

**INSTALLATION  
OPERATION  
MAINTENANCE  
MANUAL  
INDIRECT  
CLOSED LOOP**



Alternate Energy Technologies, LLC.  
PO Box 61326  
Jacksonville, Florida 32236  
904-781-830

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## INTRODUCTION

***“Conservation for today... Energy for tomorrow...”***

Alternate Energy Technologies, LLC., (AET) would like to extend our congratulations on your purchase of an Eagle Sun™ Solar Water Heating Systems. Years of research and development, backed by critical engineering, has brought you the finest solar products you can buy. Please take time to read this booklet thoroughly. Each step is outlined completely and clarified by diagrams where necessary.

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

Your Eagle Sun™ System has been pre-engineered to be a complete solar appliance that incorporates ease of installation and maximum efficiency for years of trouble-free service. The Eagle Sun™ System uses the sun’s energy to heat your water, reducing your electricity consumption. The Eagle Sun™ System will pay for itself many times over the life of the system. All installations require a connection to your home water system. Only a qualified person or someone thoroughly familiar with standard plumbing and electrical practices should do the installation. If you have questions on the proper methods to make these connections, consult a qualified plumber or solar contractor for prescribed methods in your area. In most cases your installing solar contractor is familiar with the codes and their application. The codes are intended to protect the health, safety, and welfare of the public.

The Eagle Sun™ System collects heat by circulating fluid between the collectors and a heat exchanger wrapped around the base of the storage tank. When sufficient sunlight is available, a differential control unit energizes the circulation pump. An antifreeze solution is pumped through the collector loop where it absorbs heat and transfers the heat, via the heat exchangers, into the storage tank. As sufficient sunlight diminishes, or the storage tank reaches it desired temperature, the differential control de-energizes the pump and circulation is suspended.

## YOUR EAGLE SUN SYSTEM

Your Eagle Sun™ System consists of a collector array, a storage tank with an integrated heat exchanger, a differential control unit, a circulation pump, and a variety of system plumbing components.

<b><u>MANUFACTURER</u></b>	<b><u>MODEL #</u></b>
SYSTEM NUMBERS:	I-80-40, I-80-42, I-80-48, I-80-52, I-80-64, I-80-80, I-120-64, I-120-80, I-120-96
COLLECTOR:	AET - MSC or AE Series solar collectors
TANK:	AET - “Thermomiser” TM80HE-1 or TM120HE-1
PUMP/CONTROLLER: (SPS):	Taco SPS-PC (solar pumping station w/Taco 008-VTF6)
OR....	
PUMP:	Taco 008-VTF6 pump w/integrated differential temperature control
CHECK VALVE:	Hammond UP947 (or equivalent)
PRESSURE RELIEF VALVE:	Watts Model 3L (or equivalent)
AIR VENT:	Honeywell Maxi-vent FV147A (or equivalent)
ISOLATION VALVE(s):	Conbraco Series 70-200 (or equivalent)
DRAIN VALVE(s):	Watts Series BD (or equivalent)
*ANTI-SCALD VALVE:	Honeywell AM101UT-1 Thermostatic Mixing Valve (or equivalent )
EXPANSION TANK:	Honeywell TK300 Series (or equivalent)
*THERMOMETER:	Wika Model Type TI.3 (or equivalent)
PRESSURE GAUGE:	Ametek Series P-500 (or equivalent)

*\*Items not provided in the kit, to be supplied by others*

Job site conditions will require the installation contractor to supply some, or all of the following; plumbing connections, piping, pipe insulation and various valves between your water system and the solar system.

# **INSTALLATION INSTRUCTIONS**

## PRE-INSTALLATION CHECKLIST

Unlike other types of solar collectors, the AET solar collectors do not add a significant amount of weight to the roof. However, if the collectors are placed at a steeper pitch than the roof itself, the additional exposed flat surfaces could present extreme wind loading forces during sustained high winds. Neither wind loading (including uplift) nor the additional weight of filled collectors shall exceed the live or dead load ratings of the building, roof, roof anchorage, foundation or soil. Collector supports shall not impose undue stresses on the collectors. The design load shall be as specified by the codes in force at the installation site and shall include an additional load due to snow accumulation for applicable locations. Check local codes for roof load requirements. The mounting hardware supplied with your solar system has been designed for specific wind loads, but only if adequate support structure is present with sufficiently strong structural members (such as engineered trusses). Most building permit offices may be able to help you with recommended roofing practices for your area. All exposed materials used in the installation of this system shall be protected from ultraviolet radiation. Components should be of a UV stable material or covered/coated to prevent premature degradation.

Obtain all applicable permits. Structural members penetrated by the solar system components must meet local codes. The installer is to run the piping in such a way that the performance of any fire rated assembly is not reduced. This applies to the collector mounting as well as the installation of any other system components.

Inspect the roof. If it is in poor condition, it is advisable to replace all or part of the roof where the system will be attached. Locate a roof area facing as close to due south as possible for the placement of the solar collectors. The plumbing runs must be planned in advance so that the shortest possible route between the storage tank and collector is made. Make sure you have no low points in the sloped horizontal pipe runs. This could trap water and in freezing weather cause the pipe to rupture.

Make sure you have all the necessary plumbing materials, tools, and accessories before beginning work.

### CAUTION!

Solar collectors become very hot when in direct sunlight with no fluid being circulated through them. Extreme caution should be taken when standing near, or handling solar collectors in this state. Where possible, cover the collectors with a tarpaulin or other opaque covering until you are ready to energize the system. The circulating pump becomes very hot when running. Do not touch before allowing sufficient time to cool down.

Wear gloves when handling the solar collectors! They get extremely hot when left exposed to the sun. The bright orange plastic caps should be removed prior to placing the collectors on the roof otherwise they may get so hot that they melt in place. Also, never try to lift the collectors by the pipe nipples. These bend when hot and would damage the collector. You should have a tarp handy to keep the collectors covered during the entire installation process. This will prevent the collectors becoming too hot to handle as you make your final adjustments and connections.

EagleSun Indirect Systems are pre-engineered systems. Plumbing materials specified in this system to be constructed of copper, brass, bronze or stainless steel and designed to meet or exceed the expected design temperature and pressure ratings of the system. Use of galvanized steel, CPVC, PVC, PEX or any other type of plastic pipe is prohibited. Indirect systems are designed to use ½" copper pipe for the collector/tank interconnect piping. Type M may be used except where otherwise specified by the Authority Having Jurisdiction. Use only lead-free solder. Use of 50/50 lead solder is expressly prohibited. If installed as a pre-heater to an existing water heating system, this system should not subject the existing system to excessive temperature or pressure or bypass existing safety devices. The installer should review the site specific conditions to insure proper operation can be achieved.

Dielectric, brass or bronze nipples should be used on all connections to the water storage tank. Dielectric unions are not approved for installation with these solar systems. Incompatible materials shall be isolated or treated to prevent degradation to the extent that their function could be significantly impaired under in-service conditions.

With solar tanks, the cold input from the pressurized supply line to the house (either city water or well water) must be fed into the tank inlet. This is marked "Cold Inlet" and is located on top of the tank. There is a long plastic tube attached internally to this connection so that incoming cold water is directed immediately to the bottom of the tank, and therefore does not mix and cool down the hot water. A cold-water shutoff valve must be installed above this connection so that water flow may be completely stopped in the event of a leak, repair, or maintenance. This system includes two isolation ball valves required for servicing the solar collector plumbing loop. These valves should remain in the open position under normal operating conditions and should only be closed when maintenance is being performed. The valves are located as to not disrupt the normal flow of water through the water heater storage tank.

The hot water output to the house from the tank should be connected to the port labeled "Hot Outlet" on the top of the tank. Again, a dielectric nipple must be used where a connection is made between galvanized and copper pipes. (Dielectric unions are not recommended.) A mixing valve must be installed at this point to limit the temperature of water delivered to the home.

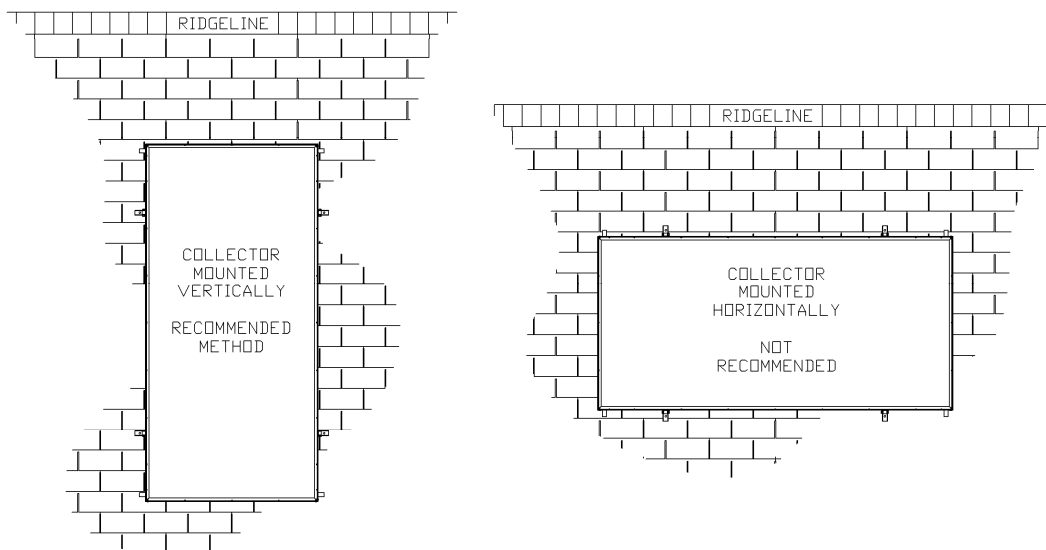
All hot water lines should be insulated with at least 1/2" thick heat resistant rubber tubing insulation such as Armstrong Armaflex. The final 5 feet of the cold water supply should be insulated to R2.6. All rooftop components are to be protected from ultraviolet radiation, either by design or as per the manufacturer's recommendations. Components requiring any maintenance should be installed free from obstructions.

