



Evacuated Tube Solar Thermal Collectors Installation Guide and Owners Manual

Please follow all safety warnings. Protective eye wear and gloves must be worn when assembling the unit.

Table of Contents.

Solar Basics

- 1.1 Introduction.
- 1.2 How Do They Work?
- 1.3 Collector Specifications.

System Design

- 2.1 Overall System Configuration.
- 2.2 High Limit Pressure/Temperature Relief Safety Controls.
- 2.3 System Expansion.
- 2.4 Air Purge Valve.
- 2.5 Overheating.
- 2.6 Stagnation.
- 2.7 Freeze And Stagnation Protection.
- 2.8 Collector Orienting and Location Selection.
- 2.9 Collector Hail Resistance.
- 2.10 Transfer Fluid Quality.
- 2.11 Pump Selection.
- 2.12 Plumbing Connections.
- 2.13 Temperature Probe
- 2.14 Insulation.
- 2.15 System Sizing.
- 2.16 Additional Components.

Installation

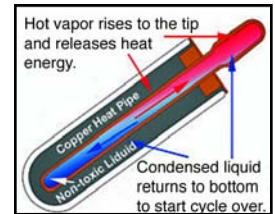
- 3.1 Delivery and Inspection.
- 3.2 Mounting Fasteners.



SOLAR BASICS

1.1 Introduction. Congratulations! You have just taken the first step in reducing your energy bills, your dependence on fossil fuels, and your impact on the environment. With correct system design, installation, and operation your collector should deliver years of efficient, reliable, clean solar thermal energy.

1.2 How Do They Work? At the heart of this process is the Heat Pipe. This is a sealed copper tube with a bulb on one end that we call a Condenser. Inside this copper tube is a fluid that boils when it reaches a temperature of 84 degrees. When the fluid boils it turns into steam and travels up the tube to the Condenser bulb. Inside the Condenser bulb the steam releases its heat energy and converts back into a liquid. The liquid then falls back down to the bottom of the copper tube and the process starts all over again.



In order to collect more sunlight we have added the Absorber Plates. These metal plates absorb solar energy and directly transfer it into the Heat Pipe. Our custom designed Absorber Plates centrally cradle the Heat Pipe with an open end on each side. This opening allows more plate overall to be exposed and increases our efficiencies over other brands.

To increase our absorptance, we have coated the inside of a glass tube that the Absorber Plates and Heat Pipe live in with a special paint that acts like a one way mirror. We call this paint the "Selective Surface."



The outside is a shiny purple color that absorbs solar energy. The mirrored finish on the inside will trap that solar energy and force it to quickly warm the Absorber Plates, which then transfer the energy into the Heat Pipe. We then wrap another strong Borosilicate glass tube around the whole thing to protect it from the elements. Between these two layers of glass we have added one of the best insulations available...Nothing.



All of the air has been sucked out and the space between the inner and outer tubes is in a vacuum. Without a transfer medium (the air within the tubes) the heat inside has no path out, and the cold air outside has no path in, so they simply stay put, offering us an incredible layer of invisible insulation. Think of it as a Thermos without a jacket. While the inside tube may be 400° F, the outer tube will still remain cool to the touch. This also means that there aren't any standing heat losses to the environment, such as in a flat plate collector.



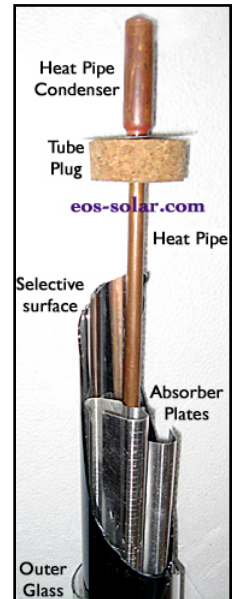
To seal the inner tube from the environment we have decided to use a cork based Tube Plug. Many brands use a less expensive rubber based Tube Plug. We choose to use cork for the same reason that it has been used to seal fine wines for hundreds of years. It allows for better heat expansion and moisture absorption within the inner tube, and it is a non-petroleum based renewable resource.

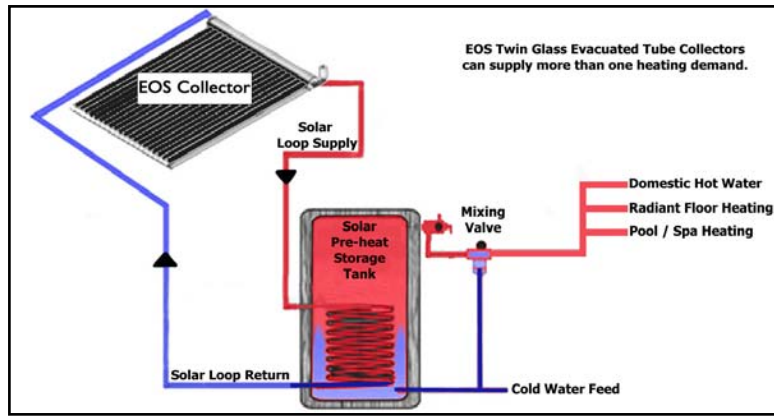


To help us gauge the strength of our vacuum we added a device called the Barium Getter. This layer of barium coats the bottom of the inner tube and turns it into a shiny silver color. If the vacuum is ever lost the barium will turn into a white



Evacuated tubes are then plugged into a rack mounted Header Manifold. This manifold is housed within an





A transfer fluid is then used to pump the heat absorbed from the collector to a heat exchanger. This quickly warms our domestic or radiant hot water and sends the cool transfer fluid back up to the collector to absorb more energy.

