure to tighten the fitting, see Figures 10-a and 10-b.

Attach the automotive thermometer with the small radiator hose clamp provided to the tube that you just attached to the wand isolation valve, so it will read the temperature of the heat exchange fluid coming from the solar collector to the wand (see Figures 10-a and 10-b). **NOTE: THE INLET FLUID TEMPERATURE AND OUTLET FLUID TEMPERATURE SHOULD USUALLY BE WITHIN 20ºF OF EACH OTHER, THE INLET BEING HOTTER.**

The low fluid level indicator light will be either mounted on the temperature gauge or located near it. The red LED indicator light will need to be connected electrically as shown in Figures 7-f, 14-a and 14-b.

3.13 **STEP 13: Installation of Water Tank High Limit Temperature Switch or Sensor.**


Mount the cut off switch in contact with the tank top (see Figure 13-a). Be sure it is sufficiently far away from the flue of a gas-fired water heater so it will not be affected by the exhaust gases. Then wire up the system according to Figures 7-f for direct connection or Figure 14-a, if using a linear current amplifier. **The negative wire from the PV panel to the linear current amplifier or pump is not connected now. It will be connected later.**

**CAUTION: DO NOT CONNECT BOTH WIRES FROM THE PV PANEL TO THE LINEAR CURRENT AMPLIFIER OR PUMP UNTIL AFTER THE SYSTEM IS FULL OF FLUID. THIS PREVENTS THE PUMP FROM RUNNING DRY WHICH DAMAGES THE BEARING.**
3.13.2 STEP 13B: Installing the Water Tank Temperature Sensor near the Top of the Tank (Delta-T Controller Systems Only)

The temperature sensor is a short piece of ⅜-inch copper tubing flattened at one end, with a thermistor epoxied into it and two wires coming out of the un-flattened end. This sensor needs to be placed in contact with the tank outer wall, near the top. It must be placed under the tank’s foam or fiber insulation. The recommended place to install the sensor is near the top electric heating element of an electric water heater or the pressure/temperature relief valve near where it connects to the tank. Using a screwdriver peel the plastic shield on the pressure relief valve away from the tank’s outer sheet metal shell. Then using a screwdriver push a hole through the insulation, at an angle, until you contact the tank wall. Move the screwdriver around to make the hole big enough for the sensor. Carefully push the sensor into the hole so it is in contact with the tank wall. Push the tank insulation back in place, and slide the plastic disk back in place. **NOTE:** BE SURE TO TAPE OR FILE OFF SHARP SHEET METAL EDGES THAT COULD CUT INTO AND SHORT THE SENSOR WIRES (see Figure 13-b).
**CAUTION: DON’T DRILL INTO OR PUNCTURE TANK WALL**

Water Tank near Top Temperature Sensor Installation

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**Figure 13-b Tank Top Temperature Sensor Installation**

3.14 **STEP 14: Control Systems, Insolation and Delta-T**

The standard PV-powered “Insolation based” control is what is shipped with most systems going to the Southwest, where winter temperatures are higher on average. When there is enough sun to drive the pump it runs. In early morning or late afternoon the pump may be sending heat from the hot water tank to the solar collector, cooling the tank and heating the outdoors. In sunny Southwest climates this loss is small. In Northern climates it can be a larger loss. This problem is eliminated by the use of a Delta-T controller which will only turn the pump on when the solar collector is hotter than the water tank by about 16°F.

