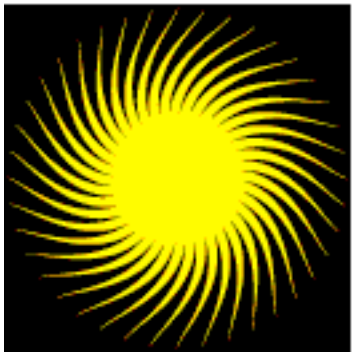
Solar
Consultants



Drainback Solar Water Heater

using Rheem/Richmond SolarAide
Integral Heat Exchanger Water Heater

User's Manual

This manual describes our drainback type solar water heater with the following characteristics:

- Sealed solar fluid loop (no need to top up fluid seasonally as with systems that are open to the air.)
- Self-protected from freezing or overheating with or without electric power being on.
- Allows extra collectors for space heating.
- Backup is built in to the upper portion of the electric water heater, or can be separate water heater.
- Uses industry-standard circulators (pumps). Other brands can be substituted for replacement without system redesign.

1. Components

Words that appear in the glossary (at the end of the manual) are in italics the first time they appear in the text. The operation of the backup water heater is covered in its own manual provided by the manufacturer.

The *solar loop* of the system consists of a small (8-20 gallon) electric water heater tank used to store *solar fluid*, a *pressure relief valve*, a Taco 009 cast iron circulator to lift the fluid and move it through the collectors, one or more thermal collectors, and the heat exchanger built into the Rheem SolarAide water heater. The solar fluid is either water with a pink-tinted anti-corrosive buffer added or a propylene or ethylene glycol antifreeze mixture. A boiler drain and fill plug are provided for maintenance.

The potable, or domestic hot water is stored in the 80-gallon electric water heater and does not mix with the solar fluid. The system may include a tempering valve to manage the outgoing water temperature.

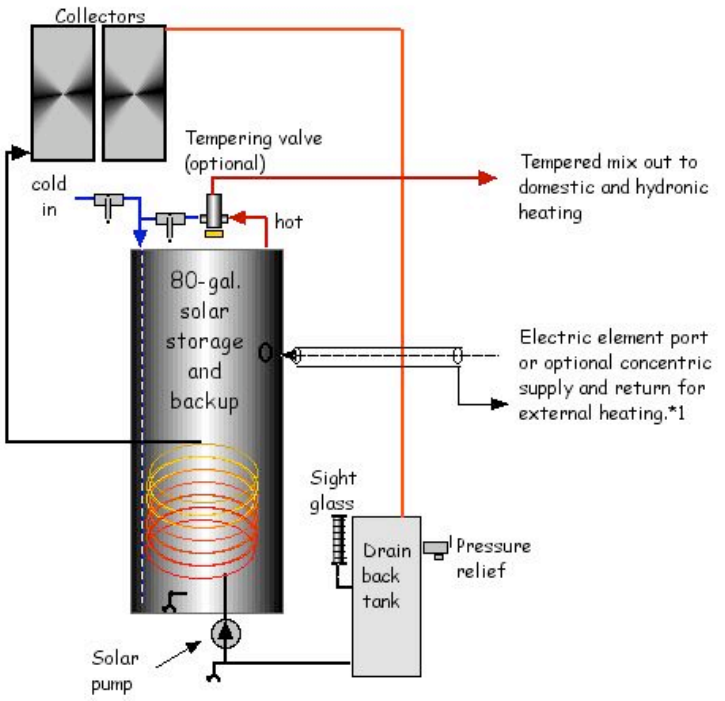
The solar pump is controlled by a differential temperature control, typically a Heliotrope Thermal Delta-T or Independent Energy GL-30, mounted

on the side of a tank or wall near the solar pump. Either brand uses a 10kΩ temperature sensor at the top of the collector array and in the lower portion of the potable water storage tank. The control continually compares a temperature sensors to determine when to turn on the pump.

Solar Domestic Hot Water System

• Drainback type; built-in freeze and over-heating protection, low maintenance.

• Uses integral heat exchanger tank; simplifies system by reducing number of moving parts.



* Note 1: The element port can be used for a gas instantaneous water heater, boiler, or other source of auxilliary heat input.