In most instances, the solar collectors can be attached to the roof using the standard mounting hardware provided with the solar system. Certain types of roofing will require special attention for proper mounting. For example, a clay tile or cement tile roof. Complete roofing attachment methods of solar collectors for these various types of roofs are beyond the scope of this manual. The manual will describe and illustrate some of these approved mounting techniques. A competent contractor should be used to ensure that all roof penetrations and attachment points are not a source of rainwater leakage later on. Standard plumbing roof jacks or solar industry copper flashings may be used for plumbing penetrations in most cases.

The collectors should be canted slightly toward the inlet side to ensure they drain completely when maintenance is required on the system.

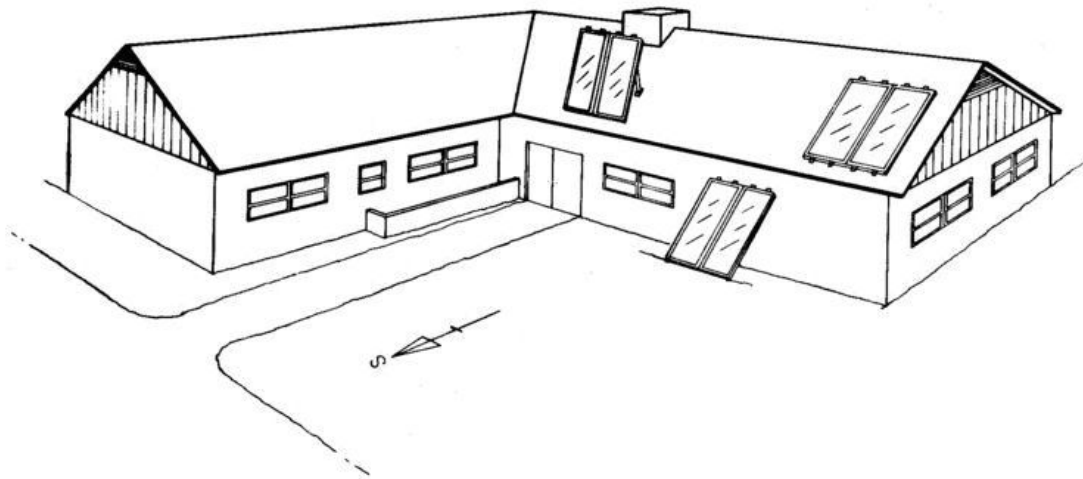
Electrical connections should only be made after the plumbing system is fully installed and ready to be charged. Insure that the controller is in the "OFF" position until you are ready to energize the pump. Remember to remove collector coverings prior to energizing the system.

**NOTE: All collectors are to be mounted vertically (see below), sloped in order to be completely void of fluid when drained, and oriented in such manner as described below under COLLECTOR LOCATION.**



## COLLECTOR LOCATION

The solar collectors provide with your EagleSun system and been certified for performance by the Solar Rating and Certification Corporation. Proper location the solar collector(s) is important for maximum system efficiency. The collector(s) should be located in a section of the roof which is unshaded for the middle six hours of the day in each month of the year. Roof mounted collectors should be placed in the central field of the roof area, and where permissible, a minimum of 3' from the eaves, valleys, hip and ridge lines to minimize wind loading conditions. Collectors should be placed as close to the water storage tank as possible to minimize heat loss in the plumbing runs. The illustration below shows several alternatives for collector mounting.



## COLLECTOR ORIENTATION

For best year-round performance, collectors should be mounted facing due south and at an angle from horizontal equal to the latitude of the install location. For reasons of aesthetics, it is most practical to mount the collectors “flush”, or in the same plane as the roof angle, to simulate skylights. A minor increase in collector area may be required to account for the loss in efficiency due to the off-angle mounting.

For best winter production, proper orientation is achieved when the collectors are facing due south and tilted at an angle from horizontal to latitude + 10°. This favors the winter sun because ambient temperatures are lower during the winter and collector efficiency can suffer. When collectors are mounted one behind the other, they shall be spaced apart so the morning and afternoon sun, on December 21 - when the sun is at its lowest altitude, will not cast shadows from one collector onto the other and cause a loss in efficiency.

If the collectors are to be tilted off the plane of the roof, they should be tilted upward using the pre-drilled strut provided by the manufacturer. Use the nominal dimensions listed in the hardware spacing chart, the trigonometric formulas on the following page and the angle values (sin, cos & tan) from Appendix A to calculate the length of the support strut and spacing between collectors if required.

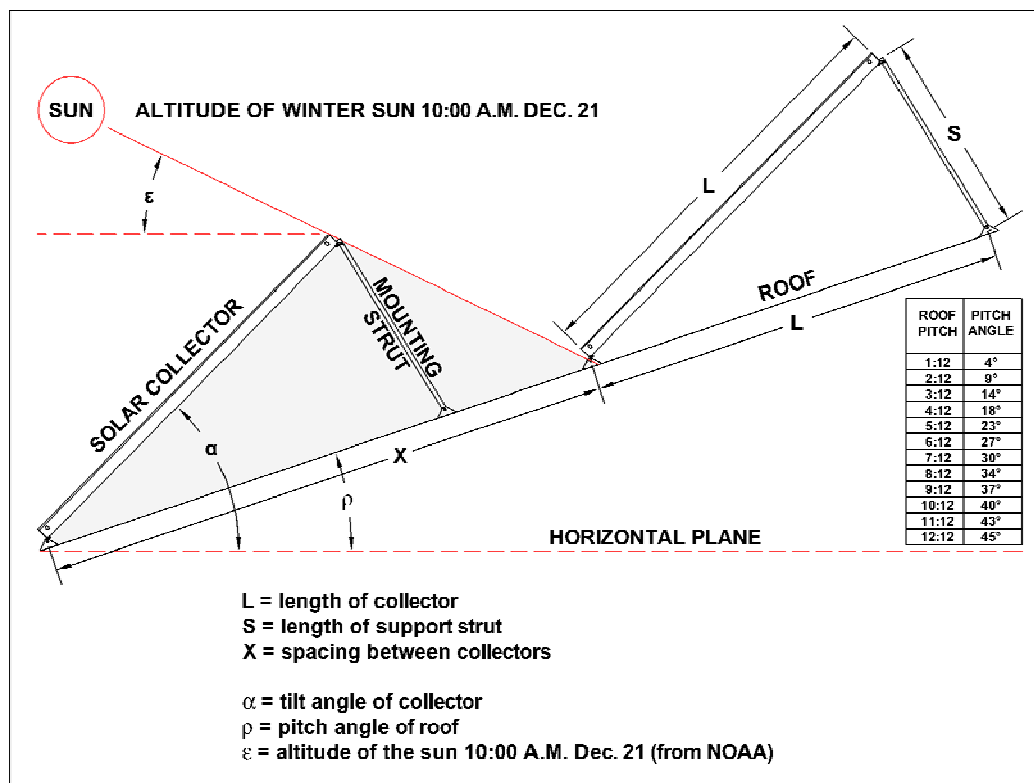
Building materials adjacent to solar equipment shall not be exposed to elevated temperatures which could accelerate their deterioration. Many non-metal roofing materials will soften in the temperature range of 60 – 80°C (140-180°F) and begin to degrade above this temperature.

The location, orientation, and position of the collector relative to nearby objects and surfaces shall be such that water run-off from the collector surface is not impeded nor is excessive build-up of snow on lower portions of the collector glazing permitted to occur.

## MOUNTING HARDWARE SPACING

Solar Collector Dimensions												
Model No.	AE-21	AE-24	AE-26	AE-28	AE-32	AE-40	MSC-21	MSC-24	MSC-26	MSC-28	MSC-32	MSC-40
Length (l)	85.187	97.187	77.187	85.187	97.187	121.187	86.125	98.125	78.125	86.125	98.125	122.125
Width (w)	35.187	35.187	47.187	47.187	47.187	47.187	35.875	35.875	47.875	47.875	47.875	47.875
Height (h)	3.137	3.137	3.137	3.137	3.137	3.137	3.082	3.082	3.082	3.082	3.082	3.082
Area	20.82	23.75	25.29	27.91	31.85	39.71	21.46	24.45	25.97	28.63	32.62	40.60
Weight	74	84	90	99	113	153	76	87	91	102	116	151
MOUNTING HARDWARE SPACING – Centerline to Centerline (in)												
AE-MH MSC-MH	86.187	98.187	78.187	86.187	98.187	122.187	88.233	100.233	80.233	88.233	100.233	124.233
AE-FM MSC-RRM	88.663	100.663	80.663	88.663	100.663	122.663	87.375	99.375	79.375	87.375	99.375	123.375
AE-RM MSC-RM	86.835	98.835	78.835	86.835	98.835	122.835	87.333	99.333	79.333	87.333	99.333	123.333

Dimensions shown (length, width and height) are nominal and listed in inches, area in ft<sup>2</sup> and weight in lbs. Use the formulas below for tilted applications.