1.3 Collector Specifications. (subject to change without notice)

Model Description	EOS-S10
Style of Collection	Twin Glass Evacuated Tube
# of Tubes	10
Tube Outer Diameter	Ø58mm
Tube Weight	4.4 lbs / 1.99kg
Tube Material	Borosilicate Glass
Tube Coating	Graded AlN/SS-AlN/Cu on glass
Absorptance	>0.94%
Emittance	<0.06%
Vacuum	P±5 X 10 ⁻³ pa
Absorber Area per Tube	0.08m ² / 0.86ft ²
Aperture Dimensions	0.094m ² /0.308ft ² per tube
Transmittance of Outer Tube	0.91
MAX Stagnation Temperature	240°C / 464°F
Heat Loss Coefficient	≤0.6 w/ (m ² *°C)
Bearing Hailstone Ability	Hailstone Diameter Ø25mm/Ø1"
MAX Operating Pressure	800 kPa / 116 psi
Maximum Strength of Tubes	0.8Mpa / 120psi
Heat Pipe Transfer Fluid	Purified Water
Heat Pipe Activation Temp	86°F / 30°C
Allowed Horizontal Angle	0° ± 5°
Angle of Inclination	15° - 90°
Brazing Material	BcuP6 & BAg45CuZn
Heat Exchanger Material	Copper (94%)
Operating Pressure	6 bar
Connection Ports	18mm/0.7"
Fluid Capacity	290ml/9.8oz.
Collector Flow Rate	0.1L/tube/minute -- 0.026G/tube/minute
MAX Flow Rate	15L/min --3.9G/min
Manifold Casing Material	Enamel or Powder Coated Extruded Aluminum
Manifold Casing Insulation	Compressed Glass/Rock Wool
Frame Material	304 Stainless Steel
Sealing Material	Silicone Rubber and ABS UV resistant plastic
Aprx. Embedded Carbon Emissions	129 kg of CO ₂ (for calculating eco-footprint)
Gross Dry Weight	35kg / 77lbs
Width Overall	812 m / 32" (not including copper ports)
Depth Overall	157 mm / 6.2"
Height Overall	2032mm / 80"
Model Description	EOS-S20
Style of Collection	Twin Glass Evacuated Tube
# of Tubes	20
Tube Outer Diameter	Ø58mm
Tube Weight	4.4 lbs / 1.99kg
Tube Material	Borosilicate Glass
Tube Coating	Graded AlN/SS-AlN/Cu on glass
Absorptance	>0.94%
Emittance	<0.06%
Vacuum	P±5 X 10 ⁻³ pa
Absorber Area per Tube	0.08m ² / 0.86ft ²
Aperture Dimensions	0.094m ² /0.308ft ² per tube
Transmittance of Outer Tube	0.91
MAX Stagnation Temperature	240°C / 464°F
Heat Loss Coefficient	≤0.6 w/ (m ² *°C)
Bearing Hailstone Ability	Hailstone Diameter Ø25mm/Ø1"
MAX Operating Pressure	800 kPa / 116 psi
Maximum Strength of Tubes	0.8Mpa / 120psi
Heat Pipe Transfer Fluid	Purified Water
Heat Pipe Activation Temp	86°F / 30°C
Allowed Horizontal Angle	0° ± 5°
Angle of Inclination	15° - 90°
Brazing Material	BcuP6 & BAg45CuZn
Heat Exchanger Material	Copper (94%)
Operating Pressure	6 bar
Connection Ports	18mm/0.7"
Fluid Capacity	520ml / 17.58 oz.
Collector Flow Rate	0.1L/tube/minute -- 0.026G/tube/minute
MAX Flow Rate	15L/min --3.9G/min
Manifold Casing Material	Enamel or Powder Coated Extruded Aluminum
Manifold Casing Insulation	Compressed Glass/Rock Wool
Frame Material	304 Stainless Steel
Sealing Material	Silicone Rubber and ABS UV resistant plastic
Aprx. Embedded Carbon Emissions	258 kg of CO ₂ (for calculating eco-footprint)
Gross Dry Weight	64kg / 141lbs
Width Overall	1.98 m / 77.95"
Depth Overall	157 mm / 6.2"
Height Overall	2.07 m / 81.49"

Btu output can be estimated at approximately 140 BTUs per tube at 1Kw/M²/Day. Insolation and energy calculation values can be found at the rear of the manual.

Model Description	EOS-S30
Style of Collection	Twin Glass Evacuated Tube
# of Tubes	30
Tube Outer Diameter	Ø58mm
Tube Weight	4.4 lbs / 1.99kg
Tube Material	Borosilicate Glass
Tube Coating	Graded AlN/SS-AlN/Cu on glass
Absorptance	>0.94%
Emittance	<0.06%
Vacuum	P±5 X 10 ⁻³ pa
Absorber Area per Tube	0.08m ² / 0.86ft ²
Aperture Dimensions	0.094m ² /0.308ft ² per tube
Transmittance of Outer Tube	0.91
MAX Stagnation Temperature	240°C / 464°F
Heat Loss Coefficient	≤0.6 w/ (m ² *°C)
Bearing Hailstone Ability	Hailstone Diameter Ø25mm/Ø1"
MAX Operating Pressure	800 kPa / 116 psi
Maximum Strength of Tubes	0.8Mpa / 120psi
Heat Pipe Transfer Fluid	Purified Water
Heat Pipe Activation Temp	86°F / 30°C
Allowed Horizontal Angle	0° ± 5°
Angle of Inclination	15° - 90°
Brazing Material	BcuP6 & BAg45CuZn
Heat Exchanger Material	Copper (94%)
Operating Pressure	6 bar
Connection Ports	18mm/0.7"
Fluid Capacity	715ml / 24 oz.
Collector Flow Rate	0.1L/tube/minute -- 0.026G/tube/minute
MAX Flow Rate	15L/min --3.9G/min
Manifold Casing Material	Enamel or Powder Coated Extruded Aluminum
Manifold Casing Insulation	Compressed Glass/Rock Wool
Frame Material	304 Stainless Steel
Sealing Material	Silicone Rubber and ABS UV resistant plastic
Aprx. Embedded Carbon Emissions	387 kg of CO ₂ (for calculating eco-footprint)
Gross Dry Weight	95kg / 209lbs
Width Overall	2.78 m / 109.5"
Depth Overall	157 mm / 6.2"
Height Overall	2.07 m / 81.49"

SYSTEM DESIGN

2.1 Overall System Configuration. Prior to installation, a properly planned system design is a necessity. In order to provide reliable, efficient, and *safe* operation a professionally designed system is advised. We are fond of the K.I.S.S method of design. Keep It Simple, Stupid. Over engineering a system design is an invitation for Murphy's Law to take over, and will likely increase installation costs. You should avoid the use of automatic freeze valves, and other components that are likely to fail. They may create dangerous and expensive consequences. We advise you to use an established and proven system design that adheres to all required codes and "trade practices." Points to consider in system design include but are not limited to:

- ★High Limit Pressure and Temperature safety controls.
- ★Overheating and Stagnation.
- ★Freeze Protection.
- ★Collector Orientation and Location.
- ★Operational temperature and pump cycling control.
- ★Sufficient Lightning Strike Grounding.

2.2 High Limit Pressure/Temperature Relief Safety Controls. Temperature and Pressure Relief Valves, also called T&P valves, are emergency safety limit devices that will prevent or relieve overheated fluids and pressure. Without a relief valve, during an unsafe condition, the pressure inside a tank could rise to the point that the tank may rupture or explode. This would cause potential damage to both people and property. A solar loop shall be designed and outfitted with this means of pressure and temperature relief. Pressure relief shall be set at no higher than 150 psi. with 30 psi being the norm. Temperature relief shall occur once the solar loop or the hot water storage tank reaches 210 degrees F. (99 degrees C.) Shut off valves shall not be used between the solar collector and a means of pressure and temperature relief. We recommend that all pressure/temperature relief valves be tested once every six months to ensure that they are working correctly. T&P Valves shall be installed in a vertical position in such a way that the temperature sensor stick is maintained within the flow of the transfer fluid, preferably at the outlet of the collector.



We advise that these additional T&P Valve provisions be used:

- Drain piping should be the same size as the valve discharge through its entire length.
- Pitch must run downward away from the valve to a safe place of disposal (floor drain or outside on ground.).
- Drains should terminate within 6 to 12 inches above the floor drain in an unthreaded manor.
- Drain runs should not be longer than 30 feet with the use of no more than four elbows.
- Do not install a shut off valve in the drain line.