There are several types of low voltage DC pump motors. Those which use a phase synthesis approach will start with no significant inrush of current. The soft start is achieved using electronics and pole piece placement to simulate a 3 phase motor. Kick start motors require an inrush of current to get the motor spinning, once started the current requirements go down. For PV-powered systems a linear current amplifier (LCA) maximizes power from the PV voltage and current to create the motor inrush current needed. For AC powered systems an AC-to-low-voltage-DC transformer is used to supply the motor inrush current, see **Table 4**.
Table 4.  Pump Motor to Controller Connection Options

<table>
<thead>
<tr>
<th>Pump Motor Type</th>
<th>Controller Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insolation Control PV Power</td>
<td>Delta-T Controllers PV Power</td>
</tr>
<tr>
<td>Soft Start 3 Phase Type</td>
<td>Ivan Labs. El-SID-PV</td>
</tr>
<tr>
<td>Single Phase Kick Start</td>
<td>Linear Current Amplifier (LCA) Laing D-4</td>
</tr>
<tr>
<td>Single Phase Built in LCA</td>
<td>Laing D-5</td>
</tr>
</tbody>
</table>

Data on the PV powered seal-less pumps is provided in Figures 14-a & b. The blow up diagrams show what is inside the pump.

![Laing PV Seal-Less Pump](image-url)

Figure 14-a  Laing PV Seal-Less Pump
3.14.1 STEP 14A: Insolation Controlled Pump Using PV Power Direct Coupled

When the sun insolation is above about 300 Watt/m², the pump begins circulation. As the sun approaches 1000 Watt/m² near solar noon the pump circulates faster and faster. The flow goes from 0.2 L/min. to 0.5 L/min. respectively. Two direct coupled pumps are standard with our system, the Ivan Laboratories El-SID, (Static Impeller Driver) and the Laing D-5. Both of these pumps are brush-less and need no external electronics to start them in the morning, hence they are connected to the PV panel directly, with only the hot water tank high limit snap switch wired in series with the pump (Figure 7-f).
3.14.2 STEP 14B: Insolation Controlled Pump Using PV Power LCA Coupled

A Linear Current Amplifier must be used for pumps which do not have built-in electronics such as the Laing D-4 and other single phase brush-less DC pumps. See Table 4 to determine what type of configuration you have. Use the diagram in Figure 14-c to connect the PV panel to the LCA through the tank high limit snap switch. Then wire the LCA to the pump.

![Figure 14-c Connections for PV panel, LCA, and High Limit Cut-Off Switch](image)

3.14.3 STEP 14C: Connecting the Temperature Sensors to the Solar Converters Ltd. Controller (PV-Powered Delta-T Controller Systems Only)

Using a small screwdriver, connect the wires from the solar collector outlet and water tank top sensors to the controller as shown in Figure 14-d. **NOTE: DO NOT CONNECT THE PV PANEL NOW – IT COULD RUN THE PUMP BEFORE IT IS FILLED WITH FLUID.** **HINT: CRIMPED AND SOLDERED SPADE CONNECTORS ARE PREFERRED. IF SPADE CONNECTORS ARE NOT**
AVAILABLE, TWIST STRANDS, BEND IN U-SHAPE AND TIN WITH SOLDER. Bad connections will cause system malfunctions. Do it right the first time.

**Figure 14-d**  PV Powered Delta-T Controller with Built-In or External LCA

**STEP 14D:** Connecting the Temperature Sensors to the AC Controller, and Setting up Goldline GL-30 Controller (AC-Powered Systems Only)

Connect the solar collector temperature sensor and water tank top sensor to the controller board and tighten down, see **Figure 14-e**. The leads from the float level switch can be connected to the AUX terminals. The positive AUX terminal must be connected to power the float level switch which is in series with the level minder LED light. The LED negative must be connected to the negative AUX terminal. Check with a volt meter to be sure which AUX is positive. **HINT: CRIMPED AND SOLDERED SPADE CONNECTORS ARE PREFERRED. IF SPADE CONNECTORS ARE NOT AVAILABLE, TWIST STRANDS, BEND IN U-SHAPE AND TIN WITH SOLDER.** Bad connections will cause system malfunctions. Do it right the first time.

Check to be sure the controller storage over-temperature adjustment (“HI LIMIT”) and pump-on differential adjustment (“TURN ON”) are properly set, at 185°F (85°C) and 16°F (8.9°C) respectively.
Reinstall the controller cover. Plug in the LCD temperature display cable if the temperature display is installed. Snap the controller cover in place and install the cover retaining screws (see Figure 14-e). Leave the controller unplugged until the system has been filled.