2. Description of Operation

When sunlight hits the collectors and their temperature rises to fifteen degrees higher than that of the coolest potable water at the bottom of the storage tank, the differential temperature control switches 120VAC power to the pump. The solar fluid is driven through the heat exchanger, up to fill the collectors and, after about two minutes, can be heard gurgling down the return pipe.

Pumping continues until the collectors and the stored water come within four degrees of each other, the pump turns off and all the solar fluid drains back to its holding tank. On a day with intense mottling of clouds and sun it is possible for the pump to stop and start several times. This happens especially when the storage water has already been heated to near collector temperatures.

Since the collectors and exposed pipes have no fluid in them when they are cold, no antifreeze is necessary, but if there is danger of the solar fluid storage tank freezing antifreeze may be added.

The control includes an adjustable high temperature limit. When the lower storage tank temperature reaches the limit -- usually set inside the control

at around 110 to 130° -- the control shuts off the pump even if the collectors are still hot. This would typically occur near the end of a sunny day when little domestic hot water or space heat had been used.

3. Installation

This section is intended to inform the system owner of some of the considerations and logic that went into the installation of solar equipment. It may be helpful if a re-roofing, renovation, or other change demands part of the system be moved.

Collectors and Pipes

Your collectors may have been mounted using any of several methods, depending on whether the feet are attached directly to the collector frames or a separate aluminum frame was fabricated to hold the collectors; whether they are parallel with the roof surface or held up with legs, etc. On most roofs (other than standing seam metal) each foot has a stainless steel lag bolt that penetrates the roof into solid wood.

The collector array faces close to south at approximately a 45° angle from horizontal and is also very slightly tilted from vertical in an easterly or westerly direction so that the bottom pipe of the collectors will drain. The minimum drain slope is 1 inch in 20 feet.

There must also be a similar continuous slope in the solar pipe runs from the lower end of the collector panels on the roof to the heat exchanger and solar fluid tank. This can almost always be accomplished, but in new construction must be planned before other plumbing, ductwork, etc. occupies the needed route.

If the attic or other area where these pipes run is ever renovated, be certain the slope is not compromised. If the attic is used for storage make certain no heavy object is placed upon or hung from a pipe so as to bend it or cause a low spot.

If the collectors must be moved for roof repairs consult a solar installation professional beforehand.

Drainback Tank

The reservoir containing the solar fluid should be protected from rain and prolonged freezing temperatures in case of extended power failures. The preferred location is within the insulated area of a building, such as in a garage, basement, or crawl space. If it is installed in an attic, pipes to and from the backup water heater may be situated to provide some residual heat migration to prevent freezing, or antifreeze may be used as the solar fluid.

The drainback and the domestic water tanks must be installed on a floor or surface substantial enough to carry the full weight of the tank plus water. The table below shows approximate filled weights of three common tanks. Drain pans should be used where leaks could damage flooring or floors below. As long as the anticorrosive additives in the drainback fluid are maintained, there is little chance of the tank rusting out as will a tank containing domestic water. However, the tank should be accessible for maintenance, particularly the boiler drain at the bottom and fill plug in the piping above the tank.

Approximate Weight of Full Tanks

Tank Size	Approx. Full Wt.	Water Treatment (1:250)
10 gal.	125 lbs.	8 oz.
20 gal.	210 lbs.	16 oz.
80 gal.	870 lbs.	Potable water
120 gal.	1300 lbs.	Potable water

4. Maintenance

The top level of the fluid (with pumps off and fluid drained back) should be to the pressure relief valve. See "Checking Level and Topping Up the Solar Fluid", below. The **anti-corrosive buffer compound or antifreeze** in the solar fluid should be tested at least **every three years**.

Since the pump is lubricated by the fluid it pumps, it requires no maintenance, but if it sits too long without running the fluid can leave deposits that will prevent the pump from being able to start without being either taken apart and freed up or replaced.

Indoor **pipe insulation** should be checked every few years. Patch any areas where shrinkage or damage has caused gaps to form, using insulation rated for high temperatures (rubber foam, isocyanurate foam, or fiberglass; not plastic foam.)

Animals -- cats in particular -- are attracted to the warmth of the system. The top of a tank makes a great place to sleep. You may have to wrap screen wire around insulation to keep them from tearing it.