To calculate the length of the support strut use the formula as follows:

$$S = 2 \times L \times \sin((\alpha - \rho) \div 2)$$

Add two (2) inches to the calculated length to allow for the pre-drilled holes, positioned  $\pm 1.0$  in from each end of the support strut.

To calculate the recommended spacing between collectors use the formula as follows:

$$X = L \times \cos(\alpha - \rho) + L \times \sin(\alpha - \rho) \times \tan(90 - \rho - \epsilon)$$

This would be spacing distance required to insure collectors do not shade one another in stacked arrays or saw-tooth type mounting configurations.

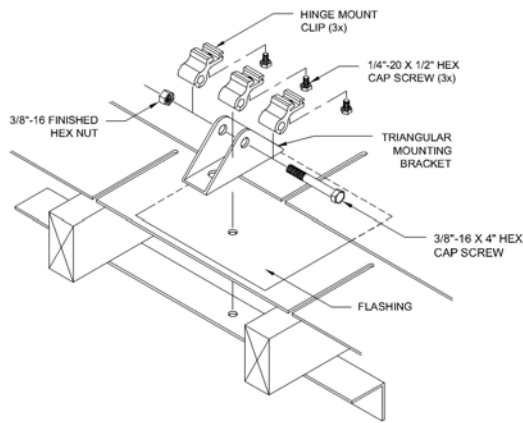


## MOUNTING HARDWARE

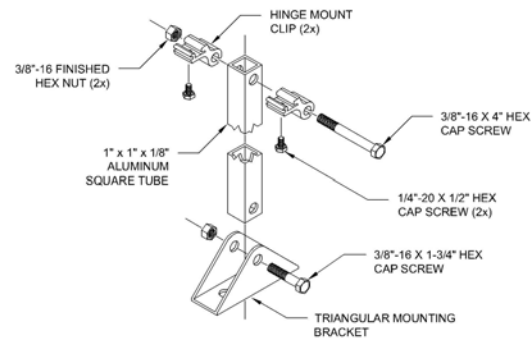
Provided in the Eagle Sun package is specially designed mounting hardware to speed collector installation. This hardware consists of ten LOCK-TIGHT hinge sets, four roof brackets, two rear struts, and bolts (see details below).

- After locating the mounting points, the mounting bracket holes should be drilled.
- A heavy coating of sealant should be applied to the bottom of the flashing plate, which should fit flat against the roof. It is necessary for the plate to slide under the above shingles to insure proper drainage of water.
- The bottom of the roof bracket and the area around the threaded rod should also be thoroughly coated with tar sealant. When the bracket is set in place, alignment with the collector hinges is necessary before final tightening of the nuts. This should be completed before the sealant has time to set.
- The threaded rod is fastened through a 2' x 6" wood or 2" x 2" x 1/4" steel angle bracket under the roof as shown.
- The rear struts should be cut to length and drilled according to the formulas detailed on the previous page. All bolts should be tightened securely. A stainless steel washer should be placed where the threaded rod passes through the aluminum bracket.

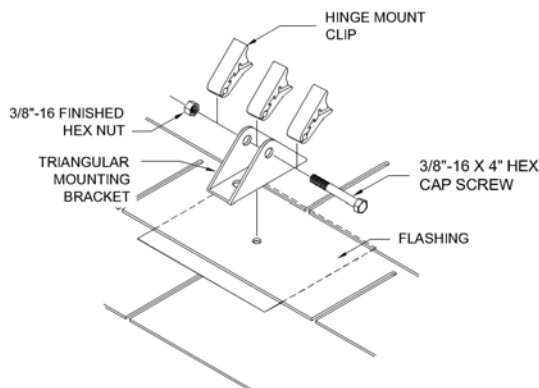
It is very important that the penetrations through the roof be well sealed. It should be carefully checked that all bolts are coated with tar and that no leaks are possible.



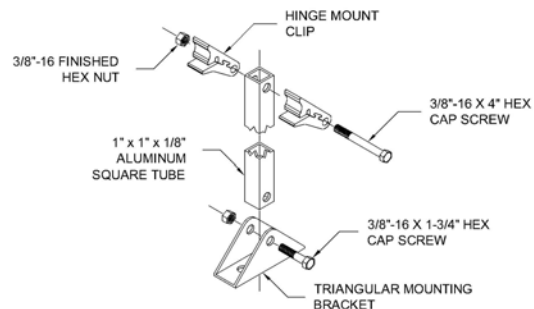
**AE Series – Standard Mount Detail**



**AE Series – Tilt Support Detail**



**MSC Series – Standard Mount Detail**



**MSC-Series – Tilt Support Detail**

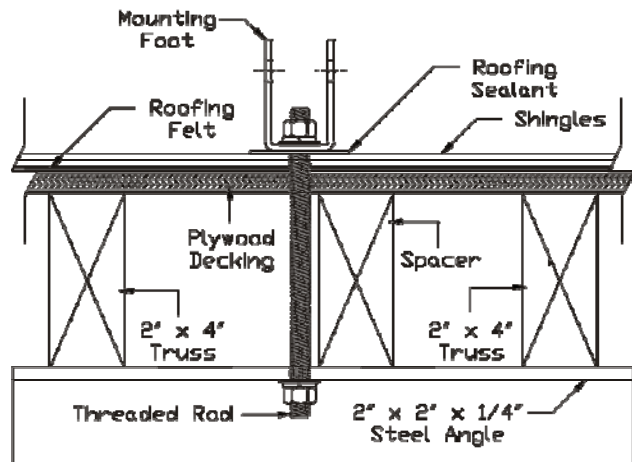
## ATTACHMENT OPTIONS

The collector shall be installed on a mount capable of maintaining tilt and azimuth to design conditions. There are three acceptable ways to secure the collector mounting brackets to the roof.

1. Spanner Mounting
2. J-Bolt Mounting
3. Lag Bolt Mounting

### SPANNER MOUNTING

In spanner mounting after the brackets are positioned on the chalk line, a 3/8" hole is drilled between the rafters. An aluminum flashing is positioned over the hole where the top of the flashing is extended up under the shingle above the 3/8" hole and extends down over it. Caulk is applied between the flashing and the roof. The bracket is then positioned over the 3/8" hole using sealant between the bracket and the flashing. A piece of 3/8" all-thread is then inserted through the hole. A washer and nut secures the all-thread to the bracket (be sure the seal underneath the washer and on top of the nut). The all-thread rod should extend about 4" below the roof rafters. Drill a 3/8" hole in a 2 x 4 and insert the all-thread rod through it. The 2 x 4 should span 2 rafters. With a washer and double bolt secure the all-thread to the 2 x 4. Tighten down until the bracket is tightly secured to the roof. Be careful not to over-tighten and bell out the roof underneath the bracket.

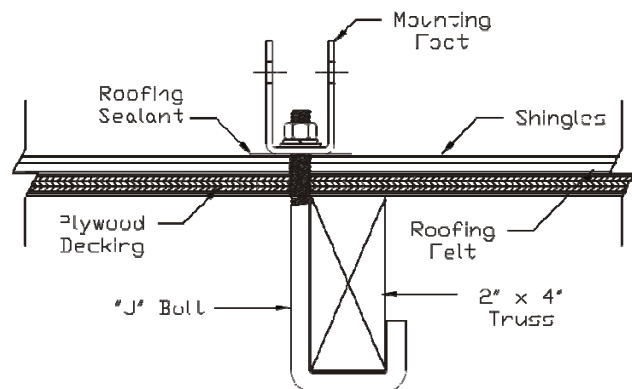


#### NOTES: Spacer Blocks

- Spacer blocks shall be installed within 1" of the thru-bolt. When thru-bolt is within 2" of a rafter, only one spacer block will be required on the opposite side of the bolt, away from the rafter. Two spacer blocks are required when the bolt is more than 2" from the rafter.
- When the mounting provisions of adjacent collectors are installed side by side and the thru-bolts are 1 1/2" or more apart, it will be necessary to have at least one spacer block (or rafter) between bolts.
- Sealant is required between mounting block and shingles/sheathing. Bolt holes shall be sealed to prevent moisture penetration.

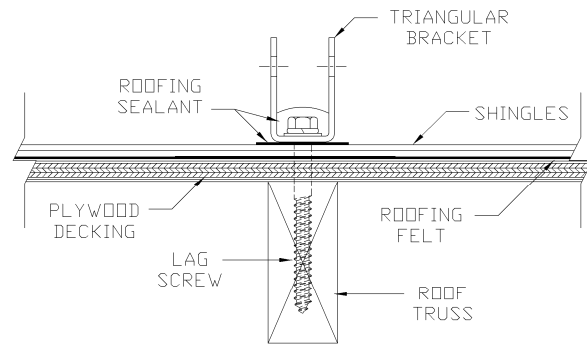
### J-BOLT MOUNTING

J-bolt mounting is done very similar to lag screw mounting except instead of drilling into the center of a rafter a hole must be drilled directly beside a rafter. The size of the hole must be slightly larger than the bolt diameter. This is more easily accomplished if the attic man would drill a pilot hole through the roof along side the chosen rafter. Fit the bolt through the mounting brackets and insert the bolt (J side first) through the hole in the roof. Work the J underneath the rafter. Pull the J-bolt snug against the rafter before tightening the nut. Use double nuts or lock-washers to securely fasten the mounting bracket to the J-bolt.