3.15 STEP 15: Flushing and Filling the System with Propylene Glycol-Water Antifreeze Heat Transfer Fluid and Replacing the Fluid Every Five Years

When a system is first installed, you must flush it out before filling to remove any debris in the lines. Every five years, it is necessary to replace the propylene glycol heat transfer fluid. In both cases, the following procedures should be used.

3.15.1 Freeze Tolerance Limits:

The system uses antifreeze to protect components from freezing and to provide protection against boiling in the summer. Propylene glycol antifreeze is used, which is non-toxic and available at auto supply stores. In order to mix the proper antifreeze heat transfer solution you must decide what level of freeze protection is required based on your local climatic conditions. In warm climates at least a 50/50 mixture of propylene glycol with water must be used for boiling protection. This will allow the system to operate to -32°C (-26°F). Below that temperature slush will form which will not circulate, but will not damage the collectors until the temperature drops below -48°C (-54°F). For the system to operate as low as -48°C (-54°F) a 60/40 propylene glycol-water mixture is required. Other mixture properties can be obtained from the propylene glycol packaging. Mix the propylene glycol antifreeze with water by volume to form the appropriate mixture.

CAUTION: BEFORE ATTEMPTING TO FILL THE SYSTEM IF THE SUN IS SHINING, COVER THE COLLECTOR WITH SOMETHING OPAQUE SUCH AS A TARP, HEAVY BLANKET, OR CRAFT PAPER.
CAUTION: The flushing process uses fresh water. If you attempt to flush the system when the air temperature is below 20°F (-7°C), the water may freeze in the collectors and cause damage. If you must fill the system when the temperature is below 20°F (-7°C), you will need to flush with antifreeze and you will need a pump capable of 2 gallons per minute of flow at 50 psi.

3.15.2 Flushing System Using City Water:

Every newly installed system should be flushed with fresh water before antifreeze is added. This removes any debris or dirt in the lines and ensures the system is well sealed before operation. The following procedure can be used to fill the system with fresh water.

1. Prior to flushing the system, the Self-Pressurizing Unit reservoir should be empty of fluid and the radiator cap should be in place and tightened. The circulation pump must be off by being unplugged or unwired during the process. All fittings around the pump and wand should be checked for tightness if this is the first filling of the system.

2. Familiarize yourself with the valves around the circulation pump, see Figures 10-a and b. There is a pump isolation valve at the outlet of the pump and a wand isolation valve at the top of the wand. They are ¼-turn ball valves, and are OPEN when the handle is aligned with the 3/8 inch fitting. There are also two ¼” inch needle valves, the fill/drain valve at the outlet of the pump and the flush valve just past the pump isolation valve. These valves connect to the outside of the system. To OPEN these valves, you turn the small T- handles counterclockwise several turns.

3. A hose bib-to-¼-inch tube adapter is included in the installation kit. Connect this assembly to a garden hose that is attached to a source of water. Attach the ¼-inch copper tube to the flush valve (just beyond the pump isolation valve on the collector side).

4. Connect the fill/drain valve to a length of ¼-inch plastic tubing and put the other end of the tube into a bucket.

5. OPEN the fill/drain valve and CLOSE the pump isolation valve which is between the two needle valves. OPEN the other isolation valve (at the wand).

6. Pressurize the hose to full line pressure. This will cause water to flow rapidly up through the collectors, back down through the wand and circulation pump, and out the fill/drain valve. Flush the system with several gallons of water, until the water that comes out is clean and free of debris and air bubbles. Make sure that the flush valve (connected to the hose) is wide open.

7. After the system is full, leave the flush valve on and close the fill/drain valve for a few seconds. This will cause fluid pressure to open the radiator cap and push a little water into the overflow. The system is now flushed and the overflow has a little water in it.

