SRCC OG-300 Certified Solar Water Heating System

Type: AC Circulating Pump and Differential Control Installation Manual

SOLAR THERMAL SYSTEMS DOMESTIC SOLAR WATER HEATER SYSTEM

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

The STS™ domestic solar water heating system has gone through an extensive design, technical and performance review by the Solar Rating & Certification Corporation (SRCC). The installation of your STS system is intended to be executed by properly licensed and experienced professional contractors in accordance with SRCC Standard OG-300, "Operating Guidelines and Minimum Standards For Certifying", and must conform to applicable federal, state and local regulations, codes, ordinances and standards governing the installation of solar water heating systems.

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 the SRCC.

OG-300 system certification is granted to Solar Thermal Systems by the SRCC. It may not be used for any commercial purpose without the prior written consent of Solar Thermal Systems. Solar Thermal Systems must approve any deviation from the materials and methods described in this manual in writing.

Solar Thermal Systems solar water heating systems can be protected against freeze damage to temperatures as low as -60°F (-51°C). This system should not be installed in any area that has experienced ambient air temperatures below -60°F. Use Table 4, Section 4 of this manual to determine the required concentration of propylene glycol and distilled water to provide adequate freeze protection in your specific climate.

Dow Chemical "Dowfrost HD" propylene glycol heat transfer fluid shall be used in this system as the primary freeze protection agent. Unauthorized fluid substitutions can result in a threat to health, welfare and safety and may cause the system piping to freeze.

All component warranties, express or implied, are voided if uninhibited glycol, potable or distilled water are substituted for the specified heat transfer fluid described in this manual, or if the heat transfer fluid is not maintained in accordance with the manufacturer's instructions.

Freeze tolerance limits are based upon an assumed set of environmental conditions. Extended periods of cold weather, including ambient air temperatures above the specified limit may cause freezing in exposed parts of the system. It is the owner's responsibility to protect the system in accordance with Solar Thermal Systems' instructions if the ambient air temperature approaches the specified freeze tolerance limit.

TABLE OF CONTENTS

1) INTRODUCTION

Solar water heating systems are climate and site specific appliances. Different types of solar systems are installed around the world in accordance with regional weather and water quality conditions. System performance varies as a function of the household hot water load, including daily showers, laundry and kitchen uses, average ground water and ambient air temperatures, the home's roof pitch and orientation, and, of course, the seasonal intensity of solar radiation. These variables, some of which change from home to home on the same neighborhood street, will determine how much energy and money your STS system will save on an annual basis.

Your STS solar system is known as a "forced circulation" system because it utilizes a mechanical pump to efficiently circulate the Dow Chemical Dowfrost HD propylene glycol heat transfer fluid (HTF) throughout the system. The HTF protects the collector piping from freezing and inhibits scaling deposits that can reduce performance in "open-loop" systems utilizing potable water as the HTF. Proper application and maintenance of the HTF can protect your STS solar water heating system to minus 60° Fahrenheit.

This manual is intended as a basic solar water heating primer. Our goal is to familiarize you with the proper installation, operation, and maintenance of your STS solar system. This system is required to be installed by properly licensed solar or plumbing contractors in accordance with SRCC Standard OG-300 and all applicable national, state and local codes, ordinances and regulations governing solar water heating installations, as well as good trade practices. Failure to follow the procedures and practices described in this manual can void the manufacturer's warranty for specific component parts.

This manual covers installations utilizing one or two Solar Thermal Systems solar collectors with a single solar storage tank and also two tank systems that include a solar storage tank and a conventional water heater. For simplicity, the singular form will be used throughout this manual when referring to all of these components and system permutations. Frequent reference is made throughout this manual to specific component parts. The placement of each component can be seen in system schematic figures 16 and 17. A description of each component and its function is found in Section 10.

2) SYSTEM DESCRIPTION AND OPERATIONAL PRINCIPLE

The key components in the STS solar water heating system include the Solar Thermal Systems solar collector, solar storage tank with integral heat exchanger, circulation pump, differential thermostat, expansion tank, pressure gauge, mixing valve and the non-toxic propylene glycol heat transfer fluid (HTF).

The Solar Thermal Systems solar collector is the heart of the STS system. Simply stated, when the sun is shining, heat energy is absorbed by the solar collector's all copper absorber plate and transferred to the HTF circulating through the solar collector. The system pump efficiently circulates this heated fluid through the collector piping and integral tank heat exchanger. As the HTF passes through the heat exchanger the heat in the fluid is transferred by conduction to the potable water in your solar storage tank. As this process is continuously repeated during the average sunny day the temperature in your solar storage tank rises.

The circulating pump in a solar water heating system may be favorably compared with the human heart. To continue the analogy, the differential thermostat, or controller, is the brain in the system. The controller uses thermistors, or sensors, to constantly monitor the temperature difference between the hottest and coldest points in the system and to automatically turn the circulating pump on and off throughout the day.

When the solar collector absorber plate is approximately twelve degrees hotter than the temperature in the bottom of your solar storage tank, the controller will turn the circulating pump on. When the temperature difference has been reduced to four degrees, the controller automatically turns the pump off.

Both single and double tank STS systems are designed to provide three separate modes of system operation. The system will, (1) accommodate 100% solar operation, (2) serve as a preheater to your solar storage tank or back-up water heater,

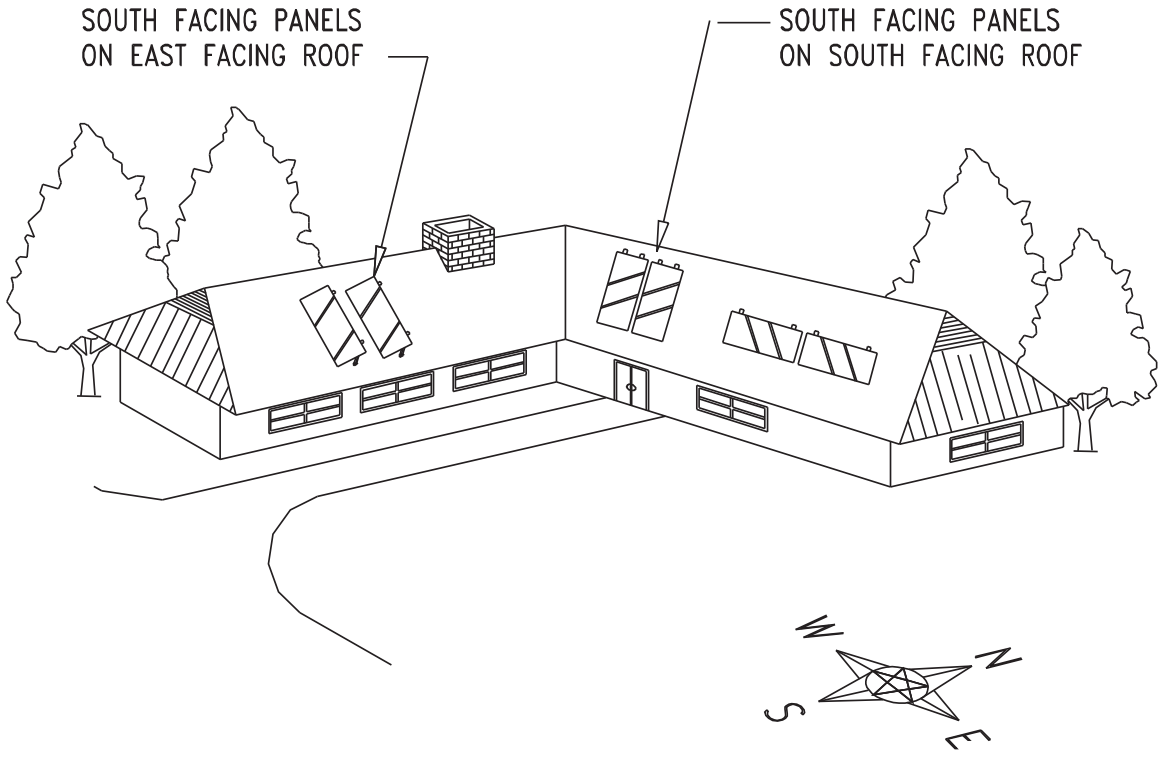


fig. 1 **COLLECTOR ORIENTATION**

or (3) bypass the solar collector and run 100% on utility power. Section Six provides instructions for setting the system for automatic operation in each of these three modes.

The Dowfrost HD HTF protects your STS solar system against freezing. Dowfrost HD can provide reliable freeze protection at temperatures as low as minus 60° Fahrenheit if properly applied and maintained. **Use of uninhibited propylene glycol, plain water or a concentration of these two fluids as the HTF in this system is strictly prohibited.**

Propylene glycol can degrade over time. The process of degradation is accelerated in presence of oxygen and/or heat. We strongly encourage you to establish a preventative maintenance schedule with your installation contractor. The HTF pH level must be maintained between 8 and 10 in order to prevent glycol oxidation and corrosion of the collector piping. **Solar Thermal Systems' collector warranty specifically excludes freeze damage for any reason and absorber plate damage resulting from the oxidation of the propylene glycol HTF.**

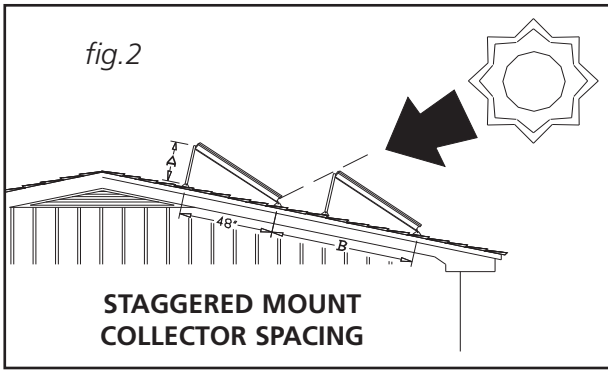
In order to completely protect the integrity of the solar collector and piping, the system is designed to be drained manually if subject to extended periods of disuse or persistent hard freeze conditions below minus 60° Fahrenheit. (See Sections 8.1 and 8.2 below).