Your water heater includes an **anode rod** that protects it from corrosion from the potable water. It should be checked every three to five years. If the electric element is wired up, **turn off the electric element's 240V (double) circuit breaker or pull the disconnect before draining any water or unscrewing the anode**. To check the rod, turn off the cold water inlet and drain off the hot water pressure down to the top of the tank, then unscrew the sacrificial anode rod -- it is the large hex-head in the top of the storage tank (water heater) -- and pull it up to examine the rod. If it is deeply pitted or more than six inches of core wire is exposed at either end of the rod, replace it. After the anode is back in place and the cold water valve is back on, open several hot water taps long enough to blow air out of the tank and lines before restoring electric power to the element.

Checking Level and Topping Up the Solar Fluid

Unlike vented drainback systems (e.g., the Astron SunMate), our solar fluid loop is sealed so there should be no evaporation under normal use. Following are instructions for checking and topping up the fluid in case any is ever lost.

You'll need: two wrenches or large pliers, one of which must have a 1-1/4" jaw opening; funnel with ~1/2" spout; Teflon™ pipe thread tape; a rag; a small bucket; and (if used in your system) propylene glycol antifreeze. If possible this procedure should be done when the drainback tank and collectors are not hot.

a) Turn off or unplug the system's differential temperature control. Wait five minutes for all the fluid to drain back into the holding tank.
b) Observe the solar fluid drainback tank. **Caution: this tank and its fittings may be very hot!** Are there any signs of fluid leakage at the

base or in the drain pan (if installed) under the tank? Any sign of drip or corrosion from leakage at the pressure relief valve, fill plug, on boiler drain? If so, note that and clean it off so you'll be able to tell next time if there has been more leakage at these points.

c) Use the rag and lift the lever on the pressure relief valve (PRV) to let off pressure. Try to leave this lever in the open position. (Some valves will not latch open.)
d) Place a wrench or pliers on the drain plug (in the pipe atop the drainback tank) and the other on the outside of the fitting holding the plug and loosen the plug. Before it gets completely open, lift the PRV lever one more time or check to make sure it is open to make certain pressure is neutral. As a further precaution, place the rag over the plug and never look at or stand over the fill plug as you complete its removal.
e) Place a bucket under the PRV, put the funnel in the fill hole and slowly add water or antifreeze/water mixture until it begins to come out the PRV or the fill hole.
f) Wrap the plug threads with Teflon™ tape and replace snugly.
g) Release the PRV lever so it returns to a closed position.
h) Make a note of how much water or antifreeze you added and the date.
i) Plug in and/or turn on the differential temperature control. (On Independent Energy controls the "On/Off/Auto" switch is accessed by removing the two cover screws and cover.) Listen for the pump to start and, in a minute or two, the solar fluid to begin returning to the drainback tank. Make sure to leave the control in its "Auto" setting of the function switch.

5. Warnings

It is acceptable, but not necessary, to turn off the system over vacation or time when no hot water is being used; the system design prevents overheating. If the pump is not run for months at a time, however, it may become stuck, requiring a service call to dismantle the pump body.

If the solar fluid pump is ever replaced, specify a new pump that has sufficient static head to push the fluid to the top of the collectors, plus a few feet extra to allow for pump aging.

6. Troubleshooting

If you are ever uncertain of whether the sun is heating your water or not, try turning off the backup, by switching off the water heater element 220V breaker or the pump to the gas backup. Be sure that power is still on to the solar control. Leave it this way for at least a day. You should continue to have hot water as long as there is a reasonable amount of sunshine and you are not using more hot water than the system was designed to supply. (This test will work only if any space-heating load is minimal or nonexistent so as not to deplete the solar-heated water.)

The best basis for troubleshooting is to become familiar with the sounds the system makes in normal operation. Also, by feeling the pipes on a sunny midday you should be able to tell a difference in the temperature of the fluid going up to the collectors and that returning. The return fluid should be warmer. But feel the pipe carefully; the returning fluid could be scalding hot!

The voltage to the temperature sensors is low, so it is perfectly safe to work with them while power to the differential temperature control is on. Sensors are thermistors with a negative coefficient of resistance to temperature, so a low resistance is analogous to a high temperature. A quick test of the control: if it is powered and switched to "Auto" but not pumping you can short the collector sensor leads to make it turn on (imitating a hot collector); if it is pumping, short the storage leads to see it turn off (imitating hot storage).