8. Close the flush valve then depressurize the hose and remove the garden hose then remove the ¼-inch tubing from the flush valve.
9. The flush and fill/drain valves are closed, now open the pump isolation valve. The system is now flushed and filled with water.

10. Connect the pressure gauge to the fill/drain valve outlet (nearest the pump outlet) and open the valve to connect the gauge to the system pressure.

11. Start the circulation pump by plugging in the AC controller or connecting the wires to the PV Delta-T Controller, or connecting the EL-SID pump to PV panel or 12 VDC Power Supply. If it is cloudy, you can use a 12VDC power supply instead of the PV panel for this test. The pressure gauge will rise 1-2 psi when the system is circulating properly.

12. As a further test, close the pump isolation valve for a few seconds. The pressure should rise quickly to about 5 psi, and should drop back to 1-2 psi with the valve closed. Open the valve again. System circulation is now verified. This “ping” test tells you fluid is circulating.

13. Disconnect the circulation pump for antifreeze filling.

14. If you have a high pressure pump go to section 3.15.3. If you do not have a pump move to section 3.15.4 for gravity filling.

3.15.3 Filling System With Antifreeze Using High Pressure Pump

Filling the system with a high pressure pump is the same as flushing described in 3.15.2, with two minor changes. The first is in 3.15.2 SUB-STEP 3. Pressure Pump SUB-STEP 3. Attach the ¼-inch pressure tube from the high pressure pump to the flush valve (just beyond the pump isolation valve on the collector side).

The second is in 3.15.2 SUB-STEP 7. Pressure Pump SUB-STEP 7. After the system is full, leave the flush valve on and close the fill/drain valve for 60 seconds. This will cause fluid pressure to open the radiator cap and push antifreeze into the overflow. The system is now flushed and the overflow reservoir should be full.

3.15.4 Filling System With Antifreeze Using Gravity

A single person can fill the system via the stopper/siphon method described here, but care must be taken if it is done at low temperatures below 20°F (-7°C) where the water used for flushing the system might freeze (Although one creative individual used hot water from the tank for flushing and then used this method to fill the system before the collectors could cool off too much). You will need to have access to the roof to get to the Self-Pressurizing Unit reservoir. You will need a container with enough antifreeze mix to fill the system plus some extra (usually one to two gallons), and a rubber stopper with siphon tubing to replace the radiator cap. This arrangement is shown in Figure 15.

1. Be sure the circulation pump is unplugged, the flush and fill/drain valves are closed, and the system is full of water. If it is sunny, cover the collectors to prevent them from boiling the water in them while you are filling the system.
2. Detach the pressure gauge from the fill/drain valve at the outlet of the circulation pump.

3. If this is the first time the system is being filled, re-check all the fittings around the pump and wand for tightness after flushing.

4. Mix up a gallon of 60% propylene glycol and 40% water mixture by volume. The higher concentration is so that any water not flushed from the system will not dilute the mixture below 50/50. If your climate requires higher concentration, start with an even higher initial concentration mixture.

5. CLOSE the pump isolation valve. Leave the wand isolation valve OPEN.

6. At the Self-Pressurizing Unit, remove the overflow reservoir cap and siphon out any water that is in the reservoir from the flushing process.

7. Fill the overflow reservoir with antifreeze mixture and replace the overflow cap.
8. Remove the 4 screws holding the roof over the radiator cap, so the cap can be removed. Place the tube end of the stopper/siphon tube into the bottom of a one or two-gallon container of antifreeze mixture. Push the tubing under the fluid surface to fill it with antifreeze. Hold your finger over the end of the tube under the stopper as you pull the tube back out and place it below the fluid level in the container to establish a siphon. Remove your finger and quickly fit the stopper into the opening of the filler neck (i.e., THE OPENING THAT WAS UNDERNEATH THE RADIATOR CAP). Now as water is drained from the system, antifreeze mixture will replace it.