3) INSTALLATION REQUIREMENTS - GENERAL

3.1 The contractor shall obtain all required permits and approvals.

3.2 The installation shall conform to all federal, state and local regulations, codes, ordinances and standards governing solar

fig.2



STAGGERED MOUNT COLLECTOR SPACING

TABLE 1

LATITUDE			25°N		30°N		35°N		40°N		45°N		50°N	
COLL. TILT			35°		40°		45°		50°		55°		60°	
			A	B	A	B	A	B	A	B	A	B	A	B
	FLAT		29	96	33	113	37	145	41	145	44	145	48	145
	5°	1/12	25	83	29	93	33	113	37	132	41	133	44	141
	9°	2/12	22	74	26	82	30	77	34	110	38	115	41	118
	14°	3/12	17	66	22	72	26	82	30	92	34	95	38	98
	18°	4/12	14	61	18	66	22	74	26	82	30	85	34	87
ROOF	23°	5/12	10	58	14	60	18	66	22	72	26	74	30	77
PITCH	27°	6/12	7	58	11	58	15	61	19	66	23	68	27	70
	30°	7/12	4	58	8	58	13	58	17	62	21	65	25	66
	34°	8/12	0	58	5	58	9	58	13	58	17	60	22	62
	37°	9/12	0	58	3	58	7	58	11	58	15	58	19	58
	40°	10/12	0	58	0	58	4	58	8	58	13	58	17	58
	43°	11/12	0	58	0	58	2	58	6	58	10	58	14	58
	45°	12/12	0	58	0	58	0	58	4	58	8	58	13	58
DIMENSIONS A AND B ARE DESIGNATED IN INCHES														

water heating system installations, and the contractor shall adhere to sound building safety and trade practices. Special consideration must be given to building code requirements for the penetration of structural members and fire rated assemblies.

3.3 The solar collector must be located in a structurally sound area of the roof that will be unshaded for the majority of the day all year round. Adjacent buildings and trees should be checked for possible winter shading.

3.4 Before the installation the contractor shall inspect the condition of the roof and notify the homeowner of any existing roof damage or necessary repairs.

3.5 The homeowner and contractor shall confirm the location of all roof and ground mounted components in advance of the installation.

4) INSTALLATION REQUIREMENTS - SPECIFIC

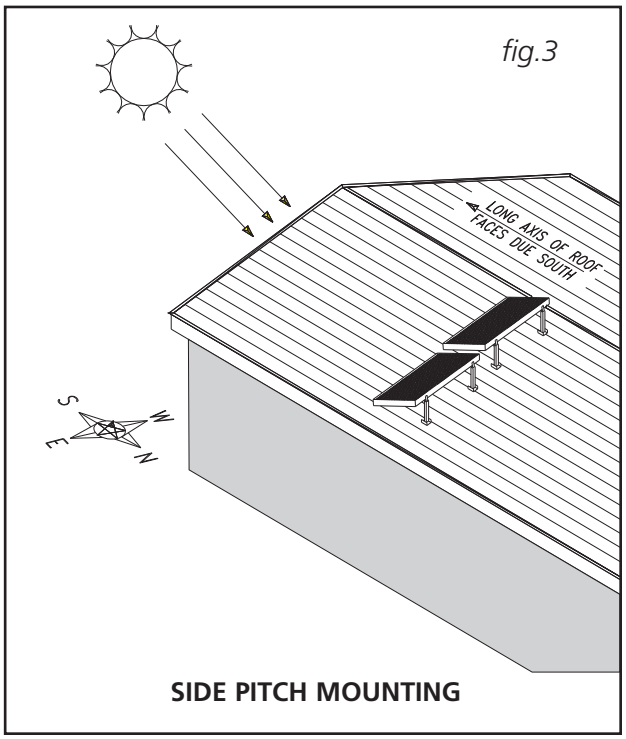
4.1 Collector Orientation

The performance of solar water heating systems in the Northern Hemisphere is optimized when the collector is mounted facing True South. Performance, however, suffers very little when the collector is oriented no more than 45° East or West of True South. The collector should be unshaded by any permanent obstacle between 9:00 a.m. and 3:00 p.m. on any day of the year.

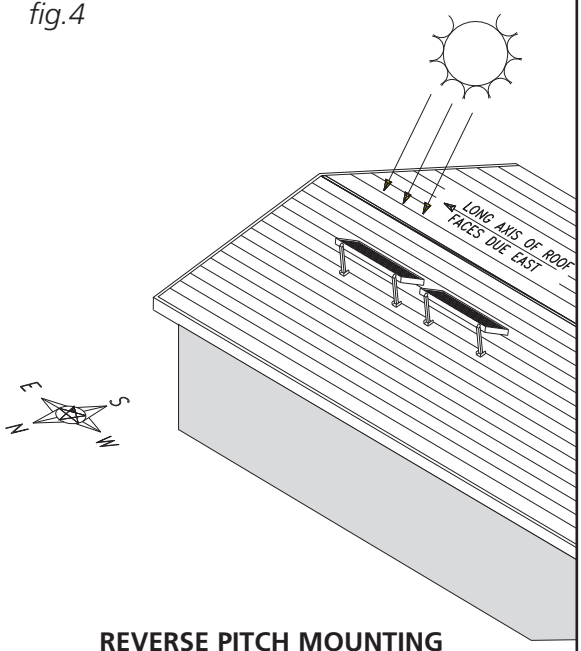
4.2 Collector Tilt

Optimal annual efficiency is achieved by tilting the solar collector at an angle that equals your latitude plus an additional 10°. This tilt angle favors the lower winter sun when collector performance is at it's lowest and minimizes overheating during the hottest summer months.

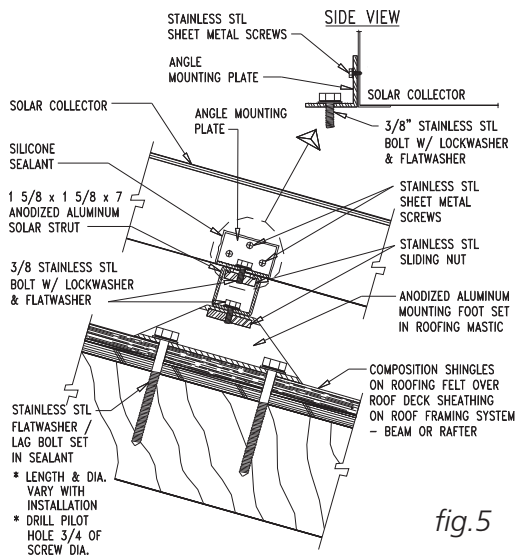
The solar collectors in a two collector staggered mount installation must be spaced far enough apart to prevent winter shading. Figure 2 and



SIDE PITCH MOUNTING



REVERSE PITCH MOUNTING



COMPOSITION SHINGLE MOUNTING

Table 1 show the correct spacing between collectors to prevent shading on December 21, when the sun is at its lowest angle.

4.3 Basic Mounting Procedures

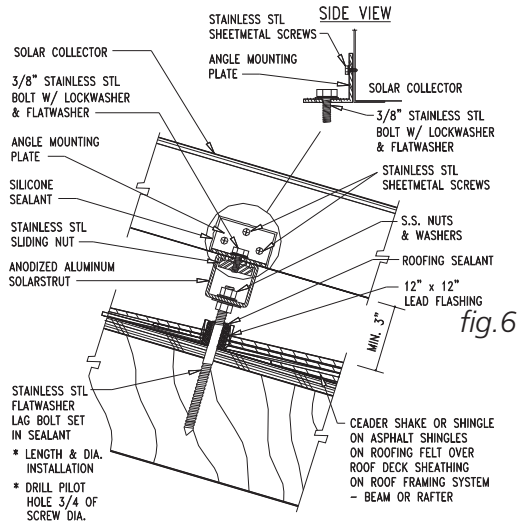
The Solar Thermal Systems solar collector in your STS solar system can be mounted in either a vertical or horizontal orientation on the roof (See Figure 1). Although the collector is protected from freeze conditions by the glycol HTF and does not normally need to be drained, it is still important to slope the collectors just slightly to allow for complete drainage if necessary. The recommended slope is 1/4" per foot of horizontal run.

To ensure proper water drainage from the glazing the collectors must maintain a minimum angle from horizontal of at least 10°. Never mount the collector directly or parallel to a flat roof surface. Use Solar Thermal Systems "Solar Strut" tilt mount kits to rack the collectors to the proper angle.

The collector should be mounted as close to the storage tank as possible to minimize heat loss in the piping runs. If the home has attic access, mounting the collectors near the roof peak provides for additional attic workspace.

The solar collector should be mounted on the roof in accordance with these general principles:

4.3.1 The most important structural consideration is to securely anchor the solar collector and the Solar Strut mounting hardware to the structural members of the roof with stainless steel hanger or lag bolts. The solar collector must be attached to the mounting hardware as detailed in Figures 5–12. (Note: The drawings in this manual detail mounting hardware for the Solar Thermal Systems Empire series collector. Drawings for the Imperial series collector are available upon request).