## LAG BOLT MOUNTING

In lag bolt mounting you must locate the center of the rafters along the top and bottom chalk lines. One method is to have one man on the roof and another in the attic. Using a hammer the man on the roof can tap the roof and determine where it is denser sounding. The roof man can drill a pilot hole while the attic man helps with distance corrections. Then the attic man can call of the distance to the next rafter while the roof man drills corresponding pilot holes. Flashing the brackets is done as previously described. Secure the brackets to the roof using a 3/8" x 3-1/2" stainless lag screw, a flat washer, and a lock washer.



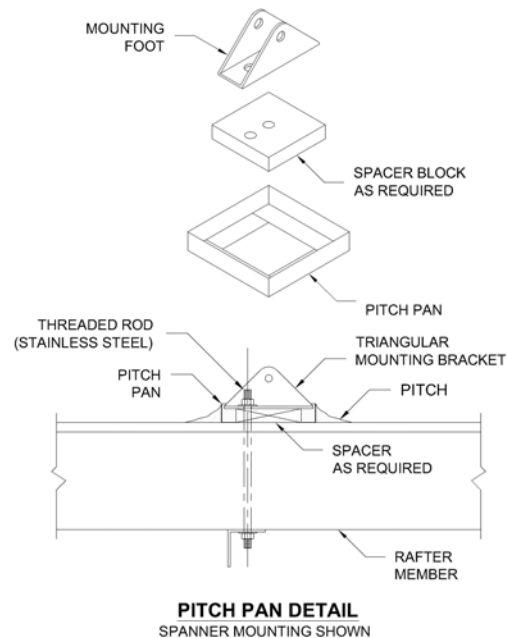
### NOTES:

- Lag bolts are to be 3/8" diameter and must penetrate the rafter member a minimum of 3".
- Pilot holes should be drilled into the centerline of the rafter and should be between 60-75% of the bolt diameter.
- Apply a liberal amount of roof sealant or a sealant pad around the opening prior to securing the mounting bracket.
- All connection hardware (bolts & washers) to be stainless steel.

## PITCH PAN

The pitch pan is necessary any time standing water is encountered. The purpose is to provide an adequate seal around any penetration in the roof. The pitch pan is placed in the proper position and flat on the roof. Its flange is sealed with roofing felt and hot tar. The holes are sealed on the inside with roofing tar to a sufficient level to insure a permanent seal.

**NOTE: All penetrations in structural members or fire rated assemblies are to be made in accordance with local codes using acceptable roofing practices.**



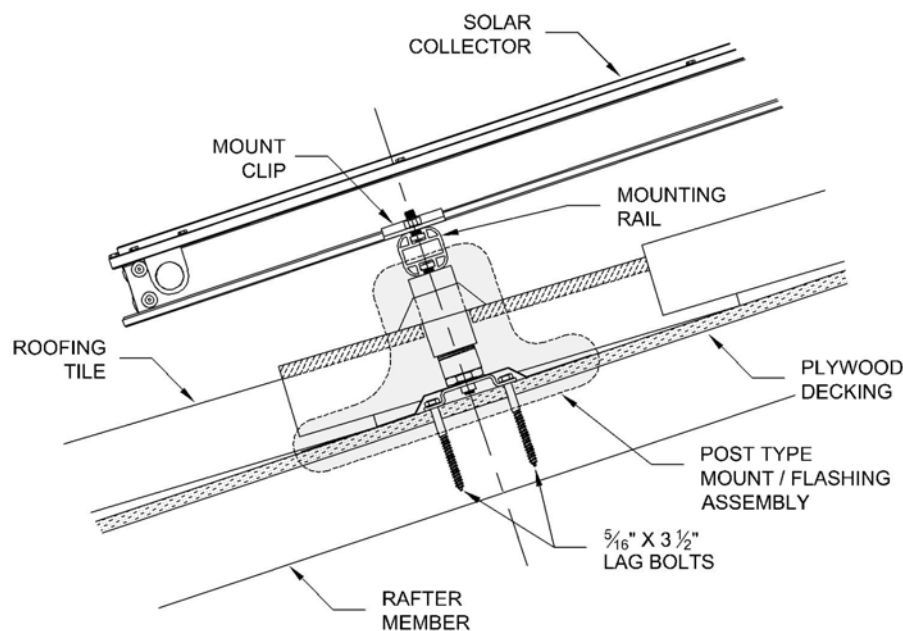
## ARRAY MOUNTING ON TILE ROOFS

Tile roofs are a little more difficult to mount solar collectors on but following this procedure will render a leak free installation. The solar panels are mounted on two rails located at the top and bottom of the solar collectors. The collectors are secured to the rails using rack mount hardware. The 1 3/4" aluminum mounting rails are anchored to the roof by using post-type, mount / flashing assemblies (preferred) or stainless steel 3/8" hanger bolts. Mounting rails are to be anchored having a sufficient number of mount points to transfer the projected loads.

### Procedure:

1. Locate the roof rafters beneath the tile where the mount assembly will be attached. Mark the tiles at the points where the mount assemblies are to be installed.
2. Using a 1/4" x 6" drill bit, drill a pilot hole through the tile and at a sufficient depth to intersect the roof decking, marking it.
3. Using a 2" hole saw, drill a hole through the tile, then remove tile and place aside.
4. Using the 1/4" hole/mark as a center point for alignment, fasten the mount base plate through the decking and into the rafter members with (2) 5/16" x 3 1/2" lag bolts.
5. Apply a liberal amount of roofing caulk or mastic to the bottom of the roof flashing and position it over the mount base plate. Secure its position with several roofing nails and screw in the double stud bolt with the silicone washer against the flashing.
6. Attach the male section of the threaded standoff to the open thread of the double stud bolt.
7. Replace the tile and thread the female section onto the male section through the hole in the tile.
8. Place the rubber sealing boot onto the threaded standoff.
9. Thread a 3/8" x 1" stainless steel bolt into the top end of the threaded standoff allowing for sufficient space to slide the mounting rail onto the head of the bolt.
10. Install additional mount assemblies using the methods described in steps 1-9.
11. Slide a section of mounting rail across the bolt heads spanning the threaded standoffs and secure into position by turning the standoffs in the counter-clockwise direction. Repeat for each mounting rail section.

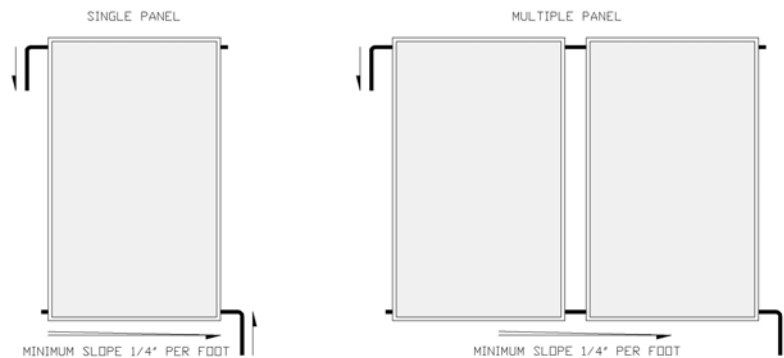
NOTE: Where is not possible to locate the rafters, use the spanner mount method. Be sure to follow the instruction for the proper use and placement of spacer blocks.



## COLLECTOR PIPING

The piping of the system should be considered before a final decision is made on how the collectors are mounted. Piping should be made of copper tube of the type meeting local codes, insulated with K-flex Seam Seal or similar, and painted or wrapped with aluminum tape where exposed to ultraviolet radiation. The collector inlet/outlet piping is 1" nominal copper pipe. Use reducing couplings to reduce down to the proper system piping size. Multi-panel arrays should be plumbed in reverse-return (see multiple panel layout below) or should include a balancing valve to insure even flow across the array(s).

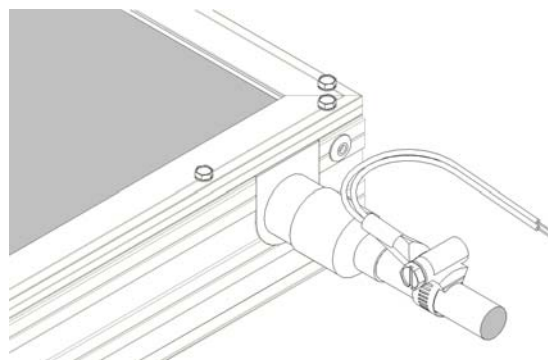
Care should be taken in the spacing of collectors as attachment of piping is easiest with properly aligned collectors. The collectors and piping to the storage tank should be slightly sloped downward (3" in 8 feet) to allow draining in case of freezing conditions. Piping should be adequately supported for correct pitch and supports shall be designed to avoid compressing or damaging the insulation material. Soldered connections should be made with 95/5 solder.



This system includes two isolation ball valves required for servicing the solar collector plumbing loop. These valves should remain in the open position under normal operating conditions and should only be closed when maintenance is being performed. The valves are located as to not disrupt the normal flow of water through the water heater storage tank.

