Solar Hot Water Audit Program for APS

Prepared by:

Geoff Sutton

Project Coordinator

Arizona Solar Center

Your Guide to Solar in Arizona

July 2012

Why does the program exist?

- Safety structure, water damage
- Safety personal, pets
- Component continuity for ratings, designer/hybrid systems
- Operational life, that correct parts are used
- Homeowner receives what they purchased
- APS receives the RECs they purchased

Federal Requirements

The American Recovery and Reinvestment Act of 2009

Must meet:

- Performance certification by Solar Rating Certification Corporation (SRCC) or comparable State endorsed entity
- Supply at least half of the homeowners needs

State Requirements

Arizona Solar Energy Tax Credit: A.R.S. 43-1083

- Systems must be new, carry a minimum 2 year warranty, comply with AZ Department of Commerce, rating, certification, performance, installation, safety, standards
- All applicable codes
- All applicable Federal, State, and Local Laws (IPC, UPC, IFC, IMC…)
- Consumer protection standards adopted by the Arizona Department of Commerce, including but not limited to freeze and temperature standards

APS Requirements

- Arizona Corporation Commission (ACC); Renewable Energy Standard and Tariff (REST)
- Must carry correct Arizona Registrar of Contractors (RoC) license, C-37, C37R, K-77, K-78, L-77, L-78
- Incentive paid on OG-300 rating from SRCC, presently .50c per annual kW hr. saving. If the system is different the incentive cannot be calculated

We all have a vested interest

- There are Federal, State, Local, and Utility programs with a vested interest financially and legally in the Arizona Solar Water Heating program

- Add Homeowners, Installers, Dealers, Manufactures, AHJ's, the various city, state and national codes into the mix and the program becomes very multilayered

End Result

System install residential cost is ~$8,000

- Federal 30% = ~$2,400
- State 25% cap = ~$1,000
- Utility .50c = ~$1,600

- Total incentives = ~ $5,000 (taxes, ratepayer fees), plus implementation costs

- For every 1,000 installs over $5 million in tax incentives and ratepayer fees are involved

APS Standards

- APS must comply under A.R.S. 9-468 2.b to use a standard "as prescribed by a solar rating and certification corporation" for the incentive payments

- The standard that APS uses is the SRCC OG-300 published "Annual Savings" to determine their incentive

Disclaimer

- Examples might show other discrepancies or issues

- Examples will show different manufactures and work from installers, the following is in no means meant to single out any one installer or manufacture, but are to be used as an educational tool

Audit History

- APS had randomly selected approximately 145 solar hot water systems from 2009-2010 that had been incentivized and green tagged by their appropriate AHJ's

- A standardized checklist was used keying on 30 specific questions and ~7 system type questions

APS and SRP had discussions in early 2010 on field installs through an independent third party

Audit tools and process established

Pilot study of approximately 250 sites (150 APS and 100 SRP)

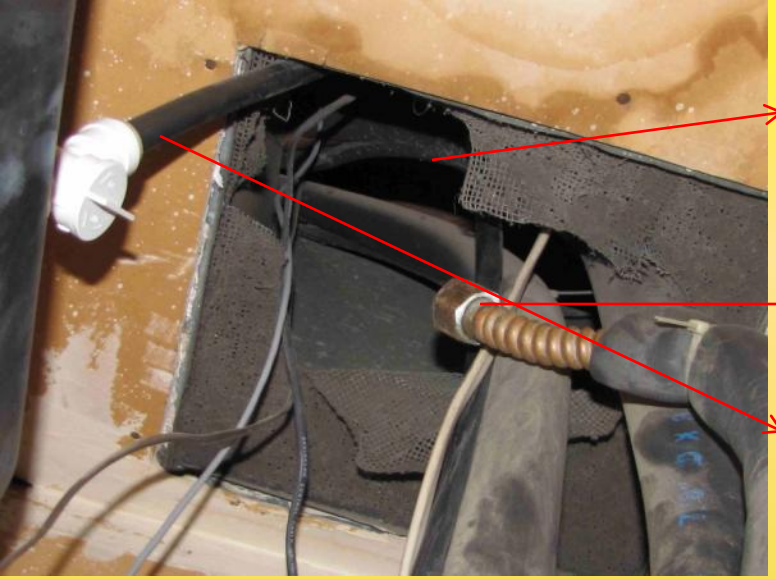
Program immediate implementation (failure rate upper 90's%)