SHINGLE ROOF MOUNTING

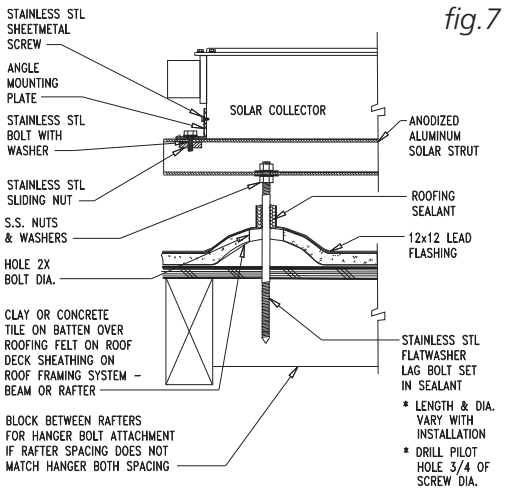


fig.7

TILE ROOF MOUNTING

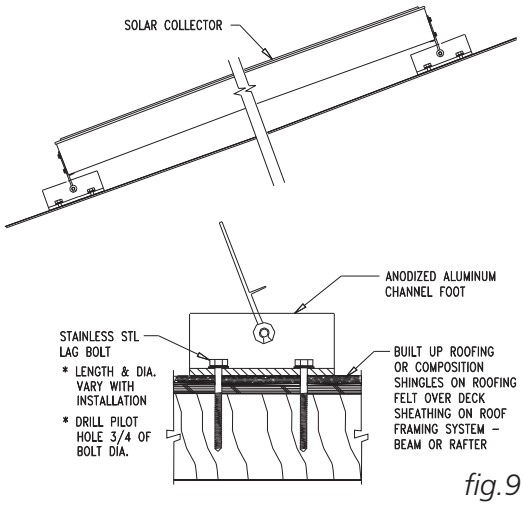


fig.9

FLUSH MOUNTING

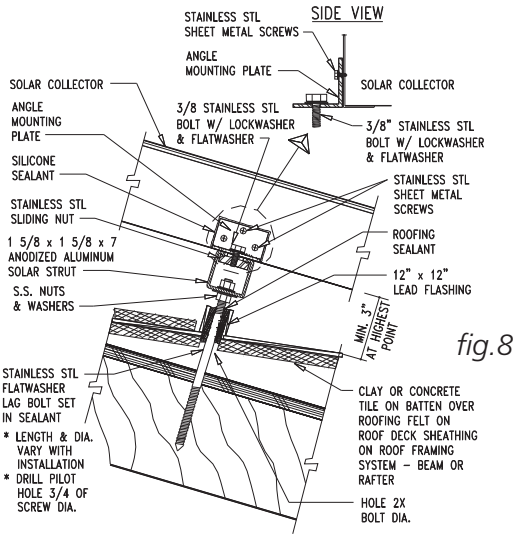


fig.8

TILE ROOF MOUNTING

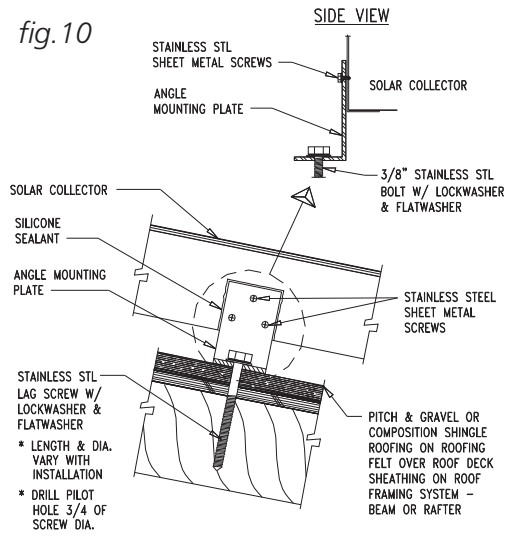


fig.10

STAND OFF MOUNTING

4.3.2 The collector must be raised from the roof surface to allow for rainwater and debris to pass under the collectors and for proper ventilation of the roofing material. There should be at least 1 1/2" of clearance between the roof surface and the bottom of the solar collectors.

4.3.3 In selecting mounting hardware and fasteners it is extremely important to avoid galvanic corrosion resulting from the direct contact of incompatible metals. Use of Solar Thermal Systems anodized aluminum "Solar Strut" mounting hardware and stainless steel lag or hanger bolts, lock washers and round washers is recommended. In climates subject to severe winters or high humidity use of galvanized fasteners is prohibited.

4.3.4 Preserving the integrity of the roof membrane is the most important roofing consideration. Ensure that all roof penetrations required to plumb and mount the solar collector are properly flashed and sealed in accordance with standard roofing practices. Tremco "POLYroof" is the recommended elastomer for sealing roof penetrations. Henry Co. 204, 208 or 209 roof mastic or Dow Corning Glazing Sealant also are acceptable sealants.

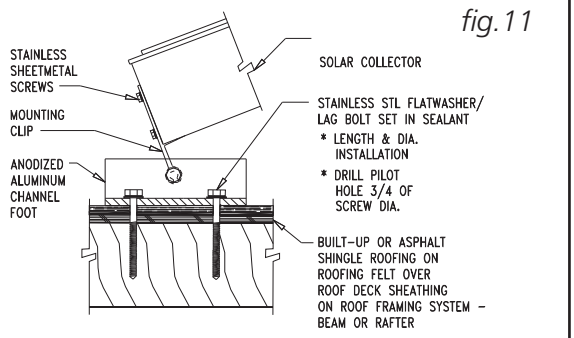
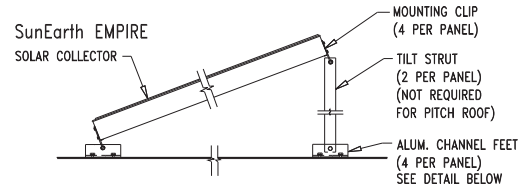


fig.11



TILT MOUNT

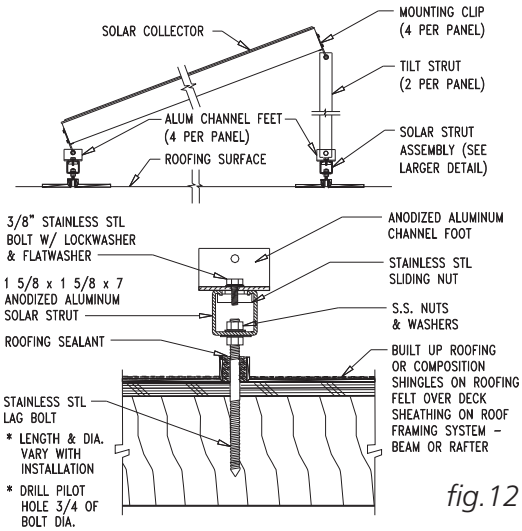


fig.12

STAND OFF TILT MOUNT

4.3.5 If the region is subject to hurricane conditions, additional steps may be required to secure the collector and mounting hardware to the structural members. In certain areas of the country, local building codes may require collector wind load testing or prescribe specific mounting procedures. Consult your local building department.

4.4 Collector Loop Pipe Insulation

The collector loop cold supply and hot return lines must be well insulated with a high quality flexible closed cell insulation to minimize heat loss. The wall thickness of the pipe insulation should not be less than 3/4". A 1" wall thickness is required in all areas prone to annual hard freeze conditions. When it comes to pipe insulation the rule is simple: thicker is better. The specified insulation material is Rubatex Insul-Tube 180 or equal.

To the extent possible, slide the insulation material over the pipe without cutting or taping. All butt joints must be sealed with contact adhesive. The use of rigid polyethylene pipe insulation is prohibited. The temperatures generated by your collector in the summer months or under stagnation conditions can melt this type of material.

Any above ground exterior pipe insulation is subject to UV degradation and must be wrapped with foil tape or painted with two coats of high quality water-based acrylic resin coating as supplied by the insulation manufacturer. Rubatex UV Protective Coating or equal is the required coating material.

4.5 Collector Plumbing

Solar Thermal Systems requires the use of all copper and brass fittings in the collector loop plumbing. Couplings rather than unions should be used to join the collectors to avoid leaks and fluid loss. Use only lead-free solder. Engelhard Silvabrite 100 or equal is required. Use of 50/50 lead solder is expressly prohibited. Use of galvanized steel, CPVC, PVC, or any other type of plastic pipe is prohibited.

Piping in new solar installations can be covered with dirt, grease, solder flux or other impurities that over time affect the quality of the glycol HTF. A thorough cleaning is required before charging the system with glycol. Carefully review the cleaning procedures in "Charging The System" outlined below.

All vertical piping between the storage tank and the collector shall be supported at each story or at maximum intervals of ten feet (10'). Copper plumbers tape or tube strap is required. The pipe insulation may not be compressed or crimped by the strapping material.

The installation of all horizontal and vertical piping may not reduce the performance or rating of any structural member or fire rated assembly. Adhere to all applicable local codes and ordi-

nances.

4.6 Collector Sensor Placement

The collector sensor must be located on the hot water return line as close to the collector as possible. Sensors are typically accurate to +/- 1/2°F if properly installed and weatherized. To maximize sensor accuracy, attach the flanged portion of the sensor to the Solar Thermal Systems collector header pipe with a stainless steel hose clamp. Wire nuts used to connect the sensor and low voltage wiring shall be all plastic, sealed with silicone and thoroughly wrapped in electrician's tape.

The sensor "bundle" must be placed under the rubber pipe insulation covering the collector header. Thoroughly wrap and weatherize the insulation with electrician's tape or insulation tape as provided by the manufacturer (Rubatex Insul-Tape or equal). See Figure 13 for collector sensor installation detail.

4.7 Low Voltage Wiring

The low voltage wiring used to connect the sensors to the controller should be a minimum18 AWG. The wiring should be bare or tinned copper, two conductor, PVC insulated, with a PVC UV rated gray jacket suitable for exterior use. Use Eastman Wire & Cable No. 5704, Belden Wire and Cable No. 8461 or equal.