2.3 System Expansion. As in any hot water generation system, as temperatures of fluids increase so does their volume. Allowances for this expansion must be accounted for by utilizing an expansion vessel or tank. Tank selection shall be based on system size, and should be done by a professional.

2.4 Air Purge Valve. It is recommended that an Automatic Air Purge Valve be attached by an isolation ball valve at the highest point. Typically this is at the inlet of the collector. Leave it open for a week or so after installation to ensure all air is removed, and then seal it off and isolate it to prevent accidental leakages.

2.5 Overheating. Overheating a Solar Thermal system is an easy thing to do, and an easy thing to prevent with proper system design. A correct design should ensure that it is difficult to overheat the water storage tank in a single high sun load day with minimal use. If a design requires for large loads in the winter that are not required in summer (radiant floor heating) it is advisable to design the system for optimum seasonal use (see 2.8) If overloading of the tank stores is unavoidable, (such as during a vacation weekend in summer, when everyone is away and no hot water will be used,) a temperature dump zone like an EOS HDZ unit, a cast iron radiator in the basement, or an alternate heat use such as a pool or spa, or water release (dump to drain) valve should be employed. Shading tubes is also an option.

2.6 Stagnation. Stagnation is a situation that occurs when a fully loaded collector has no means of releasing it's energy. This is most likely caused by a pump or pump control failure. Without a heat transfer medium to remove heat from the collector, it is not unusual to expect manifold temperatures up to 320 degrees F. (160 degrees C.). *These temperatures will not harm the collector but care should be used to prevent burns to people.* In this condition the T&P valve should be venting. If there is a T&P valve failure, steam will form within the header and may force its way back thru to the storage tank and to a secondary T&P valve. Under normal operation situations, stagnation due to power failure is a rare occurrence as power failures usually correspond with bad weather where the sunny skies needed to generate high temperatures are not available.

2.7 Freeze And Stagnation Protection. The solar loop shall be designed with an adequate form of freeze protection in climates where temperatures below 41 degrees F. (5 degrees C.) are possible. System design can dictate how this is accomplished. Our recommendation is that an antifreeze solution be employed with a heat exchanger in the solar loop, and/or the circulation pump be operated by a low manifold temperature sensor. Keep in mind that proper safety and pressure limiting devices shall be used in a closed loop system. When glycol is used, measures shall be taken to prevent stagnation within the collector manifold. Stagnation will not harm the collector, however, glycol will become acidic when exposed to uncommonly high temperatures. Periodic inspection, testing, and replacement of the glycol shall be done in order to prevent internal damage to the system. EOS evacuated tubes and heat pipes are not susceptible to damage from cold temperatures. **DO NOT USE ETHYLENE BASED GLYCOLS... ONLY USE PROPYLENE GLYCOL.**

2.8 Collector Orienting and Location Selection. EOS collectors should be installed in locations that can provide uninhibited sunlight between the hours of 9 a.m. and 3 p.m., as this is the time when solar energy is at its greatest. Partial shading from wires or small items shall not be a concern. We advise that collectors be installed so that they face the Earth's Equator, at an angle that corresponds with the installation's latitude. Deviations of 20 degrees from due South (or North if you are in a Southern Hemisphere,) is acceptable and should not effect the collectors BTU output significantly. When mounting your EOS collector, be sure to account for any possible wind loads that may be present. The frame and mounting bracket that EOS provides have been tested for winds up to 100 mph, however we shall not be held responsible for the installers failure to adequately fasten all attachment points. If EOS collectors are to be used in areas of high winds, it is advisable to use some form of supplementary attachment reinforcement. (i.e.: stainless steel guy wires.) Snow loads are to be considered minimal as the round design of the evacuated tubes does not provide a significant amount of area for load collection. However, due to the fact that evacuated tube collectors do not re-radiate heat to the outside, large snow depths will not melt and may marginally effect system performance. In areas of deep snow expectations, it is recommended that the collector be mounted in such a way that it prevents deep snow from blocking the collector face. The collector should be placed as close as possible to the storage tank, as increased line runs reduce efficiency and increase installation costs.

Collectors can be installed on a horizontal angle of $\pm 5^\circ$ from the horizontal for drain-back system installations.

Collector heat output can be "tweaked" simply by re-orientating their position.

To maximize the potential heat output for winter use (such as when used for space heating), we advise that the collector be installed at an angle 15° - 20° greater than the corresponding latitude. This will allow for maximum collector area facing the sun during the winter months while decreasing the facing surface area in the summer months. This is conversely true for summer months. Estimated heat output variance is approximately 1% for every 1° angle difference until maximum effect is reached.

DO NOT install the unit in such manner that the tubes are positioned horizontally, or upside down... it will not work. The ideal angle for installation is within 20° - 80° of horizontal.

2.9 Collector Hail Resistance. EOS evacuated tubes are made from a very strong Borosilicate (pyrex) glass. The tubes ability to withstand strikes from hailstones is greatly effected by the angle of impact. When installed at a 40 degree or greater angle, our tubes have shown that they are able to withstand the impact of hailstones up to 25mm (1"). At a 90 degree installation angle (flat, which is not recommended) our tubes can still withstand impact from hailstones up to 20 mm (3/4"). Remember, the greater the degree of installation, the greater the ability of the tubes to withstand hail impact. In the event that a tube does become broken, it is advisable to replace it as soon as possible. The unit will still function with one or more broken tubes, however you will find a loss in heat output. Replacing tubes can be done very easily and quickly because of the modular design of the EOS collector.

2.10 Transfer Fluid Quality. We do not recommend running potable water thru the EOS collector. Unusually large mineral deposits (550 p.p.m), or hard water (200 p.p.m.), may form scale within the collector. These deposits will, over time, reduce the flow and capacity of the collector, voiding any and all warranty claims. EOS collectors shall not be used in areas that are prone to have high concentrations of chloride or saline/brine solutions. If a saline/brine (>2500 p.p.m) or chloride (2 p.p.m.) solution is desired to be heated, (fish tanks, pools/spas) a stainless/ aluminum/titanium heat exchanger should be used. Closed loop systems are preferred. Ethylene glycol antifreeze shall not be used. Propylene glycol can be used and should be checked periodically to ensure its pH value is maintained between 8 and 10.

2.11 Pump Selection. Pump selection shall be preformed based upon system size. When metering your flow rate, you MUST MONITOR PUMP AMPERAGES. Do not exceed nameplate amperages, as this will undoubtedly cause pump failure. If your pump amperage is above nameplate at optimal flow-rate, increase pump size as required. FLOW RATES SHOULD NOT EXCEED 0.026 GPM PER TUBE for maximum efficiency.