Utility requested two special site visits

Results were surprising

Summer of 2010 one of the utilities has two upset customers with their Solar Hot Water System Installs

This is what was found:



One foot square hole directly into unconditioned attic

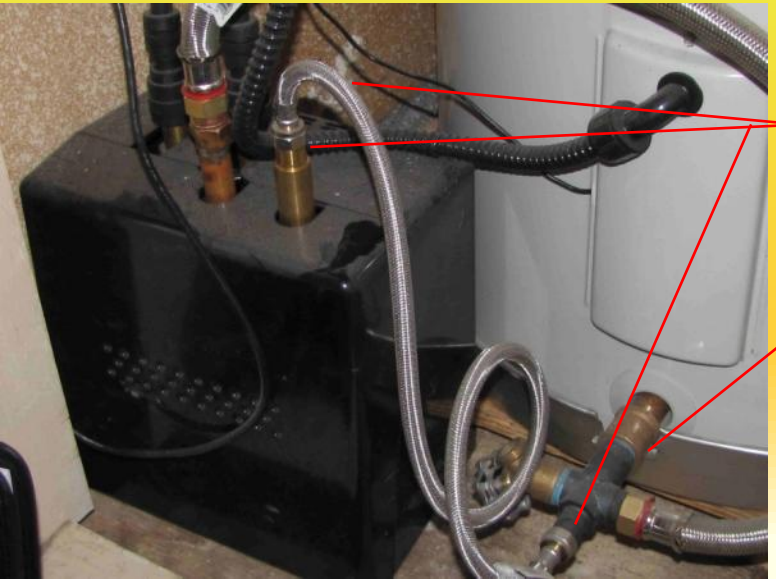
Old lines not removed

Lines not insulated

System drains up

Contractor had incorrect RoC license

Tie-down tearing out of roof, strap in wrong location to header



Lines not insulated

Drip pan has been cut into, system in a conditioned space did not drain to a safe location