## SENSOR MOUNTING AT COLLECTOR

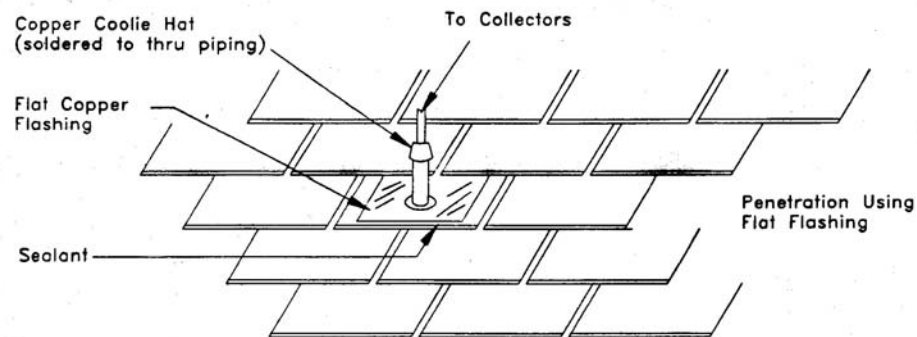
The controller heat sensor is mounted to the nipple outlet of the collector. A stainless steel, screw-type pipe clamp secures the sensor to the pipe. Insure the sensor is clamped across the flat / compressed portion of the sensor. Clamping across the barrel of the sensor can cause permanent damage to the sensor. The entire nipple should be wrapped thoroughly with insulating tape so that the sensor is isolated from the outside air. Sensor interconnect wiring should be 18-22 Ga and rated for outdoor use. Sensor wire should not be in direct contact with the piping, The sensor wire is to be wrapped to the outside of the pipe insulation. Do not run the wires parallel to telephone or power cables. If the sensor wires are located in an area with strong sources of electromagnetic interference (EMI), shielded cable or twisted pair should be used or the wires can be run in a grounded metal conduit. All connections exposed to the weather must be made with waterproof "outdoor" rated connectors.



## PIPING THROUGH THE ROOF

Penetrations of the building through which piping or wiring is passed shall not reduce or impair the function of the enclosure. Penetrations through walls or other surfaces shall not allow intrusion by insects and/or vermin. Required roof penetrations shall be made in accordance with applicable codes and also by practices recommended by the National Roofing Contractors Association. When penetrations are required in structural members to accompany passage of solar components, those modified structural members shall comply with local building codes. Penetrations through fire-rated assemblies etc. shall not reduce the building's fire resistance required by local codes, ordinances and applicable standards.

One inch holes are drilled through the roof on the same plane as the supply and return header nipples. Do not drill the hole above the supply header of the collector. This will prevent the collector from draining. Placing the hole below the supply header is acceptable, but it is more aesthetic if it is located on the same plane. A copper flashing is placed around the hole with its base cemented to the roof and its upper edges slid under the adjoining shingle. The copper tube supply and return line is then pushed up through the hole in the flashing. A "coolie cap" is then slid over the copper tube till it meets the flashing. After piping to the collectors is completed, the "coolie cap" is soldered to the copper tube. This allows for expansion and contraction of the copper pipe, while maintaining a rain/snow barrier. Polybutylene adhesive is then placed on the top and bottom of the flashing, providing a weatherproof seal. The sensor wire should also be run through the return flashing.



In-roof piping hangers shall provide adequate support and correct pitch of pipes. Supports for insulated pipes should avoid compressing or damaging the insulation material.

## STORAGE TANK PLACEMENT

To minimize expense and heat loss, the tank should be placed near the collectors and central to points of greatest water demand. It should be located indoor in as warm a spot as possible. It should be located with adequate ventilation, with a minimum of 6-8 inches of clearance and with ready access to controls and serviceable parts.

Provision should be made to prevent water damage in case of leakage. A catch pan with a minimum of 3/4" drain line at least 2" in height may be installed and pitched for proper drainage where the tank is installed in or above the living space. Electrical service of 240V should be available for the element and 110V for the pump and controller. System subassemblies which are exposed to public traffic and are maintained at elevated temperatures shall either be insulated sufficiently to keep exposed surface temperatures below 60°C (140°F) during operation, or they shall be suitably isolated. Any other exposed areas that are maintained at hazardous temperatures shall be identified with appropriate warnings.

## SENSOR MOUNTING AT STORAGE TANK

The sensor mounted at the storage tank should be located in the lower portion of the tank. Sensors can be of the immersion, plug or strap/bolt-on type. Both immersion and plug-type sensors require a welded lug (port) on the storage tank, whereas, strap/bolt-on sensors require a threaded stud for sensor attachment.

Procedure:

1. Remove the lower element access plate (cover) and insulation to expose the tank wall.
2. Where a port is available, remove the plug from the tank and replace with the immersion sensor thermowell (and sensor) or plug-type sensor. Remember to use Teflon tape or pipe dope to aid in sealing the threads.
3. Where a sensor mounting stud is available, remove the nut and place the strap/bolt-on sensor over the stud, securing in place with the fastening nut.
4. Attach 18/2 sensor wire to the wires of the sensor and run the wire up the tank to the controller attaching it to the terminals marked tank and common.
5. Replace the insulation and cover.

## CLOSED LOOP FLUID HANDLING SYSTEM

In locations where there are more than 15 freezing nights per year, or where corrosion or mineral build-up is a problem and pipes cannot be drained, an EagleSun closed loop system is recommended. The closed loop system provides separate antifreeze solution to be pumped to the collectors preventing freeze damage and inhibiting corrosion and mineral buildup. The antifreeze will aid in controlling excessive temperatures with may occur due to a loss in power. Manual intervention is required as a secondary precaution to protect components from freeze damage, when air temperatures fall below -20° F (-28.9°C).

*“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 the Supplier’s instructions if the air temperature is anticipated to approach the specified freeze tolerance limit.”*

The storage tank is equipped with a heat exchanger which wraps around the bottom exterior of the storage tank. This provides a double-wall for protection against fluid leaks into the potable water system. The pump provides flow to the collectors while flow to the tank and outlets in the house are provided by city water pressure. When the collectors are at a higher temperature than the tank, the pump is switched on. This function is controlled by a differential temperature controller.

The solar loop plumbing includes a check valve to limit “reverse-thermosiphoning” of the solar loop. This prevents the loss of thermal energy from the storage tank when the system is not in operation and/or during the evening hours when the tank temperature exceeds the outdoor ambient air temperature. Typical plumbing configurations are shown in the diagrams at the end of this manual.

The closed, solar loop should be charged with an antifreeze solution at the ratio recommended by the fluid manufacturer for the location. The system should be charged to a pressure equal to the system height divided by 2.31 plus 20 psi, not to exceed 30 psi when cold. The solar loop pressure should not exceed the normal operating pressure of the potable water system. A pressure gauge monitors the system pressure and indicates any leakage of fluid. A pressure relief valve is included to prevent excessive pressure build-up in the system.

A 2.0 gallon expansion tank is included to handle the thermal contraction and expansion of the heat transfer fluid. The expansion tank is sized per the *2000 ASHRAE Systems and Equipment Handbook* and should be charged to a pressure within 5 psi of the system pressure. For residential applications, 2.0 gallons of expansion is sufficient enough to handle up to 6 liquid gallons in the solar loop which includes the collectors and interconnect piping. Additional expansion volume will require a larger tank.

An air vent is included in the system to prevent air lock and pump cavitation. Care should be taken that no air can be trapped in lines to and from collectors.

The solar storage tank is UL listed for water heating applications. A 240 VAC, 4.5 kW backup element is provided in the top of the tank to supply hot water during inclement weather. This electric element provides “back-up” heat when the solar system is being serviced or during times of inclement weather, where solar contribution is low. A thermostat with reset is included to limit over-temperature conditions.

The storage tank is equipped with a temperature and pressure relief valve to handle over-temperature and/or over-pressure conditions. The water storage tank used in this system hosts an approximate R-Factor of 17.3. Refer to the manufacturer's documentation for specific instruction on the tank installation.

AET offers five different sizes of collector in two series; AE and MSC. The minimum and maximum flow rates are based on a minimum of 8° F rise in temperature across the collector and 20° F ΔT maximum. The recommended flow rate is based on one panel and should be multiplied by the number of panels in the bank not to exceed the maximum collectors per bank.

MODEL #	Max # of Collectors per Bank	Fluid Capacity	BTU's* per Day	Flow Rate, GPM	System Design Pressure (psig)	System Design Temp (°F)
<b>AE-21</b>	8	0.70	21,000	1	80	< 250
<b>AE-24</b>	8	0.76	24,000	1	80	< 250
<b>AE-26</b>	7	0.90	25,000	1.25	80	< 250
<b>AE-32</b>	7	1.05	32,000	1.25	80	< 250
<b>AE-40</b>	6	1.22	40,000	1.5	80	< 250
<b>MSC-21</b>	8	0.70	21,000	1	80	< 250
<b>MSC-24</b>	8	0.76	24,000	1	80	< 250
<b>MSC-26</b>	7	0.90	26,000	1.25	80	< 250
<b>MSC-32</b>	7	1.05	32,000	1.25	80	< 250
<b>MSC-40</b>	6	1.22	42,000	1.5	80	< 250

\*Btu's are based on testing through SRCC for Category C, Clear Day (36°F) application.  
Go to: <http://www.aetsolar.com/certifications.shtml> for more information.

## CLOSED LOOP PUMP/CONTROL COMBO

The 00-VT operates the collector pump to transfer heat between the collector and a storage tank based on a setpoint temperature difference (delta T) and setpoint temperature difference differential. The setpoint temperature difference is fixed at 10°F and the setpoint temperature difference differential is fixed at 5°F. Circulator must be mounted with the motor in a horizontal position. It may be mounted vertically with the motor up, provided that the system pressure is at least 20 psi (136 kPa).