2.12 Plumbing Connections. The Collector Tubes shall not be installed until all other plumbing connections have been made, the system is full, and all controls are functioning. 1/2" diameter and 3/4" diameter line runs are typically used as flow rates tend to be relatively low. USE ONLY SUITABLE MATERIALS FOR INTERCONNECTION. Remember that you should allow for "worst case scenarios" with regard to heat and pressure, and that piping materials must be able to withstand these high requirements. DO NOT BRAZE near the header ports as this may damage nearby grommets and insulation. Use solder only. DO NOT twist the piping on the ends, as this may distort or reposition the header manifold within the interior. After all plumbing is done, it is recommended that leak checks be performed with an inert pressurized gas such as nitrogen. Do not over pressurize. A holding charge of 50 psi over 24 hrs should be sufficient. All line runs should be adequately supported every 6 feet. Keep in mind that the insulation should not be compromised and that all piping should slope upward toward the collector to limit the system from becoming air bound.

2.13 Temperature Probe. Coat the temperature sensor with a thermal conductive paste, or insert paste into the OUTLET bulb well prior to insertion. This should be a very snug fit. If it is not snug, use a piece of copper wire to wedge the sensor in place as this will allow for greater precision in operation. After the sensor is in place we recommend that a sealant be used to ensure that water and ice can not penetrate the bulb well.

2.14 Insulation. All line sets should be insulated with an insulation that can handle consistently high temperatures. In locations that are prone to sunlight exposure, you must allow for UV protection.

2.15 System Sizing. System sizing should be done by a professional, as this is the most important step of the installation.

To ensure that system sizes are correct we have included a rough guide for solar insolation values for the United States in the appendix.

We urge you to use our software for a better idea of thermal output for your location. In situations where overheating may be a concern, we recommend that a suitably sized Heat Dump Zone Station be installed into the transfer fluid loop. Collectors can be installed in consecutive sets of up to 90 tubes in series. Thereafter, 90 tube sets shall be installed in parallel.

2.16 Additional Components. It is advisable to include on your solar loop the following:

1. **Service Valves.** Two hose bibs separated by a ball valve. This will enable you to drain and fill the system easily.
2. **Pressure/Temperature gauge.** This allows for a quick easy method to monitor the system fluids.
4. **Flow Meter.** Can be separate, or permanently installed. For use during set up to optimize collector flow rates.
5. **ANTI-SCALD VALVE.** Most important accessory! **MUST** be installed at outlet of DHW solar tank. To prevent serious burns from excessively hot water. Should be set no higher than 120°F for DHW. Can be set higher for process water.
6. **Tank Drain** for the solar storage tank. This will enable you to remove sediment from the tank periodically.
7. **Check Valve.** To be used to prevent migration of temperature to a cold collector manifold during winter night cycle.
8. **Control Circuit.** It is best to use a differential control that provides additional safety controls.
9. **HDZ Units.** If there is any possibility that the system may be oversized, or that there is a possibility that a system may not be used frequent enough to offset the solar gain, a Heat Dump Zone unit should be installed into the solar transfer fluid loop.

INSTALLATION

3.1 Delivery and Inspection. It is the responsibility of the installer to ensure that all packages have arrived in good condition. Each unit is carefully inspected prior to leaving our factory. Familiarize yourself with the packing list and ensure that all parts are accounted for and are in good condition. If you find that a component is missing please contact your supplier for replacement parts. Check all evacuated tubes to ensure that the vacuum seals are good. This is done by checking the Barium Getter at the bottom of each tube. If the silver glazing is present the tube is good. If a white powder, or no color at all is seen, carefully remove the tube and discard. *Do not expose evacuated tubes that contain heat pipes to direct sunlight as the condensers will pose a burn hazard to you.* Do not install evacuated tubes until the rest of the unit is installed. Unpack and check the frame and header manifold for missing parts and/or damage. Additional fasteners that are not supplied may be required. Dry fit everything prior to final installation. **DO NOT REST THE HEADER MANIFOLD VERTICALLY ON THE EXTRUDING PIPING. THIS WILL DISTORT THE MANIFOLD.**

3.2 Mounting Fasteners. You will find that we do not include mounting fasteners with our collectors. It is the responsibility of the installer to assess the mounting situation and provide adequate mounting solutions. Keep in mind that the standard frame and the variable pitch frame are both made of 304 Stainless Steel. Zinc or Zinc/Aluminum galvanized fasteners or supplies *should not* be used in direct contact with the Stainless Steel. A galvanic reaction may occur resulting in premature failure of the metals. Use of stainless fasteners is advised, If stainless fasteners are not a viable option or in situations where the mounting surface is composed of a dissimilar metal then adequate means of separation (such as rubber separator washers) shall be used.

3.3 Mounting Options. The collector comes supplied with a standard frame that is suitable for flush mount applications. Keep in mind that the flush mount should only be utilized if the roof or mounting surface angle is appropriate for the application. Otherwise, the included stainless steel variable angle mounting bracket should be utilized. **DO NOT FORGET... THE VARIABLE ANGLE FRAME CAN BE USED "FLIPPED" TO CREATE A WALL MOUNT.** This will give the collector the appearance of an awning and will enable you to mount it virtually anywhere.

3.4 Assembly Of The Collector. The collector can either be assembled directly on a mounting surface or remotely then installed.

a.) Begin by making sure that all parts are accounted for.

1. Header Manifold.
2. Four (4) stainless steel mounting clips and fasteners.
3. Receiver Clip Mounting Strut.
4. Tube Receiver Clips (should be the same number as tubes/manifold sockets.)
5. Two (2) collector side rails.

b.) Lay out the side rails so that they are orientated with the bent mounting notch for the manifold and lower rack mounting strut pointing in the same direction, with the notch pointing up.

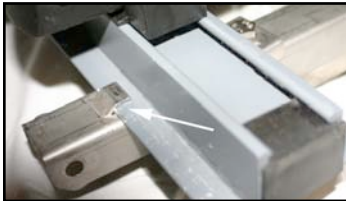
c.) Set the lower Header Manifold mounting rail into the top notch on each side rail. (make sure the tube sockets are pointing downward.)



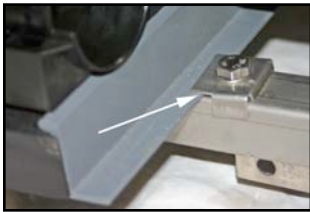
d.) Attach the top two Stainless Steel Mounting Clips and Fasteners into the corresponding holes on the side rails above the Header Manifold top mounting rail. A thread locking compound should be used on these bolts. Finger tighten only at this time, as you will want to level and align everything before you are done. **NOTE: The orientation of the bolt nut and it's placement within the horseshoe shaped clip is specific.**



e.) Set the Receiver Clip Mounting Strut mounting rail into the lower notch on each side rail. (orientation is specific: deep rail on top.)



f.) Attach the lower two Stainless Steel Mounting Clips and Fasteners into the corresponding holes on the side rails above the Receiver Clip Mounting Strut top mounting rail. Again, a thread locking compound should be used on these bolts. Finger tighten only.



g.) Align and level the collector in place. This is very important, as a failure to ensure that everything is straight and square may result in damage to the Evacuated Tubes.

h.) Once everything is square, using either an adjustable wrench, or a 9/16ths box/socket wrench, tighten all bolts in place, then again measure to ensure that everything is square.