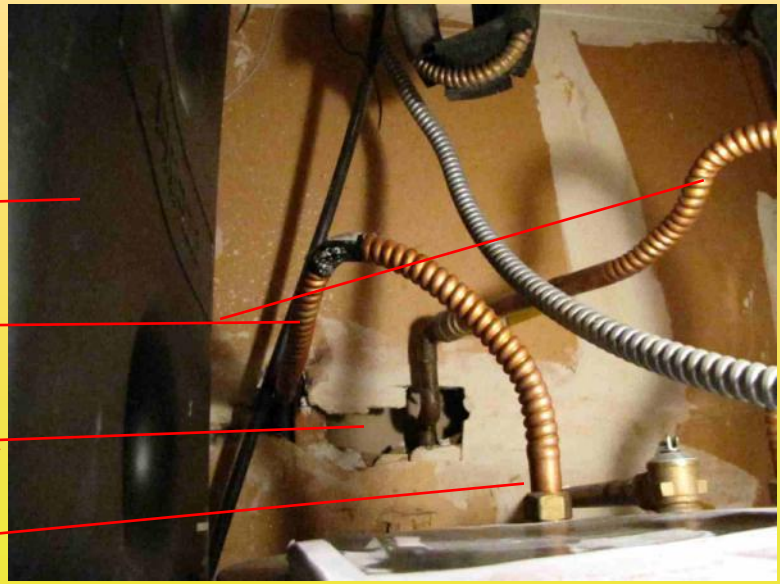
Sensor wire runs inside whirly bird

Tank not insulated

No insulation on lines

Hole knocked into wall for plumbing

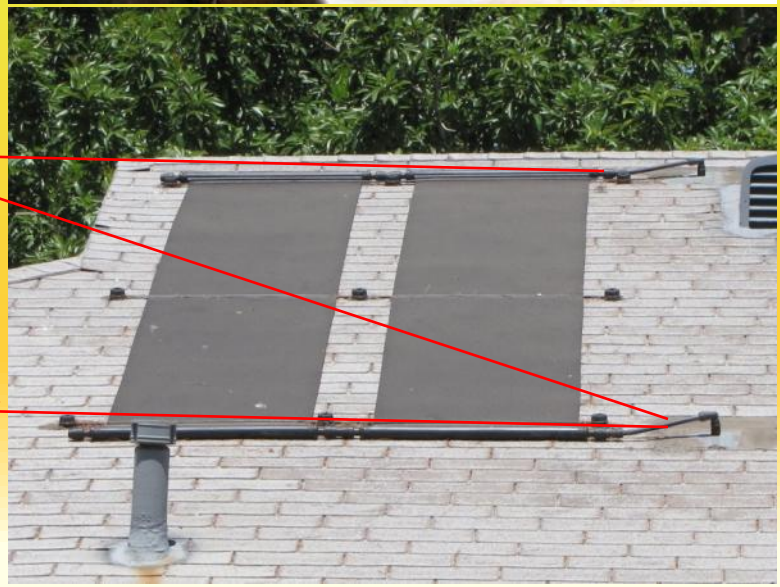
No mixing valve



No Sikaflex

Inlet and outlet on same side of collectors

System drains up



Open hole into attic, insulation falling into house

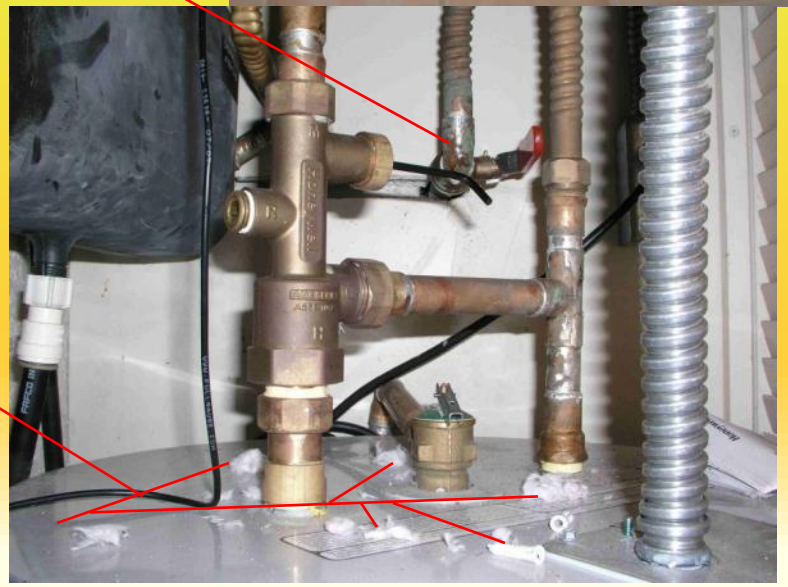
PEX not insulated

Tank not insulated

Circulation module lines reversed

No drip pan

No labels



Insulation from attic falling into house

Drains up

Incorrect flashing install

Installer did not understand how to install solar hot water systems

Multiple missed holes not correctly flashed on roof