The pump bodies normally run hot to the touch. They should never become so hot as to discolor or blister their paint, however. Always unplug the control before servicing the pumps.

The solar heating system is functionally independent of the backup water heating or space heating systems. If your water is not as hot as usual on cloudy days, the backup heater is likely the culprit. If it is continually lukewarm even though the water heater tanks are hot, the tempering valve is suspect.

Symptom:	**Likely Causes:**
1) Pump never runs.	1a) If diff. temp. control Power *LED* is not lit check the outlet or circuit breaker.
	1b) Open cover of GL-30 or use switch on side of Delta-T; move switch from AUTO to ON. This should force the "Pumping" LED and both pumps on. If the pumps come on and run normally the problem is in a sensor, sensor wiring, or internal to the control. Temperature sensor/wire at collector is open or sensor/wire at tank is shorted, or a sensor is defective. Disconnect sensor wires from control and test with ohmmeter. Control literature includes temperature/ resistance charts, or call Solar Consultants to find out if reading is normal.
2) Pump hums and gets hot but does not circulate fluid.	2) Pump's running capacitor or one winding is bad; rotor may be stuck.
3) Pump runs all the time, 24 hours a day.	3a) Test as 1b) above, but turn switch from AUTO to OFF. If pump(s) do not stop then relay in control is stuck on.
	3b) Temperature sensor/wire at collector is shorted or sensor/wire at tank is open, or sensor is defective. Test with ohmmeter. Control literature includes temperature/ resistance charts, or call Solar Consultants to find out if reading is normal.
4) Pump runs long after sun is down, but not all night. (In very hot weather pump could run all night.)	4) System is not effectively getting heat from the collectors into the water. If the solar fluid tank is not hot, the solar fluid volume may be too low to fill collectors.

5) System turns pump off even though the sun is still on the collectors.	5) High temperature limit of storage water (usually 110 to 130° at bottom of tank) may have been reached.
6) Steam hisses from the pressure relief valve on the solar fluid (drainback) tank.	6) The solar loop is getting overly hot. There may not be enough fluid to complete the loop (listen for sound described in 7b).
7) Noises	7a) The pumps are lubricated by the water they pump. The noise should be a steady hum. "Bacon frying" or a soft "popcorn popping" indicates air in the lines.
	7b) After the pumps have been running for two minutes or so, solar fluid may be heard coming down the return pipe. The sound is like a gurgling fountain and is normal.
	7c) Screeching or clattering indicates pump bearings are shot; unplug the control immediately.
8) Water not hot enough	Determine the events that cause this. Is it true all the time (in which case the tempering (mixing) valve, if installed, is suspect), only when there has not been much sunshine (in which case the backup heating is not sufficient), or only when you turn off the backup (in which case the solar may not be fully functioning)? It is also possible you have begun using more hot water than your system was designed to provide.

7. Notes Regarding Parts

• collector(s) are typically either SolarHot Silver or Platinum, Alternate Energy Technologies AE, or Solargenix Energy Winston Series.
• solar fluid (drainback) tank: any electric water heater of 10-15 gal. capacity may be used. Tanks come with a temperature/pressure release safety valve. Since we are concerned only with excessive pressure, the temperature probe of the valve is cut off.
• water heater: Rheem SolarAide (also sold under the Richmond and Eagle Solar brands). If replacement is necessary, other internal or integral heat exchanger water heaters may be substituted, or an external heat exchanger and potable pump may be added to a standard water heater.
• solar fluid pump: Taco 008 or 009 (depending on height to top of collectors) or Armstrong Astro 50 or 70 (or Wilo equivalents) cast iron or bronze, flange fitting. Taco, Inc., 1160 Cranston St., Cranston, RI 02920 or Armstrong Pumps, Inc., 93 East Ave, North Tonawanda, NY 14120. If a cast iron pump is used, solar fluid must contain anti-corrosive treatment.
• differential temperature control: Goldline GL-30 (Independent Energy Inc., East Greenwich RI) or Delta-T 80 (Heliotrope Thermal)
• All other parts are standard items obtainable from local plumbing or heating supplier.

8. Specifications

Electrical requirements (Watts @ 120vAC) typical: 90 maximum: 180
Options:

- Thermostatic mixing valve (tempering valve) for water heater outlet.
- Dial thermometers to indicate fluid temperatures.
- Remote temperature readout. Can be installed up to fifty feet away.
- Direct current models available.