4.8 Installing the Solar Storage Tank and Expansion Tank

In plumbing the solar storage tank and expansion tank make sure that all the components are accessible and easy to reach. Provide for clear

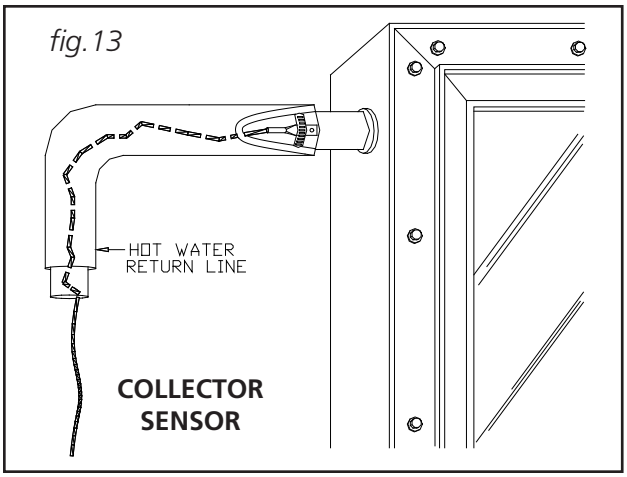


fig.13

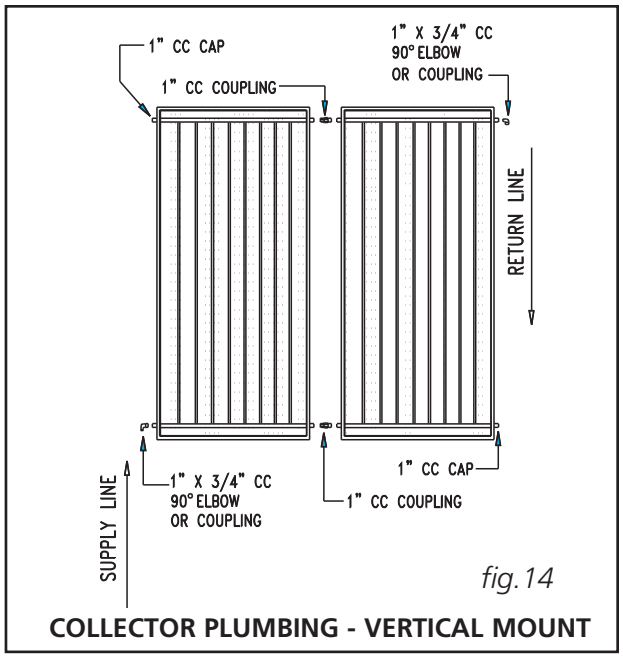


fig.14

COLLECTOR PLUMBING - VERTICAL MOUNT

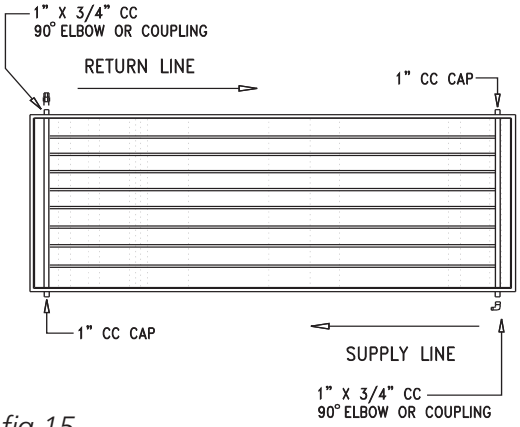


fig.15

COLLECTOR PLUMBING - HORIZONTAL MOUNT

access to the storage tank, pump, expansion tank, mixing valve, time clock and other key components. If a component in the potable water side of the system may require future service or maintenance make the connections with brass unions. Use only brass nipples and unions and copper and brass fittings in plumbing the solar storage tank and expansion tank. The use of galvanized fittings or nipples, di-electric unions, CPVC, PVC or other plastic pipe is prohibited.

Hard copper connections to the city cold water supply line and the home hot water feed lines are recommended. The gaskets in standard water heater flex hose connectors can become brittle and compressed over time and begin leaking on

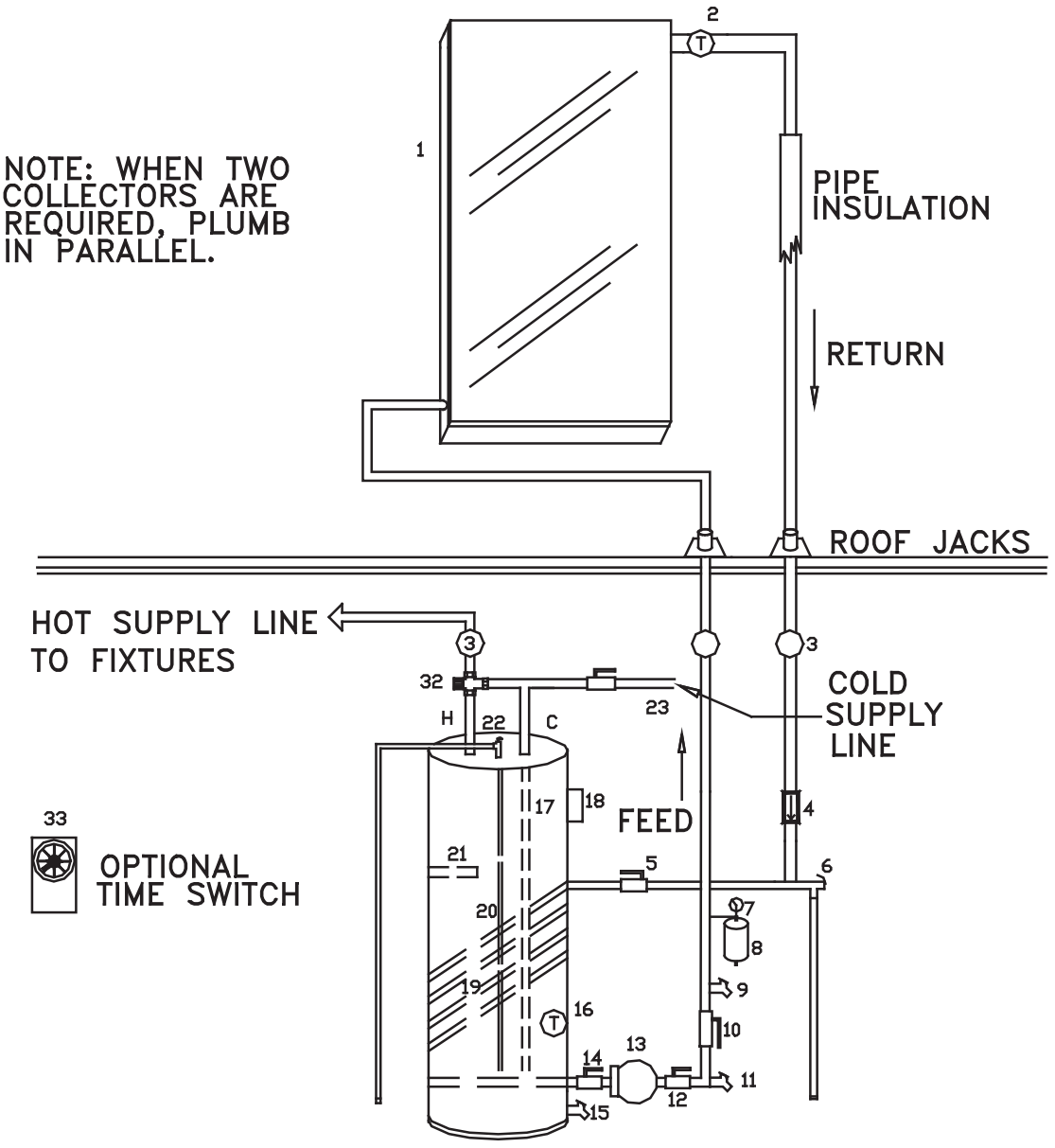


fig.16

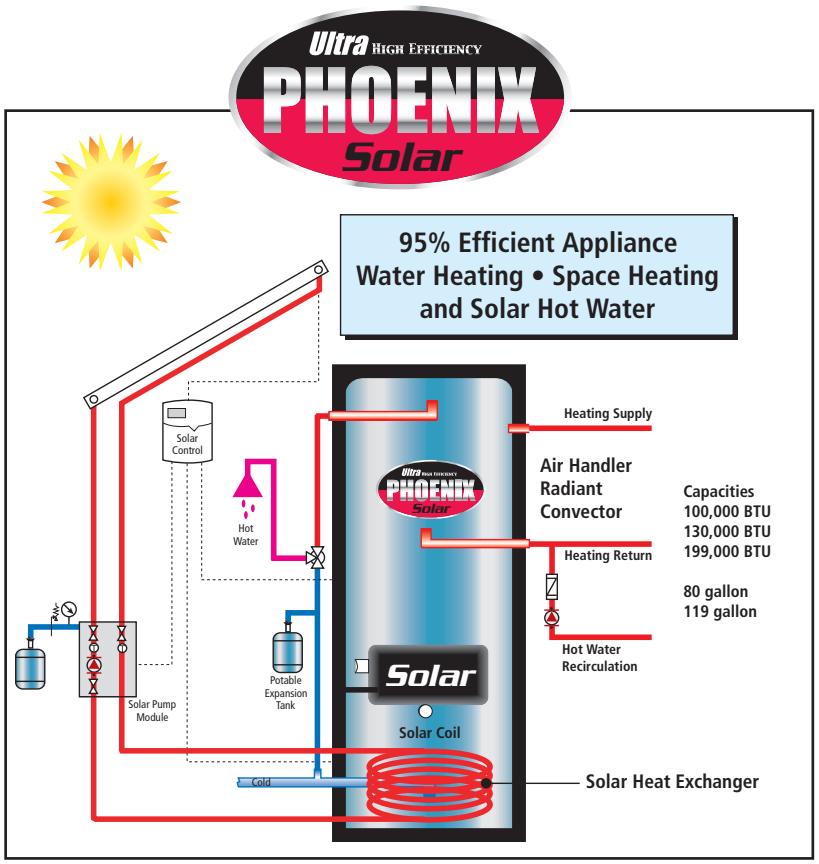
SINGLE TANK SYSTEM SCHEMATIC

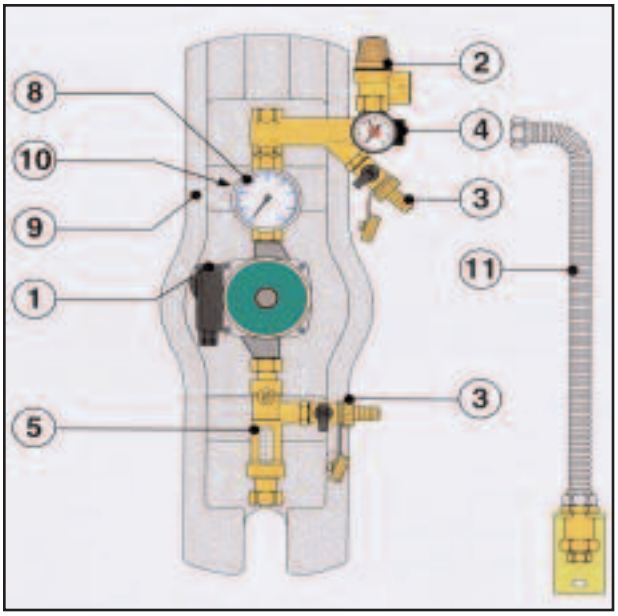
the water heater. If not detected in a timely manner even a small drip or leak may cause serious damage to the tank's electrical components or, in extreme cases, may cause the tank to leak from the outside in.