Sensor not installed correctly floating, note roof needs to be replaced

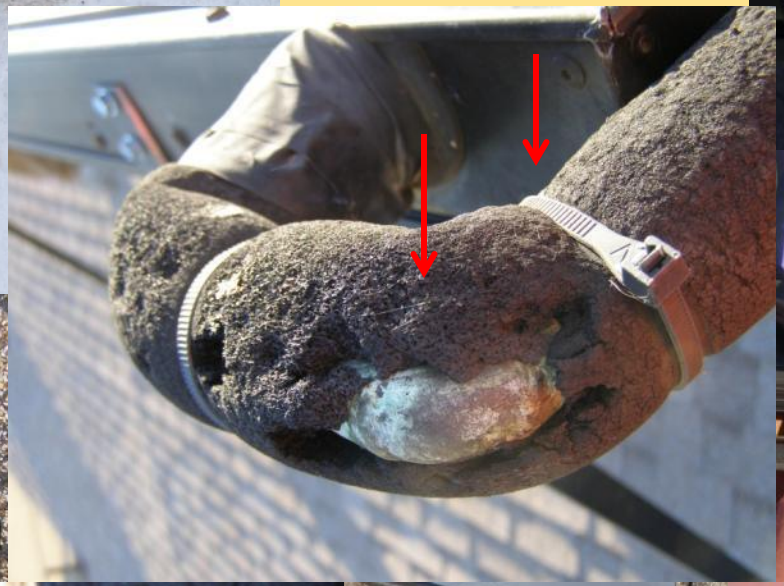
Pilot Program

APS and SRP in the 2nd half of 2010 did a random sampling of approximately 250 systems to see how they matched up to the SRCC OG-300 installation guidelines. This is to conform to the REST as required by the regulated utilities (APS) under the ACC http://www.azcc.gov/divisions/utilities/electric/environmental.asp

SRP has a separate program that closely mirrors the ACC requirements http://www.srpnet.com/environment/earthwise/solar/default.aspx

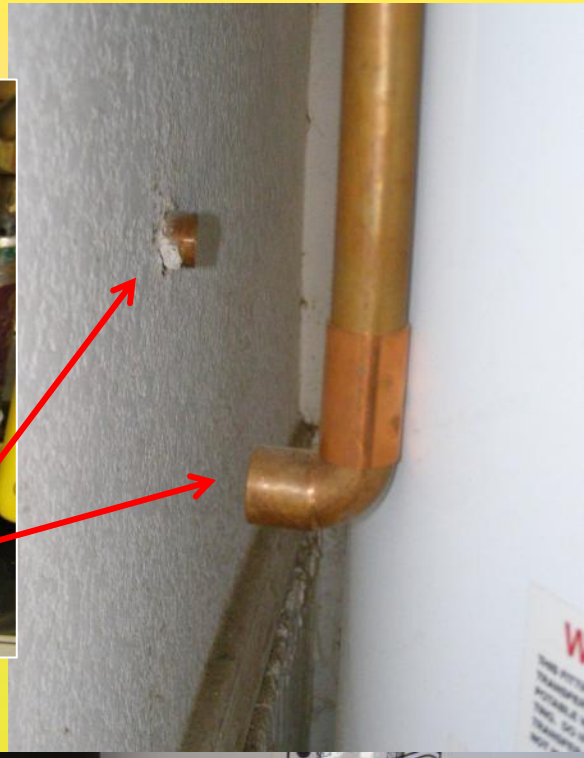
What was found in the Pilot Program: APS systems not more than one year old, and SRP systems went back up to 3 or 4 years