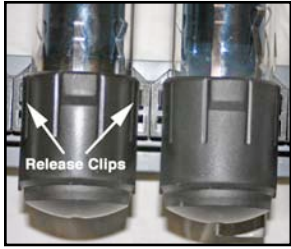
i.) Install the Receiver Clips into the Receiver Clip Mounting Strut by inserting the top edge of the clip mount into Mounting Strut rail. Confirm that the Receiver Clips are pointing open end upwards toward the Header Manifold. Then, firmly press down on the lower clip edge, pressing the clip firmly into place in the rail. Receiver Clips can slide within the Mounting Strut rail, so absolute placement is not necessary at this time.



j.) *Evacuated Tube insertion should not be done until the entire system has been completed, plumbed, and is operational. Keep Evacuated Tubes safely shaded until they are to be installed as the Condenser Bulbs will become hot enough to burn you if left in direct sunlight. Make sure you wear gloves and appropriate safety wear including safety glasses.* Begin by inspecting each tube to be used to ensure that they are structurally sound. This is easily done by checking that the silvery Barium coating is intact at the bottom of each tube. If it is white or transparent, safely discard and replace the tube as it is bad.



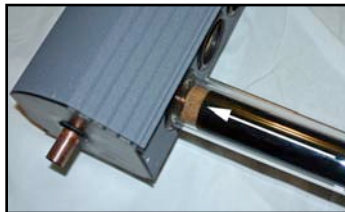
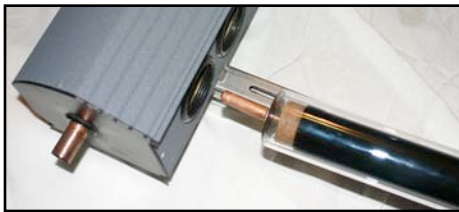
k.) Open the corresponding Receiver Clip by squeezing the sides to release the closures, use of a flathead screwdriver may be necessary.



l.) Liberally apply thermal grease to the Condenser Bulb, this will ensure good thermal conductivity.

m.) Use a soap/water solution in a squirt/spray bottle as a lubricant on the glass where it will contact the rubber sockets within the Header Manifold, as this will make insertion much easier.

n.) Pull out about 10"-12" of heat pipe so that you can easily align the Condenser Bulb with the Manifold Header Condenser Socket and gently push the Heat Pipe up into it's socket. Once it is seated, use a twisting motion to push the evacuated tube up into the manifold while grasping the Tube as closely to the top as possible. **DO NOT FORCE, AND WEAR ALL SAFETY AND PROTECTIVE GEAR.** The clear portion at the top of the evacuated tube should no longer be visible, and the bulb tip should safely clear the Receiver Clip and the Evacuated Tube Positioning Screw at the bottom of the tube.



n.) Gently press the Evacuated Tube down into the Receiver Clip.



o.) Using a control screwdriver carefully adjust the Evacuated Tube Positioning Screw (in the bottom of the Receiver Clip). This screw is only meant to hold the tube in place and is not designed to adjust the Evacuated Tube in any way. Firstly, push the tube up into the manifold so that it is seated firmly, then adjust the screw up to hold the tube in place. **OVER-TIGHTENING OF THIS SCREW MAY RESULT IN EVACUATED TUBE DAMAGE! IF YOU ARE UNSURE OF THE PROPER SET POINT, ADJUST IT TO IT'S LOWEST SETTING.**



p.) Close the Receiver Clip and ensure that both sides of the clip closures have seated securely.

q.) Repeat for as many tubes as necessary.

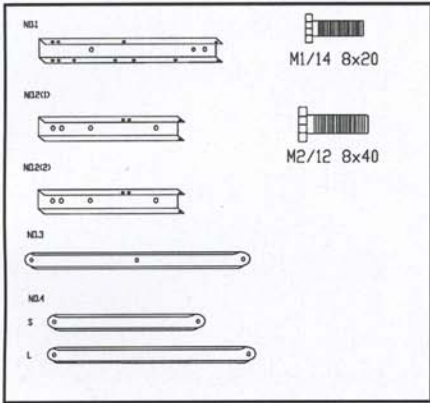
r.) Re-check and tighten all fasteners.

s.) Using a glass cleaner, clean all of the tubes and re-check tube placement.

3.5 Assembly of Variable Pitch Frame.

The frame is designed to be used on either a pitched or flat roof. It can even be inverted and used to mount the collector as an awning on a vertical surface. You should find the following parts enclosed.

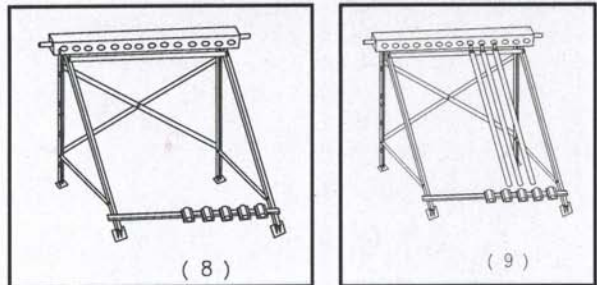
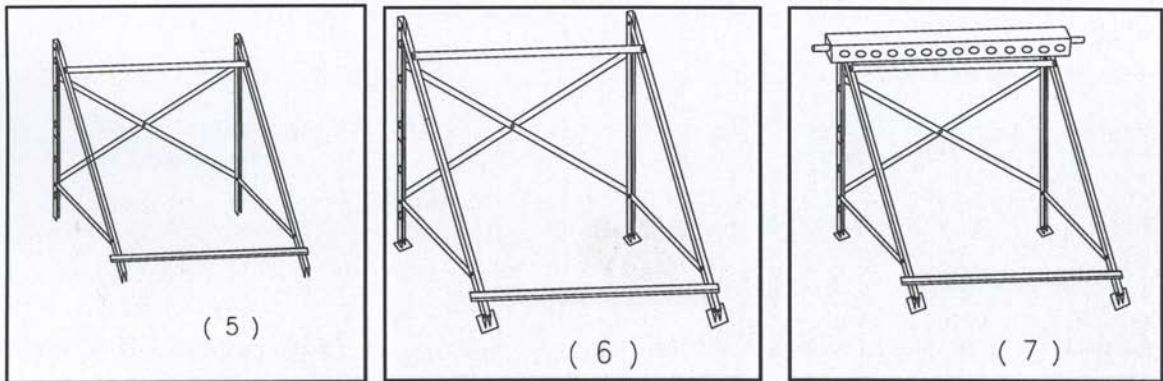
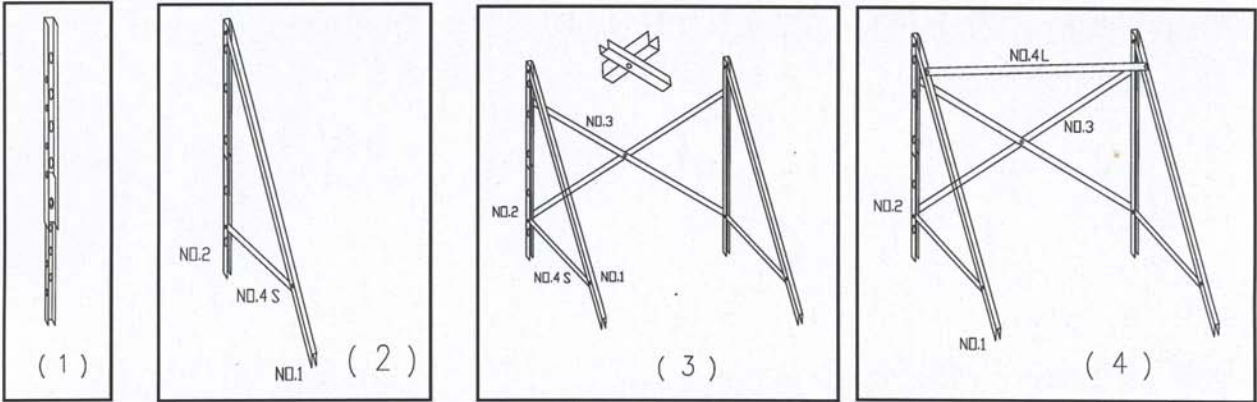
Locate the rear posts. You will find that there are four lengths of drilled stainless steel box frame. There are two larger, and two smaller widths. The smaller of the two can be seated within the larger box frame. Note that the holes on the sides will correspond for the insertion of bolts. This will enable you to adjust the working angle by sliding the two parts up and down within each other. If an angle is required that is shorter than any that have been provided, simply cut the upper portion down and re-drill holes and struts if necessary.