Tank plumbing is required to provide for the isolation of the solar storage tank from the city cold water supply line by means of an isolating ball valve (No. 23).

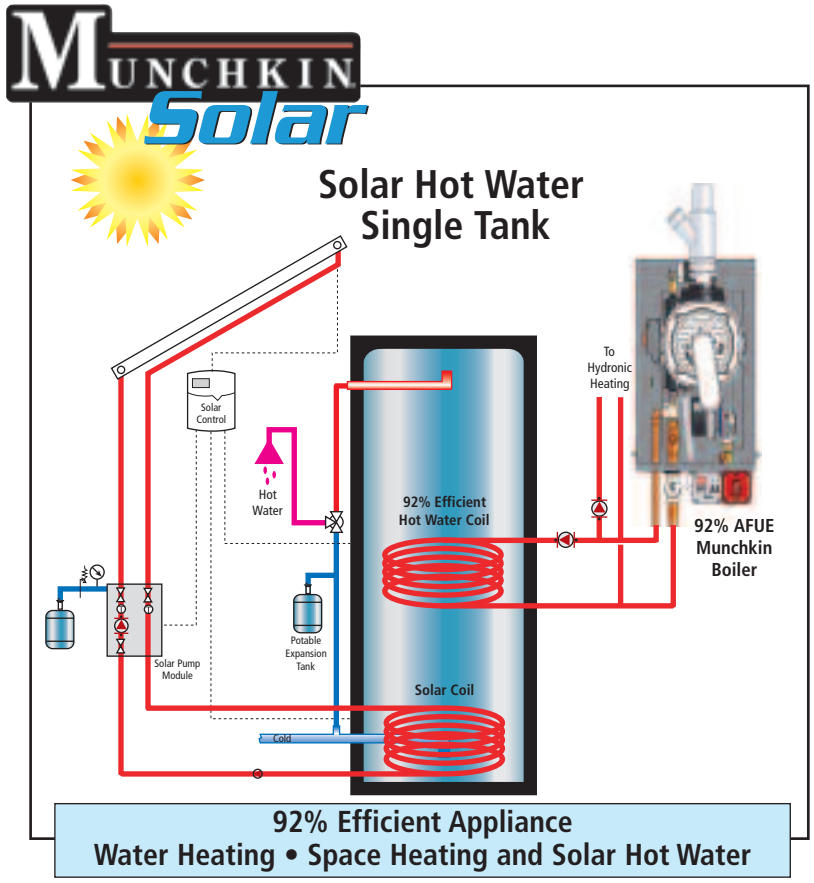
Line thermometers shall be installed in the collector supply and return lines to allow for a simple diagnostic check of proper system operation. On a sunny day the hot water return line should be approximately 5 – 12° warmer than the water in the collector supply line. Compare the temperature readings in the two line thermometers (No. 3).

In a single tank system install a third thermome-





1 008F Taco Circulator
2 PRV
3 Purge Ports
4 Pressure Gauge
5 Flowmeter/Regulator
8 Thermometer
9 Insulation Clamshell
10 Check Valve/Shutoff
11 Expansion Tank Connection Kit
- Expansion Tank (not shown)
- Mounting Bracket (not shown)



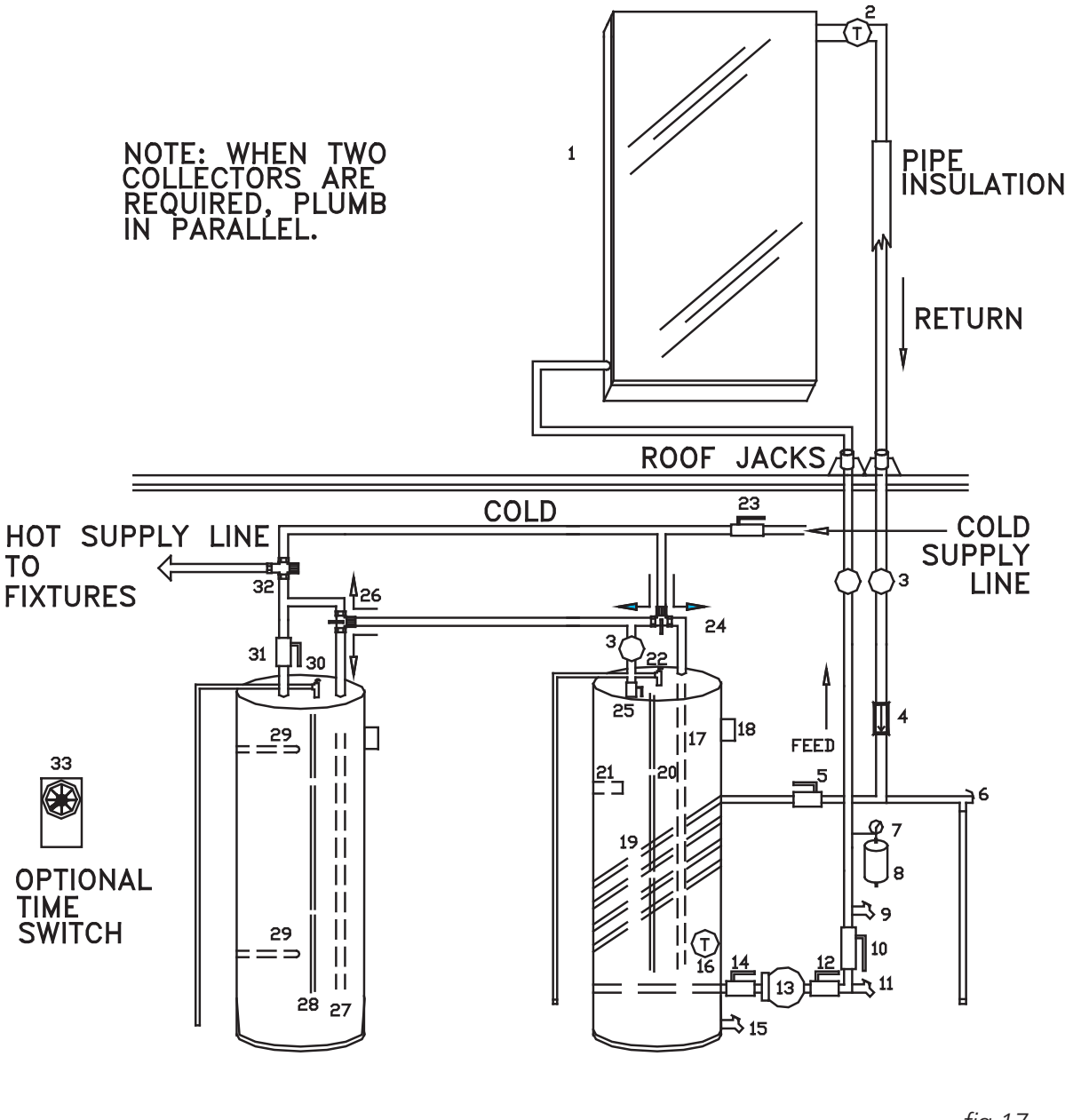


fig.17

DOUBLE TANK SYSTEM SCHEMATIC

ter (No. 3) directly after the mixing valve above the solar storage tank. In a two tank system you may install the third thermometer either directly above the hot outlet on the solar storage tank or after the mixing valve on the back-up water heater.

The circulation pump shall be the TACO 008F, 115 volt, or equal. The pump shall be prewired with a 6' line cord so that it can be plugged directly into the 115 volt receptacle on the side of the differential control. Two way ball valves must be installed on either side of the circulating pump (Nos.12 and 14) so that the pump can be isolated from the collector loop. Repairs or routine system maintenance can be completed without introducing air into the system or draining the HTF.

The expansion tank shall have a minimum 150

PSIG working pressure and have a total volume of not less than 4.4 gallons. The standard factory charge should be 40 PSIG. The expansion tank shall be TACO ELBI DXT18.

A high quality thermostatic mixing valve is a required component in all OG-300 certified systems and should be plumbed in line with brass union connections for ease of future repair or replacment (No. 32). The specified mixing valve shall be the Heatguard model HGBASE or equal and shall have an operating range between 95°F and 140°F. The mixing valve shall be set to 120°F.

The temperatures generated by your STS system will vary throughout the year. In the Northern Hemisphere the water temperature will be hottest in the spring and summer months while cooler temperatures are to be expect from November through March. On sunny days system temperatures may range between 110ºF to 180ºF depending upon the season and hot water demand. The mixing valve described above blends the hot and cold water supplies to deliver hot water to your fixtures at a safe, controlled temperature.

WARNING: SCALDING CAN OCCUR WITHIN FIVE SECONDS WHEN WATER TEMPERATURES APPROACH 140ºF. THE MIXING VALVE SHOULD BE ADJUSTED BY YOUR CONTRACTOR TO PROVIDE WATER TO YOUR FIXTURES AT NO MORE THAN 120ºF.