For delta T operation, the collector pump operates between the minimum variable speed output and full speed. Once the actual temperature difference rises to at least 10°F, the collector pump turns on at full speed for 10 seconds. After 10 seconds, the collector pump operates to maintain the 10°F setpoint target temperature difference. As the actual temperature difference increases, the variable speed output is increased. As the actual temperature difference decreases, the variable speed output is decreased. Once the actual temperature difference falls to the 5°F setpoint target temperature difference differential, the collector pump is turned off.

The 00-VT includes a tank maximum feature that conditionally ceases operation if the storage tank reaches the maximum tank setpoint temperature (typically 145° F). If during delta T operation the tank temperature rises to the maximum tank setpoint temperature, the control turns off the collector pump and, if applicable, the auxiliary relay.



## POWERING THE CONTROL

**WARNING:** Wiring connections must be made in accordance with all applicable electrical codes.

Insert the line voltage wires through the knockout of the enclosure and connect the live wire to the H terminal and the neutral wire to the N terminal on the PC Board. (see figure 17) Ensure that no power is present during this process.

Power to the pump/control unit can be controlled by simply unplugging the power cord from the electrical receptacle. Operation of the control can be suspended by unplugging the sensor terminal block from the pump/control unit.

Overload and over-current protection of electrically operated components shall be consistent with the maximum current rating of the device and with the provisions of Article 240, Chapter 2 of the National Electrical Code. Refer to the manufacturer's instruction sheet for specific operations and limitations.

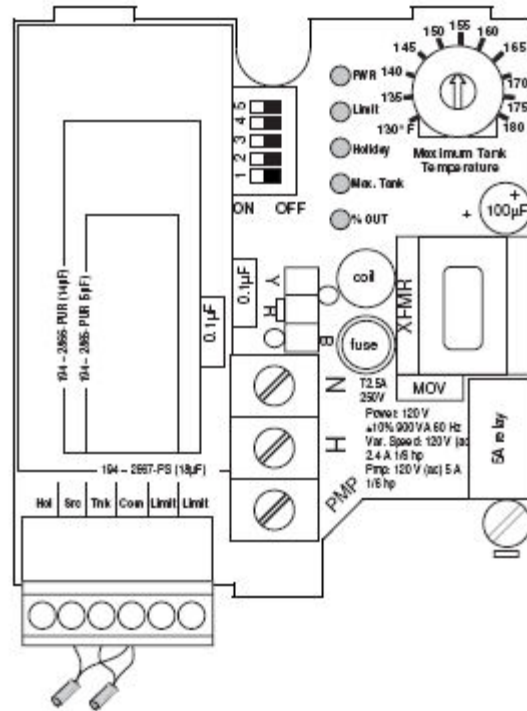


Figure 17

## CLOSED LOOP START-UP

After installation and final inspection, the system should be filled and checked for leaks at 1½ times the normal working pressure for at least ½ hour. The solar plumbing loop is filled and drained using the ball/check valve assembly on the solar loop. Connections are standard ¾" hose thread. The collector side should be filled with a solution of non-toxic antifreeze such as propylene glycol, corrosion inhibitors, and water. Potable water connections should be leak free when subjected to city water pressure.

The mixture should be of adequate concentration for freeze conditions in the geographical location of the system, and maintained at a pH level of 6.8 – 7.2. The use of toxic fluids shall comply with the Federal Hazardous Substances Act, Title 15, or its equivalent, and the requirements of the health authority having jurisdiction. All heat transfer fluids are to be compatible with the system plumbing materials.

## CLOSED LOOP MAINTENANCE

Closed loop system maintenance includes changing the antifreeze solution every four years, or when the pH of the fluid becomes unstable. To do this, the system should be drained, flushed with fresh water, and recharged. The pressure gage will indicate any system leakage. Other minor repairs could include replacing the thermometer, pressure gauge, pump or control. Projected equipment replacement:

- Pump – 5 years
- Control – 10 years
- Temperature Gauge – 10 years
- Pressure Gauge – 10 years

The collector glass should be kept clean for best system performance. Rain water will usually suffice but a garden hose will help during dry periods. The air vent caps should be loosened two turns for best system performance.

## **OPERATIONAL CHECKLIST**

Before the system is turned on, the piping and electrical systems should be evaluated to see if they match the supplied drawings. If you are satisfied that the system is installed correctly, it should be filled and powered according to the preceding instructions. When the system is in the operational mode, care should be taken to check all piping for leaks and to make sure sufficient insulation has been used to provide maximum system efficiency. All modes of operation should be checked by the installer to assure proper functioning under all conditions.

## **DRAINING/EMERGENCY PROCEDURES**

Potable water loop – Switch off the circuit breakers supplying power to the water storage tank and the solar control. Shut-off the cold water supply to the water storage tank (valve “A” as show on the schematics) make the necessary repairs.

Solar water loop – Unplug the controller from the wall receptacle or switch off the circuit breaker. If required, drain the system into a suitable container (to be used to recharge the system) or into a suitable drain line. Make the necessary repairs.

If the system is unused for an extended period of time, 7 days or more, it is recommended the system be shut-down and drained or the holiday feature enabled on the solar control (see controller documentation).

## **TROUBLESHOOTING GUIDE**

Problems with systems usually fall under two categories: system leaks or lack of sufficient solar heated water. Refer to the Dealer Locator on our website for support – <http://www.eaglesunsystem.com/locator.php>

### **LEAKS**

If leaks exist the system should be shut down for repairs. Make sure the electrical circuit to the controller is off. Close off the cold water inlet or in case of a leak in the closed loop system, isolate as much of the system as possible and then drain and repair the affected area.

There is a possibility that what appears to be a leak may be condensation on the pipes. Also water escaping for the T&P valve (on the potable loop) may be an indication of proper function as they are designed to vent off excess temperature and pressure. Leaks from the pressure relief valve (collector loop) will require the system pressure to be checked and re-charged if necessary. Leaks from the heat exchanger will be visible as fluid “percolating” from the base of the storage tank.

### **INSUFFICIENT HOT WATER**

If insufficient hot water is available a system malfunction may not be indicated. A low amount of solar radiation or heavy water demand can be the cause.

If no excessive demands are put on the system and ample solar radiation is available, the system should operate properly. The pump should run each sunny day until a full supply of hot water is stored. If the pump does not run, there is a problem on the electrical end of the system. Either the pump, controller, or sensors are malfunctioning. The controller can be bypassed by running a power cable directly to the pump and checking its function separate from the control system. Make sure that the problem is not a blown fuse or a tripped breaker. If the pump runs normally when powered externally, the control circuit is the problem area. Eagle Sun controllers use thermistor sensors to determine modes of operation. Check sensor wiring. If no faulty wiring can be discovered, replace sensors.

If the pump is running all the time, even when the collectors are cool, then the storage sensor or collector sensor may be open. It is also possible that the sensor wire itself is at fault. To check this, test the continuity with an ohm meter. Be sure to disconnect the sensor when performing this test. Test the wire with both ends open, then retest often twisting the 2 sensor wires together at one end. The system can be set on a timer or switched on manually until the controller is properly functioning.

## CONDENSATION ON COLLECTORS

If condensation occurs inside the collectors, ¼” vent holes should be drilled in the lower side of the collector. Three holes should be drilled, one at each end of the bottom of the collector and one in the center. These holes should be drilled 1” from the base of the collector. This should clear up any condensation within three days.

## OTHER PROBLEMS

A noisy pump is an indication of worn bearings obstruction or loss of prime. As a rule of thumb about 8 to 12 degrees should be expected as a normal gain across a collector in bright sun at proper flow rate.

## SYSTEM PARTS LIST

AET P/N	Description
<i>size varies</i>	AE or MSC Series solar collector(s)
<i>volume varies</i>	AET Thermo-miser solar storage tank
<b>either</b>	<b>Pumping station parts</b>
CP-SPS	EagleSun solar pumping station w/Taco 008-VTF6
ET-20	Expansion tank, 2.0 gallon
<b>or</b>	<b>Pump/Control parts</b>
CP-008VT	Taco 008-VTF6 Cartridge circulator w/Integrated DTC & flange kit (if required)
AV-150	Air vent
BD-50	Boiler drain, drain valve
BV-50	Ball valve, isolation
CV-50	Check valve
ET-20	Expansion tank, 2.0 gallon
PG100	Pressure gauge
PR-150	Pressure relief valve
* T-60	Thermometer (2)
* AM101S	Thermostatic mixing valve
* CT-34M	3/4” Type M copper tube
* PI-7812	3/4” Pipe insulation (7/8” O.D.), 1/2” wall thickness
*	Propylene Glycol, non-toxic (DowFrost, NoBurst, or equivalent)

\* parts provided by others

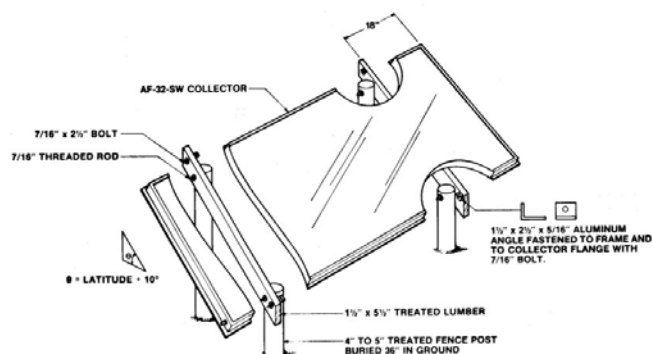
Temperature gauges installed on the feed/return piping indicate the actual temperature difference between the pipes and provide a visual indicator of system operation. When the pump is running a temperature difference of 8 - 20° F should be visible. A pressure gauge is used to display the system pressure with minor variations occurring at system startup. The system should be pressurized to within 5 psi of the expansion tank charge (30 psi as previously discussed).