5.6 Assembly of Variable Pitch Frame.

The frame is designed to be used on either a pitched or flat roof. It can even be inverted and used to mount the collector as an awning on a vertical surface. You should find the following parts enclosed.

Locate the rear posts. You will find that there are four lengths of stainless steel box frame. There are two larger, and two smaller widths. The smaller of the two can be seated within the larger box frame. Note that the holes on the sides will correspond for the insertion of bolts. This will enable you to adjust the working angle by sliding the two parts up and down within each other. If an angle is required that is shorter than any that have been provided, simply cut the upper portion down and re-drill holes and struts if necessary.



Please be sure to follow all safety precautions when installing the collector. Every effort has been used to ensure that all parts are safe for handling, however sharp edges may remain. YOU MUST WEAR PROTECTIVE EYE WEAR, GLOVES, AND CLOTHING AT ALL TIMES.

Insolation Data.

This data is provided as a guide only. You should confirm your locations Insolation data to provide absolute results. Latitudes can be utilized to provide preferred mounting angle solutions.

State	City	Latitude	Longitude	jan	feb	mar	april	may	june	july	augu	sept	oct	november	december	AVG.
AL	Birmingham	33° 34' N	86° 45' W	2.29	3.31	4.04	5.14	5.92	5.98	5.81	5.7	4.8	3.93	2.96	2.25	4.34
AK	Anchorage	61° 10' N	150° 1' W	0.21	0.76	1.68	3.12	3.98	4.58	4.25	3.16	1.98	0.98	0.37	0.12	2.09
AR	Little Rock	32° 25' N	94° 44' W	2.36	3.39	4.01	5.32	5.71	6.19	6.15	5.85	5.25	4.17	2.95	2.25	4.46
AZ	Phoenix	33° 26' N	112° 1' W	3.25	4.41	5.17	6.76	7.42	7.7	6.99	6.11	6.02	4.44	3.52	2.75	5.38
CA	Los Angeles	34° N	118° W	3.09	4.25	5.09	6.58	7.29	7.62	7.45	6.72	6.11	4.42	3.43	2.72	5.4
CA	San Francisco	38° 31' N	121° 30' W	2.35	3.33	4.42	5.95	6.84	7.39	7.55	6.51	5.75	3.92	2.65	2.06	4.89
CO	Denver	39° 45' N	104° 52' W	2.26	3.2	4.32	5.61	6.11	6.71	6.5	5.86	5.47	4.01	2.69	1.98	4.55
CT	Hartford	41° 44' N	72° 39' W	1.7	2.43	3.48	4.07	5.14	5.58	5.38	5.04	4.13	2.91	1.81	1.42	3.59
DE	Dover	39° 8' N	75° 28' W	1.85	2.62	3.6	4.33	5.44	5.91	5.64	5.3	4.38	3.23	2.21	1.66	3.84
FL	Miami	25° 48' N	80° 16' W	3.72	4.61	5.42	6.4	6.61	6.29	6.26	6.08	5.47	4.84	3.96	3.46	5.26
GA	Atlanta	33° 33' N	84° 26' W	2.31	3.37	4.08	5.2	6.02	6.01	5.81	5.59	4.76	3.95	2.98	2.33	4.37
HI	Honolulu	21° 20' N	157° 55' W	4.38	5.15	5.99	6.89	7.05	7.48	7.37	7.07	6.51	5.46	4.41	4.01	5.96
IA	Dubuque	42° 24' N	90° 42' W	1.64	2.58	3.34	4.57	5.54	6.06	5.81	5.26	4.33	3.03	1.72	1.35	3.77
ID	Boise	43° 34' N	116° 13' W	1.73	2.72	3.77	5.22	5.9	6.57	7.17	6.12	5.28	3.29	1.74	1.46	4.24
IN	Indianapolis	39° 44' N	86° 17' W	1.67	2.59	3.28	4.67	5.46	6.11	5.79	5.37	4.76	3.33	1.97	1.46	3.87
IL	Chicago	41° 53' N	87° 38' W	1.5	2.45	3.2	4.48	5.56	6.07	5.68	5.27	4.51	3.07	1.69	1.26	3.72
KS	Kansas City	39° 12' N	94° 36' W	2.06	2.89	3.62	4.92	5.58	6.17	6.21	5.59	4.9	3.49	2.2	1.75	4.11
KY	Louisville	38° 11' N	85° 44' W	1.71	2.65	3.32	4.73	5.38	6.08	5.79	5.35	4.8	3.42	2.1	1.56	3.9
LA	New Orleans	29° 37' N	90° 5' W	2.64	3.73	4.67	5.8	6.6	6.15	6.09	5.7	5.13	4.48	3.49	2.68	4.76
MA	Boston	42° 22' N	71° 2' W	1.66	2.5	3.51	4.13	5.11	5.47	5.44	5.05	4.12	2.84	1.74	1.4	3.58
MD	Annapolis	38° 35' N	76° 21' W	1.96	2.8	3.71	4.55	5.54	6.03	5.77	5.34	4.48	3.4	2.37	1.81	3.98
ME	Portland	45° 36' N	122° 36' W	1.38	2.33	3.49	4.57	5.46	6.09	6.64	5.78	4.8	2.79	1.41	1.1	3.82
MI	Detroit	42° 25' N	83° 1' W	1.43	2.33	3.19	4.34	5.44	5.98	5.64	4.99	4.25	2.73	1.52	1.14	3.68
MO	St. Louis	38° 46' N	90° 23' W	2.02	2.82	3.52	4.97	5.56	6.21	6.05	5.63	4.91	3.55	2.21	1.73	4.09
MN	Minneapolis	44° 53' N	93° 13' W	1.6	2.61	3.3	4.55	5.44	6.26	5.77	5.12	4.12	2.9	1.62	1.34	3.68
MS	Jackson	42° 16' N	84° 28' W	1.47	2.41	3.22	4.33	5.46	5.93	5.57	4.99	4.3	2.78	1.55	1.17	3.59