9. At the water tank, connect a ¼-inch plastic tube to the fill/drain valve (at the pump outlet) and put the other end of the tube into a clean pail or other container. OPEN the fill/drain valve and drain out fluid until it changes from clear water to the color of the antifreeze being added at the filler neck, then CLOSE the fill/drain valve.

If you have a large system which contains more than one gallon, you will need to go to the roof to refill the siphon container, so the end of the siphon tube is always below fluid level to keep air out of the system. (HINT: A SECOND PERSON ON THE ROOF CAN MAKE SURE THE CONTAINER IS REFILLED AS NECESSARY)

10. Move the plastic tube to the flush valve (on the other side of the pump isolation valve), and repeat the drain down operation to siphon fresh antifreeze into the other half of the flow loop. When the drained fluid changes color, CLOSE the flush valve. Finally, OPEN the isolation valve and disconnect the tubing.

11. Reattach the pressure gauge to and open the fill/drain valve at the outlet of the circulation pump.

12. OPEN the pump isolation valve between the flush and fill/drain valves.

13. Start the circulation pump by plugging in the AC controller or connecting the wires to the PV Delta-T Controller. If it is cloudy, you can use a 12VDC power supply instead of the PV panel for this test. The pressure gauge will rise 1-2 psi when the system is circulating properly.

14. As a further test, close the pump isolation valve for a few seconds. The pressure should rise quickly to about 5 psi above the valve open pressure, and should drop back to 1-2 psi above where it was with the valve open. System circulation is now verified via this “ping” test. BE SURE TO OPEN THE PUMP ISOLATION VALVE AFTER THIS TEST!

15. Remove the stopper from the filler neck and top off with antifreeze if needed, then replace the radiator cap and tighten the cap in place. Uncover the collectors if they were covered up to prevent boiling. The system is now ready for operation.

16. Dispose of the weak antifreeze mixture from the bucket. Keep the remaining fresh antifreeze mixture for topping off the system in the future.

CAUTION: If you are replacing the collector fluid, collect the used antifreeze fluid (especially the first pail or two of fluid that comes out)
3.15.5 Removing Trapped Air From a Filled System:

If circulation does not occur after filling with antifreeze, air may have been sucked into the system. To flush out the air, mix up more antifreeze solution and repeat the STEPS of either section 3.15.3 or 3.15.4 again. As you drain fluid, the bucket will fill with antifreeze mixture and trapped air bubbles will be swept from the system, so watch for them. Save the antifreeze solution – it can be used in the future for topping off the system.

**NOTE:** If circulation is occurring and some air bubbles are still trapped in the system, do not worry. When the solar collector heats up in the morning, several cubic centimeters of air and liquid are expelled from the system. The air bubbles up through the overflow reservoir fluid and escapes. The liquid is trapped in the overflow reservoir. At night when the system cools off antifreeze liquid is drawn back into the system. This action eliminates trapped air from the system and keeps the system full of fluid at all times. Check the overflow reservoir a few days after the system is installed to be sure the reservoir is still full. If it is not full refill it. The fluid you add is equal to the air that was removed from the system. When the system is circulating properly the temperature gauge near the pump will read at least 140°F (60°C) between 10AM and 2PM.

3.15.6 Antifreeze Renewal:

Check the antifreeze pH every two years by placing a drop from the flush valve onto a Pool or Spa pH indicator strip. The normal pH for new antifreeze is 8.6, which is a little basic. The antifreeze is OK if the pH is between 7.0 and 8.6, and does not need replacing. Every five years or if the pH goes below 7.0, the antifreeze in your system should be replaced with fresh antifreeze. The procedure outlined above in sections 3.15.3 or 3.15.4 for filling the system can be used to flush out the old antifreeze material and replace it with fresh fluid. Based on the fluid required to initially fill the system, estimate the amount of fluid that will be needed and mix up that amount plus some extra. You may not be able to tell the difference in color between the old fluid and fresh fluid as it drains, or you may need to simply estimate when enough fluid has drained from each half of the fluid loop. Be sure to siphon out the fluid in the overflow reservoir and replace it with fresh fluid, also. Dispose of the old fluid properly.
3.16 **STEP 16: Connecting Power to the Pump**