Design changes and part substitutions may be incorporated in custom or future systems.

9. Warranty

Parts and workmanship for a complete system installed and maintained by Solar Consultants are warranted by Solar Consultants for one year from the installation date. Individual parts, especially tanks, pumps, collectors, and controls, may be covered by additional manufacturers' warranties. Solar Consultants expands those warranties to include labor for replacement of manufacturer warranted parts.

Solar Consultants' warranty is void if the system has been allowed to run without fluid(s) or remain in a non-operating condition for more than thirty days.

Solar Consultants is not responsible for damage or loss of service attributable to domestic water chemistry, including but not limited to hardness, acidity, or chloramines content.

Manufacturers' Warranties (subject to change without notice)

Independent Energy "Goldline" controls carry a five-year pro-rated warranty. Replacement the first three years is at no parts charge; three to five years at sixty percent of list price.

Taco pumps have a one-year replacement/repair warranty for the electrical portion and three years for the cartridge, which contains all the moving parts.

Rheem/Richmond/Eagle Solar water heaters have six-year warranties.

Most brands of **collectors** carry a ten-year manufacturer's warranty against defects or leakage, but not against damage from freezing or outside forces. (Homeowner's insurance covers limb and storm damage.) Solar Consultants' used collectors are warranted for five years against defects or leakage.

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Glossary

Ball Valve an in-line valve that controls fluid flow. They are preferable to other types in that they do not restrict flow when open and never need a washer or seal replacement.

Check Valve an in-line valve that allows fluid to pass in only one direction.

Circulation Pump the larger of the two pumps in an RSM-1, it continually moves water through the floor loops. It stays on throughout the heating season.

Diverter Valve or **Bypass**, a T ball valve situated to direct the solar heated water into either the cold inlet of the backup water heater ("preheat", or winter operation) or directly feed the domestic hot water line ("solar only", or summer operation).

Expansion Tank a small tank containing an air-filled bladder surrounded by fluid. As the fluid expands it compresses the air. This evens out pressure fluctuations that would be caused by temperature change.

Injection Pump the smaller pump on an RSM-1, it is turned on by the controls as needed to add hot water to that circulating through the floor.

Key Vent a bleed valve used to purge air from a pipe. It is opened with a screwdriver or square key similar to a skate key.

LED, Light-Emitting Diode an efficient and long-lasting semiconductor used as an indicator on many controls.

Pressure Relief Valve a safety valve which opens to dump fluid or water if the pressure goes beyond its set point. Sometimes the set point is adjustable; on solar loops it may be set from 30 to 125 p.s.i. On a standard water heater the PRV is combined with a temperature probe so that it can open if either pressure or temperature exceed safe limits. The outlet of the valve is sometimes piped to the drain pan, the crawl space, or outdoors.

Radiant Loop Low-temperature hydronic heating uses large areas as the heat-bearing and distribution surface, as distinct from high-temperature radiators. Pipe laid for radiant heating, therefore, is set out in long runs that loop in a serpentine pattern through the mass. A small floor may have only one loop, but often a house will have several loops in zones. These may have valves so that they can be regulated individually, but often these are not needed.

RSM-1, RSM-1B Radiant Slab Module: the circulation pump, injection pump, control boxes, wiring, piping, and valves manufactured by Solar Consultants for hydronic heating. The original model used separate SP-33 and -34 controls; the B model uses only an SP-33.

RSM-2 Radiant heating module similar to RSM-1 but with a simplified purge valve setup.

Solar fluid The fluid consists mostly of water, mixed with an anti-corrosive buffer, propylene glycol, or ethylene glycol.

Solar loop the portion of the system that carries the fluid that passes through the collectors to be heated by the sun. This fluid is (in our systems) kept completely separate from the domestic water. Heat passes from the solar fluid to the domestic water in the heat exchanger.

SP-30, -33 or **-34, Set Point Control**, or thermostat. This white box compares a dial setting with a thermistor temperature sensor to switch a relay which can turn a pump or other load on or off.

Tempering Valve an automatic thermostat mounted at the hot water outlet of a water heater. If the outgoing water is above its set temperature, the valve allows cold water to mix in.

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