The 3/4" cold water supply line to the solar storage tank must be insulated with minimum 7/8" X 1/2" pipe insulation to a minimum distance of 5' behind the storage tank, or to the wall if closer than 5'.

4.9 Tank Sensor Placement

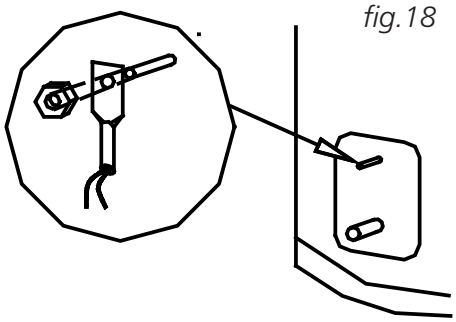
Figure 18 details the proper placement of the solar storage tank sensor. Make sure the sensor is secured to the threaded stud on the storage tank with a 10-24 stainless steel nut.

Thoroughly weatherize the wire connections in accordance with the roof sensor detail above. Replace the fiberglass insulation batting and close the access cover.

4.10 Tank Insulation

Solar Thermal Systems suppliess storage tanks that have a minimum insulation value of R-20.

fig.18



TANK SENSOR

Most solar storage tanks now come with R-16.7 factory insulation. Conventional back-up electric water heaters have insulation values between R-12 and R-20. The R value expresses the thermal conductivity of the insulation material. The higher the "R"value the more effective the insulation material is at preventing heat loss.

Whereas solar storage tanks do not come with sufficient factory insulation to meet Solar Thermal Systems' insulation specification, a supplemental insulation jacket also must be installed. We recommend an aluminum foil "bubble-pack" insulation material such as manufactured by Reflectix (or equal). When properly applied, the insulation jacket will increase the overall level of the solar tank insulation to approximately R-22. In two tank retrofit installations an installation jacket also must be installed on the back-up water heater.

If your Sts system is installed in a new home, Solar Thermal Systems specifies that the conventional water heater in a two tank system have an insulation value of R-20. Tanks with R-20 insulation or higher do not require a supplemental insulation jacket.

For best results, cut three 1" strips of material and affix these to the top, middle and bottom of your water heater or storage tank with the manufacturer's tape. This space creates an air gap between the heater and the insulation and prevents heat conduction. Wrap the material around the water heater or storage tank and secure the seams with the manufacturer's tape.

Thoroughly insulate the top of the water heater. Fit the insulation snuggly around the brass nipples or unions and temperature and pressure relief valve on the top of the water heater. If you

have an electric water heater, cut two windows in the insulation around the access plates covering the upper and lower thermostats and heating elements. Insulate the area over the assess plates, but make sure that these areas always remain accessible for service or repair as necessary.

The storage tank should not be placed directly on an uninsulated floor or concrete slab. The tank should be placed on a well insulated pad with a minimum R-value of 10. A 2" rigid polystyrene insulation pad such as manufactured by Frost King (or equal) is recommended.

4.11 Electrical and Wiring Requirements

A properly licensed contractor must make the 230 volt electrical connection to the water heater or solar storage tank and the electronic time switch (Optional No. 33). If your solar contractor is not allowed by law to make these connections consult a licensed electrician.

Never activate the circuit breaker controlling the electrical heating element until the solar storage tank is completely filled with water. This will prevent "dry firing" of the heating element. The electrical heating element will be destroyed almost instantaneously if not completely submerged in water when activated. Make sure the water heater circuit breaker is off until the solar storage tank is completely filled.

We recommend the use of a 115 volt differential control with a factory installed six foot line cord. The installation requires one 115 volt outlet to be installed near the solar storage tank. Plug the control into the outlet. The circulation pump line cord is plugged into the receptacle on the side of the controller. A 230 volt control and circulation pump may be substituted, but troubleshooting the components in the future becomes more difficult.

The specified differential thermostat is the Steca TR 301SE.

4.12 Charging the System

Once the components are plumbed you are ready to fill the solar storage tank with water and to charge the collector loop with a mixture of heat transfer fluid (HTF) and distilled or deionized water. The use of regular tap water as a mixing agent is prohibited.

Proceed as follows:

4.12.1 Begin by filling the solar tank with water. Do this by opening the cold water isolation ball valve to the solar tank (No. 23). When the tank is filled, inspect all threaded fittings and solder joints for leaks.

Please insert this section in place of 4.12.2, 3, 4 & half of 5

4.12.2 Initial fill and pressurize the solar collector loop with water, first to flush out containments, second to pressure test solar loop, and third to pressurize with HTF for final operation. This process is most easily done either at the beginning or end of the day, or on a cloudy day; avoiding full sun.

1) Begin by connecting a washing machine hose, to the upper hose bib near the relief valve above the solar circulator (No 9). The washing machine hose on its other connection should be attached to the male end of a hose which is attached to fresh make up water hose bib with the hose bib in the off position.

2) Remove the solar expansion tank during this process. The expansion tank system comes with a spring check valve to allow removal of the expansion tank even if the solar system is under pressure.

3) Close the shut off valve immediately above the solar circulator. The valve doubles as the well for the solar supply (blue) thermometer. Remove the solar supply thermometer and insulation to access the shut off valve. The shut off valve has flat sides to accept an adjustable crescent wrench, _ turn clockwise to close.

4) Attach a second hose to the lower hose connection on the solar module for the solar collector supply and place the male end either in a 5 gallon bucket, to the outside, or to a nearby toilet with the seat down to hold the hose.

5) With the power to the solar control "off", close shut off valve, open the bottom hose bib on the solar module, open the fresh water hose bib, then slowly open the upper solar module's hose bib and begin flushing the solar loop. Watch the

pressure guage to make sure you do not exceed the pressure setting of the relief valve unnecessarily. (One bar is approximately 15 psi).

6) Flush the solar loop for 5-10 minutes until air bubbles are eliminated. You can see the air bubbles if you use the 5 gallon bucket or toilet.

7) Look for leaks in the plumbing. Turn down the upper solar hose bib to a trickle, close lower hose bib completely, then finish closing upper solar hose bib, and then the fresh water hose bib.

8) Open the solar supply shut off valve, then turn "on" the solar control. You have to circulate the water through the collector(s) to keep the collector from stagnating and over heating. Continue looking for plumbing leaks. If you should find a leak, you will have to turn off solar control, drain the system, make the repair, and fill/purge/pressure test again.

9) With the system fully pressure tested, final filling the solar loop with HTF can begin. Go to table 4 & 5 in the manual. The difference between "Freeze Protection" glycol concentrations and "Burst Protection" is, Freeze Protection will keep the HTF liquid, while the Burst Protection point is slush just before the HTF expands and damages the solar collectors and piping. So, for the Bay area, 20% glycol to 80% water will give you Freeze Protection down to 19 degrees F and 10 degrees F Burst Protection. For the Sierra's, 36% glycol to 64% water will give you Freeze Protection down to 0 degrees F and Burst Protection down to -60 degrees F. Concentrations greater than 50% glycol to 50% water is not recommended as high concentrations of glycol can lessen the life of gaskets and seals.

10) Calculate the volume of gallons in your system, or simply fill and then drain the system and see how much liquid is in your bucket, plus estimate how much is left in the solar system. Each solar collector contains approximately 1 gallon of water, the SuperStor heat exchanger has 1.2 gallons, then add the volume of water in the plumbing of the solar loop. _" Type L copper has 0.025 gallons of water per linear foot, and 1" Type L copper has 0.043 gallons of water per linear foot.

11) A two collector system may have 4 gallons of fluid, so for the Bay Area, 0.8 to 1 gallon of glycol to 3 gallons of distilled water should be put in the HTF bucket.

11) With the solar loop charged with fresh water from step 7, add the HTF by using a Silver King Force Pump, or equal, to a 5 gallon bucket filled with the appropriately mixed and sized volume/ratio of glycol-water, HTF. Attach the Force Pump to the upper solar supply hose bib. Close shut off valve as shown in Step 2. Add a second 5 gallon bucket and attach hose to the lower solar supply hose bib. Recirculate HTF in its 5 gallon bucket--purging the Force Pump of air before attaching Force Pump connection to upper solar hose bib. Crack open the lower solar supply hose bib, open the upper solar supply hose bib, then begin pumping the Force Pump. The Force Pump has a built in check valve so you can stop and rest if you need to without fluid draining back. When the HTF is almost completely pumped out of the HTF bucket, move hose from the second 5 gallon bucket to the HTF bucket. Force Pump into the solar loop only as much liquid as is coming back. Keep pumping-circulating until all air is eliminated.

12) When air is eliminated, check to make sure the solar loop pressure is around 20-25 psi for installations up to 30' high from solar storage tank to solar collectors. Add or drain HTF until desired pressure is obtained. Close lower & upper solar supply hose bibs, and open solar supply shut off valve. Immediately turn the solar control "on"!

13) Make sure expansion tank pressure is precharged to desired solar loop system pressure, then attach to solar supply.

4.12.5 After charging the collector loop, shut the lower charge faucet and let the pressure pump drive up the loop pressure to the appropriate level (Generally in the range of 25 PSI). To more accurately calculate the proper pressure measure the height of the solar collector above the solar storage tank and divide this number by 2.31. Then add 20 PSI to this number. As a word of caution, the pressure in the glycol loop should not exceed 45 PSI when the system is operational on a good sunny day. Contact your solar contractor if the charged collector loop pressure exceeds this threshold.

Table 4		
Percent (volume) Glycol Concentration Required		
Temperature F	For Freeze Protection	For Burst Protection
20	18%	12%
10	29	20
0	36	24
-10	42	28
-20	46	30
-30	50	33
-40	54	35
-50	57	35
-60	60	35

Your STS solar water heating system must be charged and the fluid quality maintained by an experienced contractor. If the system is drained during the winter, or you notice a significant drop in collector loop pressure, contact your installation contractor immediately for service. The glycol HTF provides the freeze protection for your system and must be properly maintained. An experienced contractor should periodically check the HTF fluid quality.