3.16.1 **STEP 16A: Connecting PV Panel to EL-SID Pump**

Connect Pump Red to one terminal of the over-temperature cut off switch (Figure 7-f) and PV plus to the other terminal of the over-temperature cut off switch. Connect Pump Black to PV minus. Use a multi-meter, set to measure Volts, to check the polarity of the wires coming from the PV panel. If the sun is not out, a 12VDC power supply can be used to run the pump to test for circulation and verify flow. Use same procedure for Connections to the PV-Powered Delta-T Controller with Built-In Linear Current Amplifier.

3.16.2 **STEP 16B: Connecting the PV Panel to the Linear Current Amplifier or PV Delta-T Controller**

Connect the wires from the PV Panel to the terminals provided on the linear current amplifier (LCA), see Figure 14-c. Make sure that the polarity positive (+) from the solar panel goes to the positive (+) on the LCA through the tank top temperature limit switch. Use a voltmeter to find the positive (+) and negative (–) wires from the PV panel. Label them positive (+) and negative (–) with proper labels, see Figures 14-c and 14-d.

3.16.3 **STEP 16C: Plugging 115 VAC and Low Voltage DC Pumps Into the AC-Powered Controller**

Plug the 115 VAC pump into the electrical outlet on the side of the AC controller as shown in Figure 14-e. If you are using a low voltage pump with the AC controller, plug in a suitable Class II or equivalent step down transformer that outputs at least 30 Watts of power at 18 VDC. Connect the proper positive and negative 18 VDC from the transformer to the low voltage pump.

**WARNING: DO NOT PLUG IN THE PUMP UNLESS THE SYSTEM IS FULL OF FLUID. THE PUMP WILL BE DAMAGED AND NOT COVERED BY WARRANTY.** Dry pump operation is easily recognized and will cause you to pay for a new pump.

Before plugging the controller into a house electrical outlet, check the outlet for proper polarity and wiring using an electrical outlet fault tester. Do not plug the controller in unless the outlet is wired properly and shows no faults. Once plugged in, the controller power light will turn on.

3.17 **STEP 17: Installing All Warning Signs, Fluid Identification Signs, and Valve Labels**

Attach each of the warning signs at the specified location. **YOU MUST INSTALL THE SPECIFIED ANTI-SIPHON VALVE OR YOUR SYSTEM WILL NOT BE CERTIFIED BY SRCC.** Be sure to place “Solar Hot Water Can Scald” signs at each place hot water can be used if no anti-scald valve is installed. These include all kitchen,
laundry and bathroom sinks, and all showers and tub faucets. **Table 5** shows all of the signs required and their locations. Color versions of the system placards and warning signs are included at the end of the **Appendices as Figure A-3**. Cut the Labels out and use clear packing tape to make them waterproof before installing.

### Table 5. Warning Signs and Installation Locations

<table>
<thead>
<tr>
<th></th>
<th>Near Control Box and Hot Water Tank</th>
</tr>
</thead>
</table>
| 1 | **Manufacturer:** Butler Sun Solutions  
**Address:** P.O. Box 1666 Solana Beach, CA 92075-1520  
**Phone:** 858-259-8895  
**E-mail:** butlersunsolutions@roadrunner.com  
**Web:** www.butlersunsolutions.com  
**System Type:** Solar Butler 1.0  
**Date Manufactured:** Month / Year  
**System Serial Number:** # ____________  
For parts contact manufacturer  
For service contact the Installer |
| 2 | **Installer:**  
**Name:**  
**Address:**  
**Phone:**  
**E-mail:**  
**Website:** |
| 3 | On Pump  
**WARNING HOT** |
| 4 | Near Control Box and Hot Water Tank  
**Operating Parameters:**  
**Differential Temperature** 8.9°C (16°F)  
**Maximum Tank Bottom Temperature** 71°C (185°F)  
**Maximum Solar System Pressure** 16 psig  
**Freeze Protection** -32°C (-26°F) |
| 5 | Fill /Drain Valve  
**Freeze Tolerance:**  
Propylene glycol-water 50%/50% -32°C (-26°F)  
Propylene glycol-water 60%/40% -48°C (-54°F)  
**Heat Exchanger type:** DWP, AWWA  
**Fluid:** Class II, Low Toxicity, See manual for proper handling & disposal instructions.  
**Warning:** Fluid may be discharged at high temperature, 127°C (256°F), and at pressures up to 16 psig.  
**Warning:** No other fluid shall be used that would change the original classification of this system. Unauthorized alterations to this system could result in hazardous health conditions. |
6 Pump Isolation Valves