MT	Billings	45° 48' N	108° 32' W	1.55	2.57	3.52	4.82	5.63	6.45	6.39	5.75	4.67	3.19	1.77	1.3	3.96
MT	Great Falls	43° 33' N	98° 42' W	1.3	2.36	3.41	4.84	5.56	6.18	6.44	5.53	4.4	2.9	1.53	1.11	3.79
NC	Charlotte	35° 13' N	80° 56' W	2.22	3.17	3.95	4.98	5.8	6.01	5.76	5.27	4.58	3.75	2.76	2.21	4.2
ND	Fargo	46° 54' N	98° 48' W	1.44	2.39	3.36	4.79	5.62	5.82	5.94	5.14	4.01	2.83	1.59	1.31	3.68
NE	Omaha	41° 18' N	95° 54' W	1.92	2.76	3.45	4.74	5.6	6.14	6.11	5.46	4.74	3.34	2	1.57	3.98
NH	Manchester	42° 56' N	71° 26' W	1.66	2.5	3.51	4.13	5.11	5.47	5.44	5.05	4.12	2.84	1.74	1.4	3.58
NJ	Trenton	40° 13' N	74° 46' W	1.71	2.39	3.43	4.04	5.26	5.67	5.39	5.14	4.18	3	1.98	1.48	3.63
NM	Albuquerque	35° 3' N	106° 37' W	2.92	3.97	4.92	6.3	6.68	6.94	6.66	5.8	5.68	4.18	3.16	2.5	4.97
NV	Las Vegas	36° 18' N	115° 16' W	3.02	4.13	5.05	6.57	7.25	7.69	7.37	6.42	6.08	4.26	3.18	2.6	5.3
NY	New York	41° N	74° W	1.67	2.37	3.41	3.93	5.11	5.48	5.26	5.01	4.05	2.85	1.82	1.4	3.53
OH	Columbus	39° 16' N	85° 54' W	1.64	2.67	3.26	4.63	5.4	6.08	5.73	5.29	4.74	3.29	1.96	1.45	3.83
OK	Tulsa	36° 12' N	95° 54' W	2.33	3.22	3.9	5.25	5.58	6.32	6.4	5.8	5.08	3.8	2.62	2.06	4.36
OR	Portland	45° 32' N	122° 40' W	1.38	2.33	3.49	4.57	5.46	6.09	6.64	5.78	4.8	2.79	1.41	1.1	3.82
PA	Philadelphia	39° 53' N	75° 15' W	1.85	2.82	3.6	4.33	5.44	5.91	5.64	5.3	4.38	3.23	2.21	1.66	3.84
PA	Pittsburgh	40° 27' N	79° 57' W	1.59	2.4	3.26	4.07	5.05	5.53	5.27	4.94	4.05	2.88	1.86	1.41	3.53
RI	Providence	41° 44' N	71° 28' W	1.7	2.46	3.53	4.2	5.17	5.67	5.48	5.08	4.21	2.97	1.8	1.43	3.64
SC	Columbia	38° 58' N	92° 22' W	2.14	2.91	3.62	5.03	5.56	6.22	6.13	5.64	4.95	3.57	2.25	1.82	4.15
SD	Sioux Falls	45° 27' N	98° 25' W	1.72	2.71	3.31	4.65	5.61	6.1	6.04	5.42	4.47	3.2	1.78	1.43	3.87
TN	Nashville	36° 7' N	86° 41' W	1.94	2.9	3.64	4.76	5.67	5.9	5.86	5.62	4.63	3.53	2.45	1.82	4.04
TX	San Antonio	29° 32' N	98° 28' W	2.57	3.7	4.43	5.54	5.94	6.62	6.49	6.28	5.7	4.67	3.43	2.62	4.83
TX	Houston	29° 59' N	95° 22' W	2.47	3.5	4.4	5.59	6.03	6.45	6.36	6.07	5.46	4.61	3.3	2.44	4.72
UT	Salt Lake City	40° 46' N	111° 52' W	2.23	3.15	4.09	5.57	6.26	6.98	6.86	5.98	5.39	3.68	2.29	1.97	4.53
VA	Washington	38° 51' N	77° 2' W	1.95	2.8	3.66	4.46	5.42	5.88	5.63	5.22	4.38	3.36	2.34	1.79	3.9
VT	Montpelier	44° 16' N	72° 35' W	1.58	2.54	3.5	4.05	5	5.24	5.37	4.92	3.79	2.46	1.52	1.28	3.43
WA	Seattle	47° 32' N	122° 18' W	1.14	2.04	3.23	4.26	5.19	5.75	6.27	5.46	4.43	2.5	1.21	0.9	3.53
WI	Milwaukee	42° 57' N	87° 54' W	1.43	2.41	3.29	4.48	5.6	6.09	5.74	5.21	4.34	2.9	1.6	1.2	3.69
WV	Charleston	38° 22' N	81° 36' W	1.75	2.64	3.34	4.26	5.2	5.67	5.49	5.19	4.26	3.19	2.15	1.62	3.73
WY	Casper	42° 55' N	106° 28' W	1.93	2.8	3.79	5.13	5.9	6.68	6.5	5.9	5.13	3.59	2.06	1.65	4.25

Canadian Values.

Province	City	Latitude	Longitude	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year Avg
AB	Edmonton	53° 34' N	113° 31' W	1.45	2.36	3.41	4.25	4.91	5.42	5.55	4.76	3.52	2.18	1.43	1.21	3.37
BC	Victoria	48° 25' N	123° 19' W	1	1.82	2.93	4.01	5.13	5.54	5.85	5.28	3.88	2.17	1.11	0.86	3.29
MB	Winnipeg	49° 54' N	97° 14' W	1.21	2.08	3.27	4.55	5.54	5.8	5.85	4.84	3.32	2.21	1.33	1.02	3.41
NL	St. Johns	45° 19' N	65° 53' W	1.56	2.27	3.48	4.19	4.76	5.05	5.05	4.54	3.53	2.29	1.43	1.27	3.28
NS	Halifax	44° 39' N	63° 34' W	1.56	2.31	3.46	4.09	4.82	5.27	5.41	4.86	3.92	2.54	1.53	1.3	3.42
ON	Toronto	43° 41' N	79° 38' W	1.44	2.27	3.19	4.13	5.15	5.83	5.67	4.82	3.66	2.47	1.48	1.2	3.44
QC	Montreal	45° 28' N	73° 45' W	1.45	2.36	3.41	4.25	4.91	5.42	5.55	4.76	3.52	2.18	1.43	1.21	3.37
SK	Regina	45° 19' N	65° 53' W	1.14	1.96	3.02	4.69	5.48	5.79	6.14	4.96	3.42	2.29	1.3	0.95	3.42

How to size solar collectors for domestic hot water. Always under size your collector for safety reasons. The average family uses 26 gallons (98L.) of hot water per adult, and 13 gallons (49L.) of hot water per child. Size your tanks accordingly.