## COLLECTOR YARD MOUNT

When no sunny roof area is available or for “show” systems, the collectors can be mounted on the ground as shown in the figure below. The piping and control wiring to the tank should be insulated and buried. It is important that the length of these piping runs be minimized.

Notes:

- Front edge of collector should be 18” above ground
- Use washers on all bolted wood connections
- All pieces must be measured and cut to orient collector at latitude + 10° – consult trigonometric reference.
- Piping to collector may be buried.



## FLUID QUALITY

The heat transfer fluid used in this system is AWWA Heat Transfer Fluid - Class II, and of the propylene glycol type. A mixture of no greater than 50% propylene glycol to water should be used. Follow the manufacturer's recommendations for specific concentrations.

"No other fluid shall be used that would change the original classification of this system. Unauthorized alterations to this system could result in a hazardous health condition."

## HAZARDS

Solar collectors become very hot when in direct sun with no fluid being circulated through them. Extreme caution should be taken when standing near, or handling solar collectors in this state.

The circulating pumps become very hot when running. Always allow at least 30 minutes for the pump to cool down before touching the pump. Relief valves may discharge fluids at high temperature and/or pressure.

The design and installation of systems shall not impair emergency movement of the building occupants.

## FLUID SAFETY LABELING

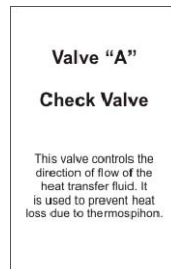
The use of toxic fluids shall comply with the Federal Hazardous Substances Act, Title 15, or its equivalent, and the requirements of the health authority having jurisdiction. Included with your Indirect system is a set of labels which describe the component function. These labels are necessary to alert the owner of potential hazards. These labels are affixed by string/wire tie (on valves) and/or "peel-and-stick" (on pipe insulation). All labeling must be in place at final inspection. Label examples are as shown:

**NOTE:** The fluid safety labeling, as described below, is intended as a means of identification for the homeowner and/or service personnel. Removal of these labels could result in personal injury.

## FLUID SAFETY LABELS

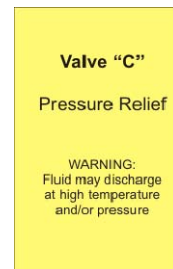
**Valve "A"** – this label is affixed to the check valve located between the fill/drain valves.

Check valves allow fluid to flow in only one direction. The valve prevents thermo-siphoning action in the system plumbing.



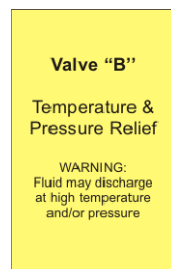
**Valve "C"** – this label is affixed to the pressure relief valve on the solar plumbing loop.

A pressure relief valve protects components from excessive pressures that may build up in the system plumbing.



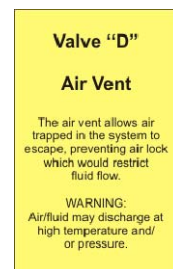
**Valve "B"** – this label is affixed to the temperature and pressure relief valve at the top of the solar storage tank.

The temperature and pressure relief valve protects system components from excessive pressures and temperatures.



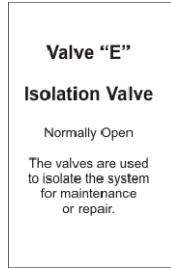
**Valve "D"** – this label is affixed to the air vent on the solar plumbing loop.

The valve allows air that has entered the system to escape, and in turn prevents air locks that would restrict flow of the heat transfer fluid.



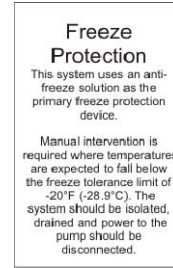
**Valve “E”** – this label is affixed to the isolation valves located at the inlet/outlet ports of the heat exchanger on the storage tank.

Isolation valves are used to manually isolate the various subsystems (i.e., the solar loop from the storage tank).



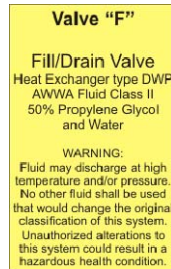
**Freeze Protection** – this label is affixed to the collector feed line at the outlet of the circulation pump.

Manual intervention is required as a secondary precaution to protect components from freeze damage, when air temperatures fall below -20° F (-28.9°C).



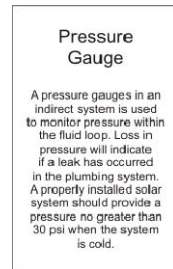
**Valve “F”** – this label is affixed to the fill/drain valves on the solar loop.

The valves are used during the fill and drain operations of the system.



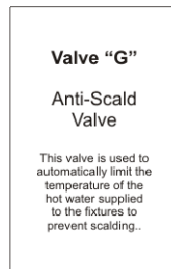
**Pressure Gauge** – this label is affixed to the pressure gauge at the expansion tank.

A pressure gauge is used to monitor pressure within the fluid loop. It can readily indicate if a leak has occurred in the system plumbing.



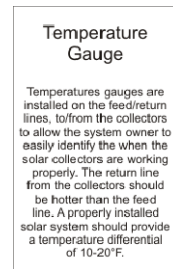
**Valve “G”** – the label is affixed to the anti-scald valve.

This valve is used to limit the temperature of the water to the fixtures in the dwelling to prevent scalding.



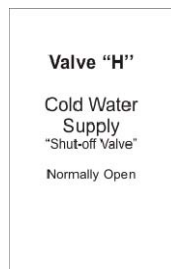
**Thermometer** – this label is affixed to the temperature gauges on the collector feed/return lines.

The gauge will display the temperature of the HTF to/from the collector. During system operation, the collector return line temp should read approximately 8° or more above the outside ambient air temperature.



**Valve “H”** - this label is affixed to the cold water supply, “shut-off” valve.

This valve is normally open and should **only** be closed when maintenance is performed on the system. Power should be disconnected, at the circuit breaker, prior to service.

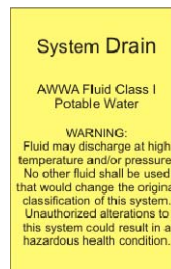


**WARNING / HOT** – labels are affixed to the collector return line at the storage tank, the hot water supply line from the water storage tank and on all system components that could present a safety hazard due to high temperatures.



**System Drain** – this label is affixed to the tank drain valve at the base of the water storage tank.

This valve is to be used only as directed in the water storage tank owner’s manual or as directed in this manual. Power should be disconnected, at the circuit breaker, prior to service.



## SYSTEM WARRANTY

Your EagleSun Solar Water Heating System includes a 5 year parts and labor warranty administered by Service Net Warranty, LLC. For questions regarding the warranty, please contact Client Support at 888-257-0846 or mail to:

**Service Net**  
*HVAC/R Division*  
Attention: CR Admin  
PO Box 928  
Jeffersonville, IN 47130

**WARNING:** The warranty registration card must be completed and submitted within 30 days of installation in order to register your warranty.

## RETURNS POLICY

All returns are subject to return authorization. No returned merchandise will be accepted without prior authorization from AET. If the return is authorized, the buyer will be issued a return authorization ("RA") number, which must be clearly marked on the package. AET will credit the purchase price of all normally stocked merchandise returned in good condition, in original packaging, within 30 days of purchase. There will be a 15% restocking charge on merchandise returned after 30 days. Items not in saleable condition, not normally stocked, and special-order items, may not be returned for credit. All items must be returned freight-prepaid. Replacements will be invoiced to the customer at normal price, and credit issued upon receipt of the failed item.

***No credit will be given for any returned component without proper Return Authorization.***

### **Collector Warranty Claim**

***THE COLLECTOR REPORT FORM IS REQUIRED FOR ALL COLLECTOR WARRANTY CLAIMS***  
***No Claim will be processed without Collector Serial Number***

- Attachment A
- 10 year Warranty on collector as a whole
- Determine must be made as to the cause of the failure. Therefore, the following are required for warranty processing:
  - Request Collector Report Form
  - Pictures
  - Returned Absorber Plate (if applicable)

- Determine most feasible course of action. It is in the best interest of AET, and our distributors and dealers to get the customer's system operational as efficiently as possible. The two most common options are repairing the defect, or replacement of components.
  - Repair
    - For a leaking collector, the most efficient way to get the system returned to operational is to facilitate a repair. This requires detailed pictures of the active leak, taken from under the glass and header shield, and forwarded to AET via email. Upon review and determination of manufacturing defect, credit will be given to the distributor or dealer from whom the collector was purchased, for cost of repair up to \$100
  - Repair
    - If a repair is not feasible, and replacement of the absorber plate may be the most viable option. Upon receipt of a Return Authorization, the installer/contractor shall obtain an absorber plate from the distributor or dealer where the collector was purchased, and arrange for the absorber plate to be returned to AET. AET may ship a replacement absorber plate to the distributor/dealer in good faith, in anticipation of the returned plate, for failure determination.
- Glass is not covered under warranty, however, if a customer calls for broken glass, they should replace it with tempered stippled/patterned glass from a dealer/distributor nearest them.