4.12.6 Dowfrost HD HTF

To ensure maximum effectiveness for corrosion protection, the glycol inhibitor package is designed for a minimum 25-30 percent concentration of glycol in water. Table 4 shows the concentrations of Dowfrost HD required to provide freeze and burst protection at various temperatures. Use the mixture most appropriate for your climate. Do not use a higher glycol to water concentration than necessary, as this will adversely impact the relative heat transfer efficiency of the solution.

Table 5	
Total Collector Loop Fluid Capacity In Gallons*	
1 Collector System	3 Gallon
2 Collector System	4 Gallons

* Assumes a total 100' pipe run using 3/4" Type M hard copper tubing. The SuperStor Solar heat exchanger has a 1.2 gallon fluid capacity.

Generally, for an extended margin of protection, you should select a temperature that is at least 5°F lower than the expected lowest ambient temperature. These figures are examples only and should not be regarded as specifications. As use conditions are not within our control, neither Solar Thermal Systems nor Dow Chemical guarantees that freeze damage may not occur at temperatures other than shown.

Water used to dilute the HTF must meet certain minimum standards for purity. Impurities in the dilution water can increase metal corrosion, reduce the effectiveness of corrosion inhibitors, increase inhibitor depletion rate, and cause the formation of scale and other deposits on the heat exchanger's internal heat transfer surfaces.

Distilled or deionized water is required.

The HTF pH level must be maintained between 8 and 10 to minimize corrosion and glycol oxidation in the piping system.

5) SYSTEM START-UP PROCEDURES

Throughout the installation procedures outlined in Section 4 above, emphasis has been placed on the correct procedures for plumbing and wiring the components, checking for plumbing leaks, pressurizing the collector glycol loop, and eliminating any trapped air that can impact fluid quality and pump performance. Having completed these tasks it is time to start up your STS solar water heating system.

When the glycol loop has been fully charged and the pressure is around 25 psi (check the pressure gauge, No. 7), set the differential controller to the "Automatic" setting. This will activate your circulating pump. The Goldline controller allows you to set the "on" differential. Turn the red rotary switch inside the control housing to 12.

The controller also allows you to limit the finished solar storage tank temperature if desired. Turn the red rotary switch inside the controller marked "Hi Limit" to the 160° setting. Solar Thermal Systems does not recommend that the Hi Limit be set any lower than 160°.

Adjust the valve settings in accordance with Section 6 below.

6) THREE MODES OF SYSTEM OPERATION

Both single and double tank Sts systems are designed to accommodate three separate modes of operation. Your solar water heating system can, (1) provide 100% solar operation during good weather, or (2) serve as a preheater to your electric water heater adding solar energy when and as available, or (3) completely bypass the solar collector loop and solar storage tank and run 100% on utility power during inclement weather.

Single Tank Operating Instructions:

6.1 100% Solar Operation:

Turn off the circuit breaker to your solar storage tank. If a water heater time switch has been installed, set the switch to the "off" position. If you have a mechanical timer remove the trippers from the face of the switch.

6.2 Solar Preheat

Leave the circuit breaker to your solar storage tank on and set the tank thermostat to the lowest acceptable temperature setting. The electric resistance heating elements will come on only when the tank temperature falls below the thermostatic set point. If the solar heated water entering the tank is warmer than the thermostatic set point, the electric heating elements will not come on. If you have a water heater timer, you may preset the timer to turn the heating element on and off at specified times throughout the day if desired.

6.3 100% Utility Power

Leave the circuit breaker to your solar storage tank on and close the isolation ball valves in the collector loop (Nos. 5 and 10). In this mode of operation **you must turn off the circulation pump.** To turn the pump off open the controller and change the operational setting from automatic to off. Failure to turn off the pump can quickly damage the pump motor, shaft, bearings or impeller.

Two Tank System Instructions:

6.4 100% Solar Operation

Follow the instructions for single tank systems above. You also must change the position of the three way ball valves above both the solar storage tank and the back-up water heater (Nos. 24 and 26). Valve handle No. 24 must be in the horizontal position. Valve handle No. 26 must be in the vertical position. See Figure 19a, 100% Solar Operation.

6.5 Solar Preheat

Follow the instructions for the single tank system for setting the thermostat and the heating elements for automatic operation. The three way valve above the solar storage tank (No. 24) must be in the vertical position. Each valve handle (Nos. 24, 25 and 26) must be placed in the horizontal position. See Figure 19b, Solar Preheat.

6.6 100% Utility Power

Follow the instructions for the single tank system above. All three ball valves above the heaters (Nos. 24, 25 and 26) must have the valve handles placed in the horizontal position. See Figures 19c 100% Utility Power and 19d.

7) ISOLATING THE MAJOR COMPONENTS AND SYSTEM SHUT DOWN PROCEDURES

Your STS solar water heating system is designed so that the key components can be easily isolated for emergency repairs or routine maintenance. By shutting a single valve you can isolate the entire system from the pressurized cold water supply line (No. 23). In the case of a storage tank or fitting leak immediately shut this valve and call your installation contractor for service.

The collector loop can be isolated from the solar storage tank by closing isolation ball valves Nos. 5 and 10. If the pressure in this loop drops or you find a glycol leak shut these valves and contact your installation contractor. Turn the circulating pump off by setting the controller to the "off" position.

In two tank systems the solar storage tank can be isolated from the back-up water heater.

Set the valve handle on the three way ball valve (No. 24) to the horizontal position and close the isolation ball valve (No. 25). By closing these two valves the tank can be serviced or replaced. The operation of the back-up water heater will not be

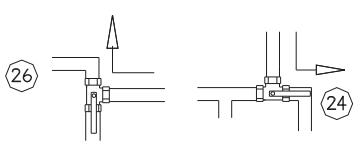


fig.19a

100% SOLAR OPERATION

effected.

The back-up water heater in two tank systems also can be isolated from the rest of the system. Close the cold water supply line ball valve (No. 23) and set the three way valve handle above the conventional water heater (No. 26) to the vertical position. Set the two way ball valve handle (No. 30) directly above the heater to the horizontal position.

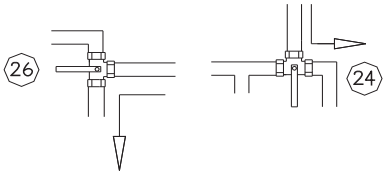


fig.19b

SOLAR PREHEAT

8) SUMMER VACATION RECOMMENDATIONS AND PROCEDURES

Solar water heating systems can build up very high temperatures when there is no daily draw on the system. If a short summer vacation is planned the best way to dissipate heat in the system is to set the controller to the "on" position. The circulating pump will run twenty-four hours

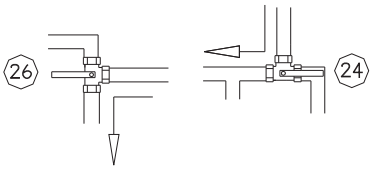


fig.19c

100% UTILITY POWER

a day and cool off the water in the solar storage tank at night. The collector radiates heat back to the atmosphere at night, preventing the system from stagnating at very high temperatures. This will not harm the pump or add substantially to your monthly utility bill. Remember to set the control to the "Automatic" setting upon your return!

During extended summer vacations (4 weeks or more) it is advisable to either cover the solar collectors with an opaque material or to manually drain the collector loop HTF. Solar Thermal Systems recommends that you cover the collectors if practical.

If you choose to drain the HTF in the collector loop follow these steps:

8.1 Turn the controller to the "off" position (No. 18).

8.2 Connect one end of a garden hose to the purge/drain valve (No 11) and place the other end in a five gallon bucket. Open the valve and gravity will drain the heat transfer fluid into the bucket. A licensed recycler, reclaimer or incinerator must dispose of the Dowfrost HD. **DO NOT DUMP DOWFROST HD INTO A STORM SEWER, ON THE GROUND OR INTO ANY BODY OF WATER.**

BE CAREFUL. THE HTF MAY BE EXTREMELY HOT!

8.3 If the system is installed with an optional time clock make sure the clock is not preset to go "ON" during your absence. If you have a mechanical time switch, remove the "on" tripper from the clock face (No. 33).

When you return home contact your service contractor to recharge the system with HTF. After the system has been recharged, set the controller to the "automatic" position. Reset the time switch.

9) MAINTENANCE AND TROUBLESHOOTING

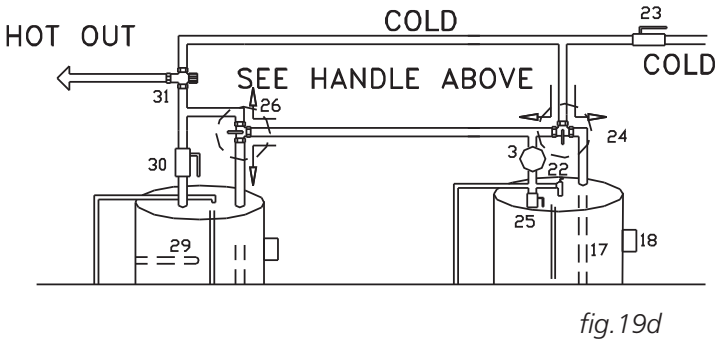


fig.19d

VALVE POSITION DIAGRAM 2-TANK SYSTEM

The following simple procedures are intended to optimize the performance of your STS solar water heating system and also to extend the life of the primary components.

9.1 Fluid Quality: It is extremely important to monitor the qual-

ity of the Dowfrost HD HTF on a periodic basis. The chemical composition of the heat transfer fluid may change over time. System pH must be maintained between 8 and 10 to avoid damage to the collector loop and absorber plate piping.