7 Shower and Sink Outlets

<table>
<thead>
<tr>
<th>Pump Isolation Valves</th>
<th>Valves -- Normally Open</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Heated Water Can Scald!!</td>
<td></td>
</tr>
<tr>
<td>Test The Water</td>
<td></td>
</tr>
<tr>
<td>Before Anyone Bathes or Drinks.</td>
<td></td>
</tr>
</tbody>
</table>

3.18 **STEP 18:** Verifying That Heat Transfer Fluid is Circulating

If the sun is not shining and the controller pump light is not on, plug the pump into a live outlet and feel it for vibration. For the PV-powered pump, connect a 12VDC power supply. There will be a very slight vibration when the pump is running. The pressure in the system will rise about 1-2 psig when circulation has been established. As a further test, close the pump isolation valve for a few seconds. The pressure should rise quickly to about 5 psi above the valve open pressure, and should drop back to 1-2 psi above where it was with the valve open. System circulation is now verified via this “ping” test. Plug the pump in and read the pressure, then unplug the pump and read the pressure. If it does not show a 1-2 psig increase while running and fails the “ping” test then the system is not circulating. Drain some fluid using the drain valve, refill the system and check again. If a bubble of gas is stuck in the pump, plug and unplug the pump several times, letting the impeller stop each time, and the bubble will be moved out of the pump and circulation should begin. When the fluid is circulating the temperature gauge near the pump will read at least 54ºC (130ºF), with the sun is shining between 10AM and 2PM.

3.19 **STEP 19:** Clean Up All Areas; Tie Up All Wires; Insulate All Exposed Piping.

**WARNING: DO NOT PLACE RUBITEX INSULATION CLOSE TO HOT WATER TANK COMBUSTION VENT PIPE.**

Leaving a clean site is always good for customer relations. A professional-looking installation will put you in a much better position to get word-of-mouth referrals. **DO NOT OVERLOOK THIS IMPORTANT STEP.**

3.20 **STEP 20:** Follow-Up Call to Customer to Verify System is Working Properly.

If the sun is out and the pump is on have your customer read the temperature gauge mounted near the pump. If the temperature gauge, when read between 10AM and 2PM, are between 54ºC (130ºF) and 100ºC (212ºF), the system is working. If the temperature is not in this range, wait 20 minutes and read it again. If the temperature is still not in the range, there may be an air bubble in the system, or some other cause of non-circulation. You will then need to return and check the system out yourself.
ON A SUNNY DAY CHECK THE TEMPERATURE GAUGE BETWEEN 10AM AND 2PM

GOOD

NORMAL OPERATING RANGE
WINTER 140°F AND SUMMER 190°F

BAD

SYSTEM IS NOT WORKING
REQUIRES MAINTENANCE

Figure 20   System Operation Analysis With Temperature Gauge
4.0 References and Appendices


Figure A-1 ACR Fireball 2001 and 2010
ACR Fireball 2001 Solar Collectors
Mounted On A Roof. San Diego, CA

Installed Solar Wands 2005

Encinitas, CA
Portland, CT

Figure A-2 Typical Installations
System Placards and Warning Signs

Figure A-3  Warning Signs to Attach To Systems