□ **Return Authorization**

- Required Information
  - Customer
  - Invoice #
  - Reason for return
  - Date failed
  - Return Carrier
  - Customer requirement (Credit or Replacement)
  - Serial Number
- File RA and provide to customer
- Enter on Complaint Record
- Notify Sales and issue Sales Order for any required replacement parts
- Upon receipt of part
  - Inspect and verify complaint
  - Document the receipt on the appropriate Warranty
  - Request RMA# from manufacturer
  - Fill out manufacturer RMA
  - Return to manufacturer
- *For "No Failure – Return to Stock" due to customer mistake, charge 15% restock fee plus freight costs – per AET Dealer Prospect Aug 08*



- **Storage Tanks**
  - 6-Year Warranty through American, Richmond/Rheem
  - Determine cause of failure
  - Provide Storage Tank Report:
    - Attachment B
  - AET will Issue Return Authorization
    - Request Customer Pull off Original Serial # Label, stick it to a piece of paper, and mail it “Attention Warranty”
    - Date of Install
    - Date of Failure
    - Nature of Failure
  
- **Taco Pumps**
  - 1 Year Warranty
  - Notify AET
  - Determine cause of failure
    - Water Type
      - City/Public
      - Well
      - Water Conditioner System
  - Replace
  
- **Goldline Controls**
  - 3 Year Limited Warranty
  - Notify AET



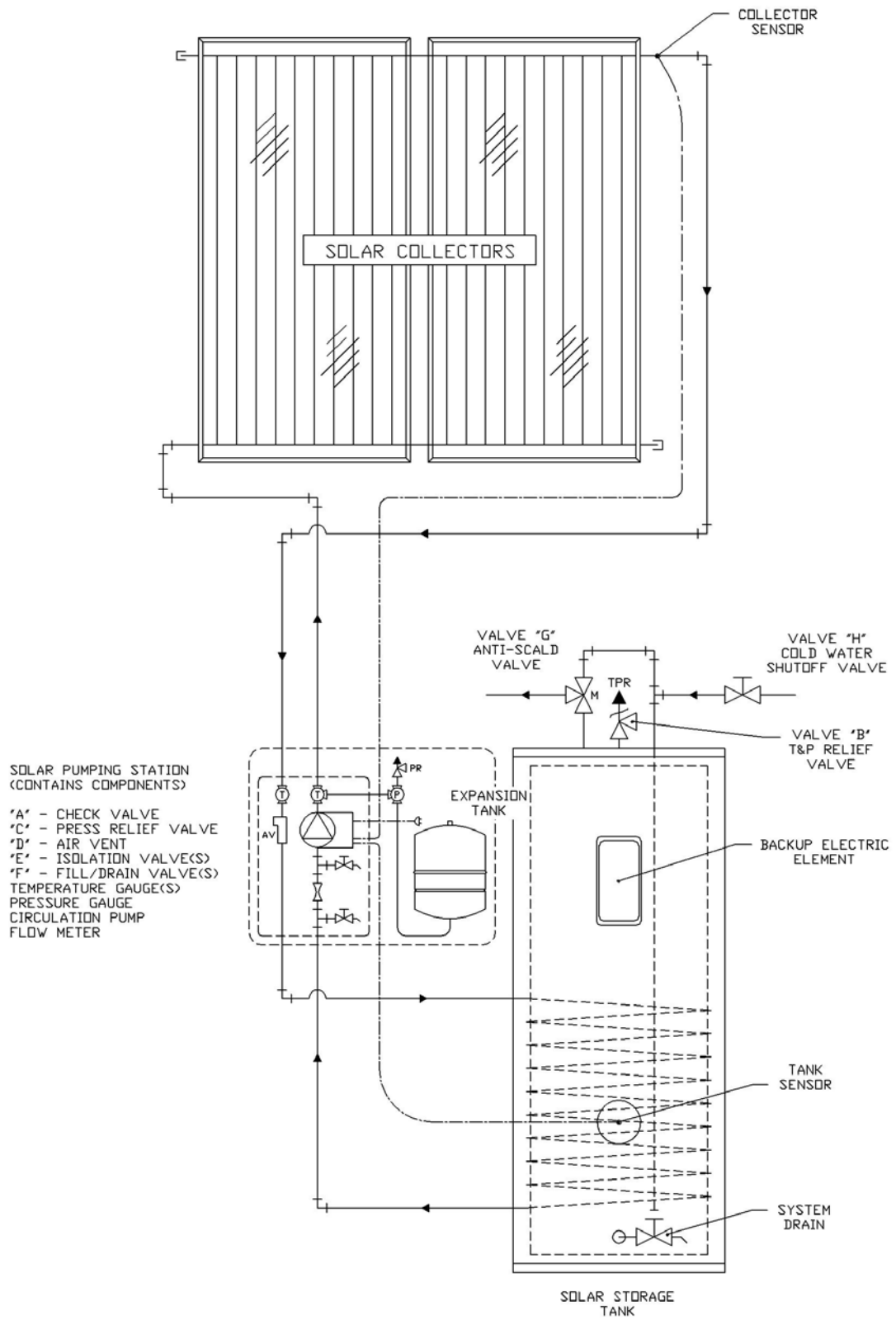
# APPENDIX A

## Trigonometric Functions of Angles

ANGLE	SIN	COS	TAN	ANGLE	SIN	COS	TAN
0.0	0.0000	1.0000	0.0000	46.0	0.7193	0.6947	1.0355
1.0	0.0174	0.9998	0.0175	47.0	0.7314	0.6820	1.0724
2.0	0.0349	0.9994	0.0349	48.0	0.7431	0.6691	1.1106
3.0	0.0523	0.9986	0.0524	49.0	0.7547	0.6561	1.1504
4.0	0.0698	0.9976	0.0699	50.0	0.7660	0.6428	1.1918
5.0	0.0872	0.9962	0.0875	51.0	0.7772	0.6293	1.2349
6.0	0.1045	0.9945	0.1051	52.0	0.7880	0.6157	1.2799
7.0	0.1219	0.9926	0.1228	53.0	0.7986	0.6018	1.3270
8.0	0.1392	0.9903	0.1405	54.0	0.8090	0.5878	1.3764
9.0	0.1564	0.9877	0.1584	55.0	0.8191	0.5736	1.4281
10.0	0.1736	0.9848	0.1763	56.0	0.8290	0.5592	1.4826
11.0	0.1908	0.9816	0.1944	57.0	0.8387	0.5446	1.5399
12.0	0.2079	0.9781	0.2126	58.0	0.8480	0.5229	1.6003
13.0	0.2249	0.9744	0.2309	59.0	0.8571	0.5150	1.6643
14.0	0.2419	0.9703	0.2493	60.0	0.8660	0.5000	1.7321
15.0	0.2588	0.9659	0.2679	61.0	0.8746	0.4848	1.8040
16.0	0.2756	0.9613	0.2867	62.0	0.8829	0.4695	1.8907
17.0	0.2924	0.9563	0.3057	63.0	0.8910	0.4540	1.9626
18.0	0.3090	0.9511	0.3249	64.0	0.8988	0.4384	2.0503
19.0	0.3256	0.9455	0.3443	65.0	0.9063	0.4226	2.1445
20.0	0.3420	0.9397	0.3640	66.0	0.9135	0.4067	2.2460
21.0	0.3584	0.9336	0.3839	67.0	0.9205	0.3907	2.3559
22.0	0.3746	0.9272	0.4040	68.0	0.9272	0.3746	2.4751
23.0	0.3907	0.9205	0.4245	69.0	0.9336	0.3584	2.6051
24.0	0.4067	0.9135	0.4452	70.0	0.9397	0.3420	2.7475
25.0	0.4226	0.9063	0.4663	71.0	0.9455	0.3256	2.9042
26.0	0.4384	0.8988	0.4877	72.0	0.9511	0.3090	3.0777
27.0	0.4540	0.8910	0.5095	73.0	0.9563	0.2924	3.2709
28.0	0.4695	0.8829	0.5317	74.0	0.9613	0.2756	3.4874
29.0	0.4848	0.8746	0.5543	75.0	0.9659	0.2588	3.7321
30.0	0.5000	0.8660	0.5773	76.0	0.9703	0.2419	4.0108
31.0	0.5150	0.8571	0.6009	77.0	0.9744	0.2249	4.3315
32.0	0.5299	0.8480	0.6249	78.0	0.9781	0.2079	4.7046
33.0	0.5446	0.8387	0.6494	79.0	0.9816	0.1908	5.1446
34.0	0.5592	0.8290	0.6745	80.0	0.9848	0.1736	5.6713
35.0	0.5736	0.8191	0.7002	81.0	0.9877	0.1564	6.3138
36.0	0.5878	0.8090	0.7265	82.0	0.9903	0.1392	7.1154
37.0	0.6018	0.7986	0.7535	83.0	0.9926	0.1219	8.1443
38.0	0.6157	0.7880	0.7813	84.0	0.9945	0.1045	9.5144
39.0	0.6293	0.7772	0.8098	85.0	0.9962	0.0872	11.4300
40.0	0.6428	0.7660	0.8391	86.0	0.9976	0.0698	14.3010
41.0	0.6561	0.7547	0.8693	87.0	0.9986	0.0523	19.0810
42.0	0.6691	0.7431	0.9004	88.0	0.9994	0.0349	28.6360
43.0	0.6820	0.7314	0.9325	89.0	0.9998	0.0174	57.2900
44.0	0.6947	0.7193	0.9657	90.0	1.0000	0.0000	infinite
45.0	0.7071	0.7071	1.0000				

# INDIRECT "I" SYSTEMS

I-80-42-SPS (80 GALLON W/ ELEC BACKUP)



# INDIRECT "I" SYSTEMS

I-80-42-VTC (80 GALLON W/ ELEC BACKUP)