- Step 1. Determine the temperature rise, and volume of the water to be heated.
- Step 2. Determine the amount of energy required to heat that amount of water.
- Step 3. Determine the EOS solar collector output value based on insolation values.
- Step 4. Determine the correct number of EOS tubes required to fulfill the load requirement.

See the following page for examples.

Hourly load requirements of constant loads, (like pools/ spas, or radiant floors) can be estimated with a rule of thumb value of 140 btus per tube/ per hour/ per 1kW/m2/hr of insolation.

Imperial Calculation.**Step 1.**

Determine the temperature rise, and volume of the water to be heated.

Let's use a family of 4.

Two adults and two children. 26 Gallons + 13 Gallons = 39 Gallons X 2 = **78 Gallons.**

Ground water in Summer Temp = 50°F. to be heated to 115°F. $115-50=65^{\circ}\text{F}$.

Step 2.

Determine the amount of energy required to heat that amount of water.

1 Gallon = 8.34 lbs. 78 Gallons X 8.34 X 65°F = **42,284 btus required.**

Step 3.

Determine the EOS solar collector output value based on insolation values.

Insolation conversion to Imperial Values. (1 kWh/m²/day = 317.1 btu/ft²/day.)

July in Portland, Maine Insolation value from chart above = **6.64.**

$6.64 \times 317.1 = 2,106 \text{ btu/ft}^2/\text{day value.}$

$2,106 \times 0.7$ EOS Evacuated tube IAM absorber conversion value = **1,474 Btu per ft² of collector absorber area.**

$1,474 \times 0.86\text{ft}^2$ of absorber area = **1,268 btu/tube/day.**

Step 4.

Determine the correct number of EOS tubes required to fulfill the load requirement.

Using the values calculated above find the number of tubes required to handle your load.

Load = 42,284 btus.

Absorber area = 1,268 btu/tube/day.

$42,284 \div 1,268 = 33 \text{ tubes.}$

Metric Calculation:**Step 1.**

Determine the temperature rise, and volume of the water to be heated.

Let's use a family of 4.

Two adults and two children. 100L + 50L = 150L X 2 = **300 Liters.**

Ground water in Summer Temp = 10°C. to be heated to 46°C. $46-10=36^{\circ}\text{C}$.

Step 2.

Determine the amount of energy required to heat that amount of water

$300\text{L} \times 36^{\circ}\text{C} = 10,800 \text{ kcal required.}$ (1L requires 1kcal to raise it 1°C.)

$10,800 \div 859.8 = 12.56 \text{ kWh}$ (1kWh = 859.8 kcal)

Step 3.

Determine the EOS solar collector output value based on insolation values.

June in Portland, Maine Insolation value from chart above = **6.09.**

6.09×0.7 EOS Evacuated tube IAM absorber conversion value = **4.26 kWh of collector absorber area.**

$4.26 \text{ kWh} \times 0.08 \text{ m}^2$ of absorber area = **0.341 kWh/tube/day.**

Step 4.

Determine the correct number of EOS tubes required to fulfill the load requirement.

Using the values calculated above find the number of tubes required to handle your load.

Load = 12.56 kWh.

Absorber area = 0.341 kWh/tube/day.

$12.56 \text{ kWh} \div 0.341 = 37 \text{ tubes.}$

CERTIFICATE of 15 YEAR LIMITED WARRANTY

GS Inc. warrants that all solar collectors, hereafter referred to as collectors, supplied by it shall be free from defects in material or workmanship, subject to the terms and conditions of this warranty. In the unlikely event that a defect becomes evident within five (5) years from the date of manufacture, GS Inc. will repair, or provide at their discretion, a replacement for the faulty part. This will be done within a reasonable time and will be done without charge for the part itself. Following this initial five (5) year warranty GS Inc. will provide an additional ten (10) year limited warranty. This extended plan will credit the cost of a replacement unit with a similar new GS Inc. product on a pro-rated schedule starting at 50% of list price in year six (6), to full list price in year fifteen (15). GS Inc. will not be responsible for any expenses whatsoever other than the replacement of the defective parts.

WARRANTY COVERAGE

Copper Manifold Header Pipes.

GS Inc. hereby warrants and represents that for the period outlined above the copper header pipe in the collector manifold shall be free from manufacturing defects in material and workmanship resulting in the leakage of transfer fluid while operating under the normal design pressures and temperatures outlined in the installation instructions. This excludes, but is not limited to; Leakage at inlet and outlet connection points, or as a result of abuse, misalignment, installation error, or an alteration to the orientation of the header; Defects resulted from abnormally high pressures(exceeding 60 psi), temperatures (exceeding 400 °F), and flow rates (exceeding 4 GPM); Leakage of the manifold material due to obvious metallic corrosion as opposed to braze failure; Any and all symptoms that are a result of scale formation, sediment deposits, or any other foreign body within the manifold interior.

Evacuated Tubes and Heat Pipes.

GS Inc. hereby warrants and represents that for the period outlined above the Evacuated Tubes and Heat Pipes shall be free from manufacturing defects in material and workmanship. This warranty excludes loss of vacuum due to breakage of the glass tubes and/or the bottom tip during transport or mishandling during installation. Any damage to the tubes is the sole responsibility of the purchaser including but not limited to: impact by hail or any other objects that could reasonably break 1.6mm thick glass; Movement, vibration, misalignment or exposure to severe weather conditions after installation. It shall be generally understood that a gradual reduction in vacuum levels over time is normal and accordingly are not considered defects covered by this warranty. Heat pipes are warranted against a loss of vacuum resulting in poor heat transfer operation from tube to condenser bulb under normal operating use. This can be confirmed by pouring water heated to 150 °F down the lower 3/4 of the heat pipe. The bulb condenser should become too hot to hold onto with bare hands (120 °F) within thirty (30) seconds. Heat pipe failure due to improper installation, improper system design, or stagnation is not covered by this warranty.

Stainless Steel Frame.

GS Inc. hereby warrants and represents that for the period outlined above the Stainless Steel Frame provided with the collector shall be free from manufacturing defects in material and workmanship. This warranty excludes corrosion that is in excess of that which is expected of grade 304 stainless steel, given the environmental conditions to which the frame is exposed. This warranty does not apply if a frame has been altered in any way without the express written authorization by GS Inc., nor shall it apply if the frame comes into contact with other metals that may result in electrolytic corrosion.

Rubber/Plastic Components

GS Inc. hereby warrants and represents that for the period outlined above the Rubber and Plastic Components provided with the collector shall be free from manufacturing defects in material and workmanship. This warranty covers these parts from cracking, perishing, or drying to such extent that the function of the component is compromised when in outdoor use. This warranty shall not be enforceable if any of these parts have been exposed to excessive temperatures, chemicals, solvents, or any other substance, including UV radiation, that may weaken, or in any way degrade the properties or function of such rubber and/or plastics.