The specified glycol HTF is Dow Chemical "Dowfrost" HD. An extremely complete manual is available from the Dow Chemical Co. by calling 1-800-447-4369 Extension DOWFROST. Dow Chemical's "Engineering and Operating Guide for Dowfrost and Dowfrost HD" describes in detail the necessary procedures to maintain the integrity of the HTF. Ask your installation contractor to establish a maintenance schedule to inspect, balance or replace the glycol HTF as needed.

9.2 The second most important component in your system, at least from a longevity standpoint, is often ignored and never seen. We are referring to the sacrificial "anode rod" installed in your solar storage tank (No. 20). Typically constructed from magnesium, anode rods are installed in "glass lined" water heaters and storage tanks to inhibit corrosion.

As the name implies, the "sacrificial" anode rod is consumed so that the tank lining is not. At a certain point in the process, the anode rod is no longer completely effective and the corrosive processes begin to eat away at the tank's glass lining. In time the solar storage tank, like any other gas or electric water heater, will begin to leak. The process is not reversible and the tank must be replaced.

System temperatures and water quality affect the rate at which the anode rod is consumed. In general, the higher the average system temperature the faster the rate of corrosion. By changing the anode rod after the fifth year of system operation, and every three to five years thereafter, it is possible to extend the life of the solar storage tank. Periodic replacement of the anode rod in your solar storage tank can significantly extend the tank life.

9.3 The solar storage tank also should be flushed annually to minimize sediment build-up on the bottom of the tank. If you live in an area with high mineral content in your water, flush the tank on a semi-annual basis. Disconnect the power to the solar tank at the circuit breaker or time switch (if present) before flushing. Turn the controller to the off position.

Open the flush valve on the bottom of the storage tank (No. 15) and drain a sufficient volume of water to eliminate the sediment. After the procedure is complete make sure the tank is completely full of water before restoring power to the thermostat and heating element. Turn the controller to the "on" position.

9.4 If you live in a dusty climate it is a good idea to wash off the dirt that settles on the collector glass once a month. Clean glass allows the collector to maintain a high level of thermal performance.

9.5 Check the exterior pipe insulation annually and patch or repair any exposed surfaces or degraded areas. Repaint as necessary.

9.6 In the unusual instance of collector glass breakage, the glass should be replaced immediately. This will reduce the likelihood of water accumulating inside the collector and deteriorating the insulation. Contact your installation contractor.

9.7 If you detect a glycol or water leak, or the glycol loop pressure drops unexpectedly, contact your installation contractor immediately to diagnose the problem and recharge the system.

9.8 If it's been a sunny day and you don't have hot water, first make sure that the controller is set in the automatic position. If the controller is properly set and the pump has not been running, unplug the line cord from the controller receptacle and plug the pump directly into a nearby 115 volt outlet. If the pump does not run it may need to be replaced. If the pump does run when plugged directly into the wall outlet, the problem may be located in the controller or one of the 10k ohm sensors. Contact your installation contractor for service.

9.9 If you have a full tank of hot water before bed and the solar storage tank is cold in the morning, the check valve (No. 4) may not be seating correctly and should be cleaned or replaced. Also make sure that the circulating pump is not running after 6:00 p.m. If the pump is running and the control indictor light "Solar" #1 is on after 6:00 p.m., check both sensors to see that they calibrate to 10K ohm resistance at

77°F. If you find a defective sensor replace it immediately.

Note that in a two tank system nighttime heat loss will be harder to detect, especially if you are operating in the solar preheat mode. Check the line thermometers (No. 3) in the collector loop piping to detect night thermosiphoning.

9.10 If the weather is poor and the auxiliary heating element will not fire, the bright red reset button on the thermostat may have to be depressed to be reset. Single tank systems have one heating element and thermostat. Double tank systems with conventional electric water heaters have two heating elements and thermostats (see fig 17, No. 29).

Never remove the protective access plate on the exterior of the solar storage tank or conventional water heater without disconnecting the 230 volt power supply at the circuit breaker.

After the circuit breaker has been turned off, remove the access plate on the storage tank or water heater and depress the red reset button on the thermostat. If it clicks when depressed the heating element should fire immediately when you reconnect the circuit breaker. It the reset button does not click and you do not have hot water after one hour, the heating element or thermostat may be defective. Contact your installation contractor for service.

In two tank systems the conventional electric water heater will be wired for electrical back-up. The solar tank will serve solely as a storage tank and will not be wired.

10) STS SYSTEM COMPONENT PARTS

See Figures 16 and 17 for the location of the specific components numbered below.

1) Solar Thermal Systems Solar Collector(s): Absorbs the sun's heat energy and transfers this heat to the HTF circulating through the collector.

2) Collector Sensor: Wired to the system controller. Works in conjunction with the tank sensor to automatically turn your circulating pump on and off at preset temperature differentials.

3) Tank and Line Thermometers: Used to determine proper system operation. Line thermometers will show an approximate 5 - 12° temperature difference between the collector supply and return lines on sunny days. In a single tank system the tank thermometer will read the temperature of the water after the mixing valve feeding your fixtures. In two tank systems the thermometer will read the finished solar tank temperature.

4) Check Valve: This valve is installed to stop or minimize convective evening heat loss in the system. The heat in the solar storage tank will rise through the collector loop piping in the evening into the much cooler solar collector and dissipate heat unless prevented from doing so by a check valve. Check valves are also sometimes referred to as one way valves.

5) Isolation Ball Valve: Used in conjunction with component No. 10 to isolate the solar collector loop from the solar storage tank.

6) Pressure Relief Valve: Will release glycol loop HTF at 150 PSI. If this valve opens and HTF fluid is expelled contact your contractor immediately. This valve also can be opened to drain the HTF from the charged glycol loop for replacement.

7) Pressure Gauge: Indicates the pressure in the charged glycol collector loop.

8) Expansion Tank: Pre-charged with air to allow for the expansion and contraction of the glycol HTF as it heats and cools.

9) Charge Valve: Used to charge the collector loop with glycol and also to eliminate air from the system.

10) Isolation Ball Valve: Used in conjunction with component No. 5 to isolate the solar collector loop from the solar storage tank. Also used with the charge valves to fill and pressurize the collector glycol loop (Nos. 9 and 11).

11) Drain/Purge Valve: Used to charge the collector loop with glycol, purge air from the loop and drain the heat exchange fluid.

12) Isolation Ball Valve: When closed in conjunction with No. 14 will isolate the circulation pump for repair or replacement.

13) Circulating Pump: Circulates the HTF through the collector loop.

14) Isolation Ball Valve: When closed in conjunction with No. 12 will isolate the circulation pump

for repair or replacement.

15) Flush Valve: Used to drain the solar storage tank and to flush sediment from the tank on an annual basis.

16) Tank Sensor: Wired to your controller. Works in conjunction with the collector sensor to turn your circulating pump on and off at preset temperature differentials.

17) Cold Water Dip Tube: Forces incoming city cold water to the bottom of the solar storage tank to prevent mixing with the warm water at the top of the tank.

18) Differential Thermostat: Known as the controller. Automatically turns the circulating pump on and off when there is sufficient heat to be gained from the solar operation. The controller also may be set to limit high temperature build up in the solar storage tank.

19) Heat Exchanger: Transfers heat from the solar collector loop to the potable water in the solar storage tank. The heat exchanger is double walled and vented. If a leak in the heat exchanger piping occurs there is no possibility that the potable water in your solar storage tank can be contaminated with the glycol HTF.

20) Anode Rod: The "sacrificial" anode rod is installed in your solar storage tank to prevent corrosion to the tank lining by neutralizing aggressive water action. Anode rods have a finite life and require periodic replacement depending on annual tank temperatures and water quality. Determine a replacement schedule with your installation contractor.

21) Heating Element & Tank Thermostat: The solar storage tank is equipped with an auxiliary 4500 watt, 230 volt electrical heating element. The thermostat controls the temperature setting of the auxiliary heating element.

22) Temperature and Pressure Relief Valve: Universally required by the plumbing code on water heaters. Will automatically release and dump water at either 150 PSI of pressure or 210° F in temperature.

23) Cold Water Supply Line Isolation Ball Valve: When open allows potable water to fill the solar storage tank or back-up water heater. When closed isolates the solar storage tank and back-up water heater from the pressurized city cold water supply line.

24) Three Way Ball Valve: Used in conjunction with component No. 26 to establish the proper mode of system operation.

25) Isolation Ball Valve: Used in conjunction with component No. 24 to completely isolate the solar storage tank for repair or replacement as necessary.

26) Three Way Ball Valve: Used in conjunction with component No. 24 to establish the proper mode of system operation.

27) Cold Water Dip Tube: See No.16 above.

28) Anode Rod: See No. 18 above.

29) Heating Elements and Thermostats: See No. 19 above. In a two tank system the back-up electric water heater has two heating elements and two thermostats.

30) Temperature and Pressure Relief Valve: See No. 22 above.

31) Optional Isolation Ball Valve. Use with component No. 26 to completely isolate the back-up water heater for repair or replacement.

32) Mixing Valve: Automatically blends hot water from the solar storage tank with incoming city cold water to an acceptable set point. A mixing valve must be installed on every STS solar water heating system.

33) Optional Time Switch: Allows you to automatically or manually turn the auxiliary heating element in the solar storage tank on and off. A time switch is a highly recommended option.

11) ESTIMATED COMPONENT LIFE

You can expect a long useful life from the primary components in your STS solar water heating system by adhering to the routine service and maintenance tips provided above.

The Solar Thermal Systems solar collectors have a design life of twenty-five to thirty years. The HTF must be maintained as specified in this manual to maximize collector life. Photovoltaic modules have design lives in excess of twenty years. The solar storage tank should last 10 to 20 years in most water quality areas by periodically replacing the anode rod. The 12 volt DC circulating pump

generally runs 20,000 hours before the brushes or motor require replacement. Like EPA mileage estimates for automobiles, these component design lives represent average figures for closed loop forced circulation systems of this type installed in the United States.

To obtain warranty service contact your installation contractor or call Solar Thermal Systems for the name of an authorized service agent near you.