Pilot Program



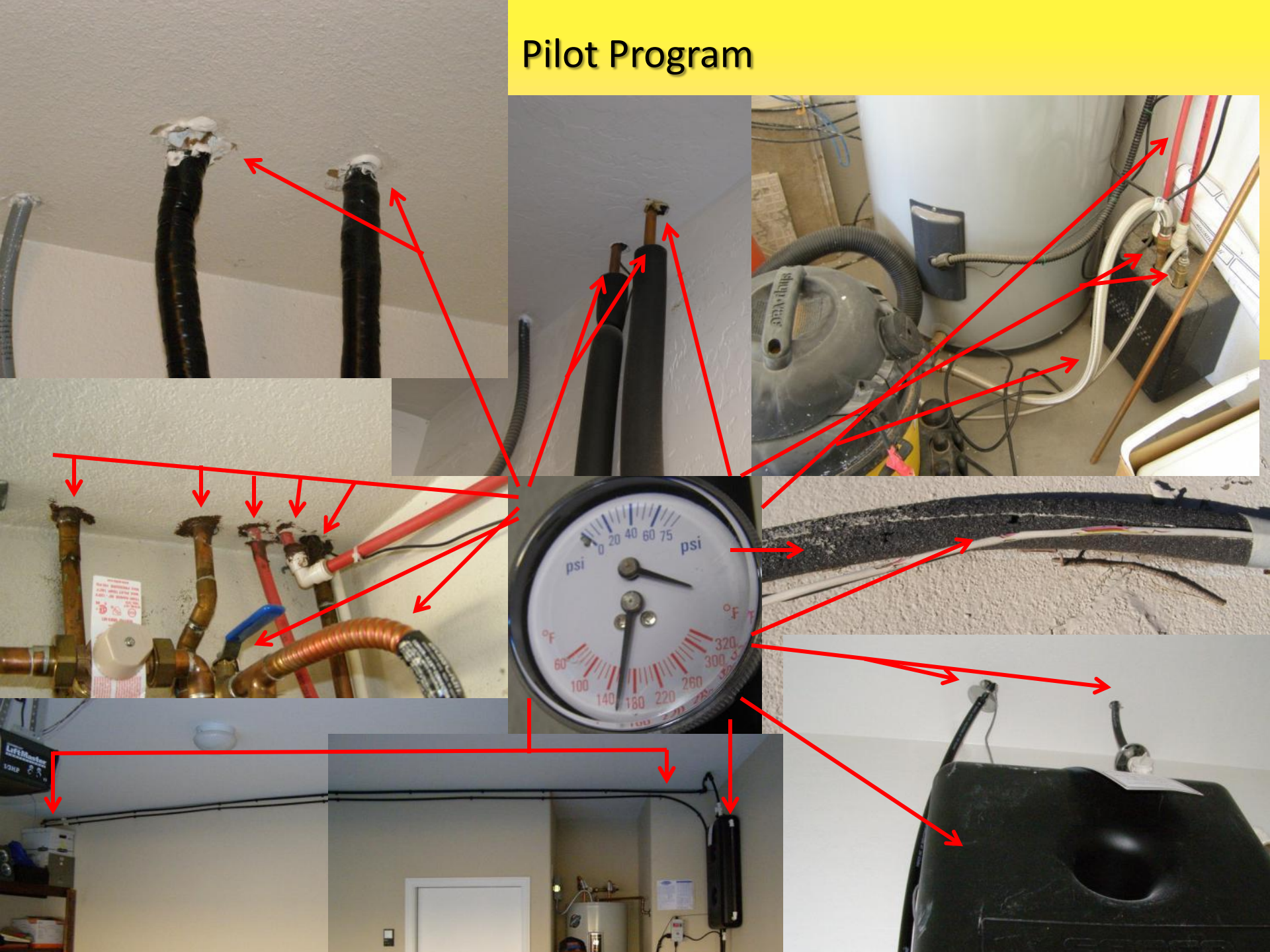
Pilot Program

Pilot Program

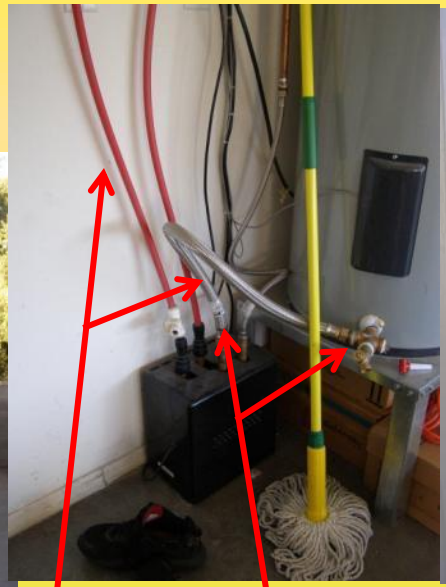


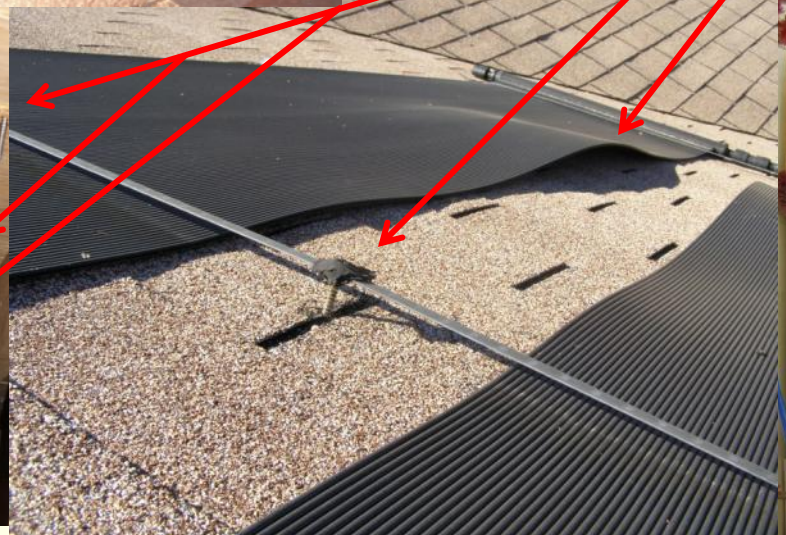
Note water

Pilot Program

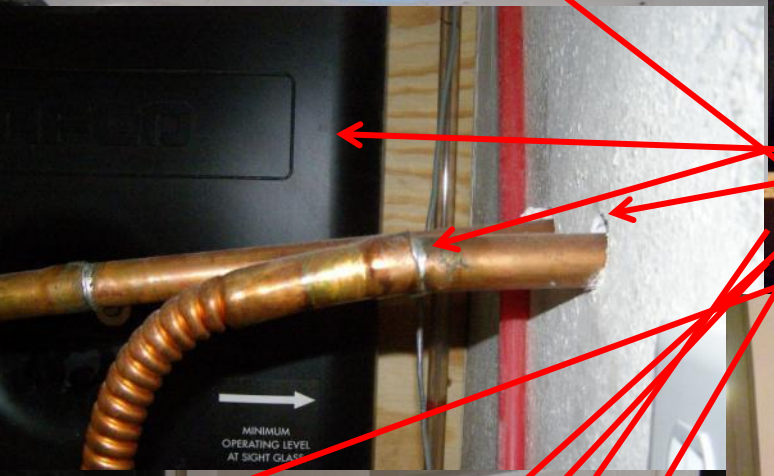


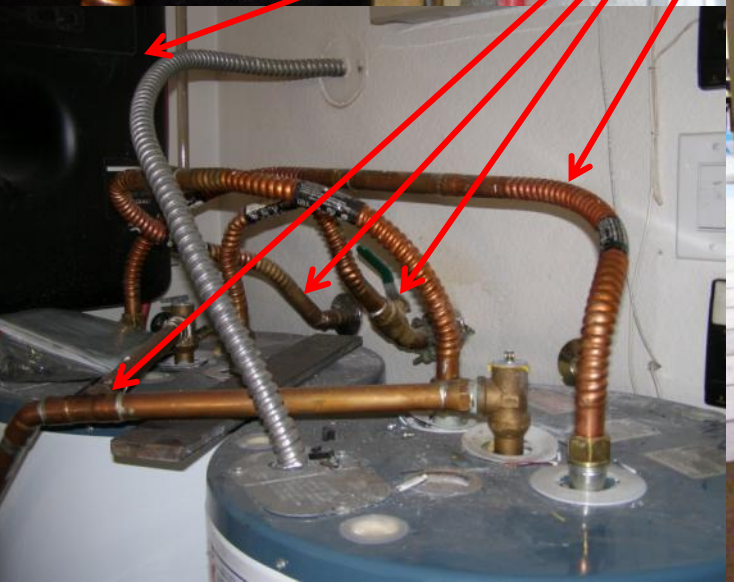
Pilot Program





Pilot Program





What was Concluded

- Installers were not familiar with the product
- Installers were not correctly trained on the product
- All National, State, Local programs, and the alphabet of codes (IPC, UPC, IBC, NEC, IFC, IECC, IMC) in place are not protecting the consumer
- Many systems were not likely performing to the SRCC OG-300 annual saving numbers that APS uses for their incentive program
- Some homeowners felt disappointed about the product
- Some homeowners had no idea of how the system works
- Lack of system compliance (by AHJ) permitted an easing in the installation standards
- <u>It became the Utilities responsibility</u>

- APS from the findings created a reworked checklist
- Checklist is different from other states and utilities
- Checklist is not a be all, end all
- Note the Azimuth treats 180 degrees (south) as 0

APS SOLAR WATER HEATING SITE VISIT CHECKLIST

Audit # 1 2 3 _ COMPLIANCE ☐ NON-COMPLIANCE ☐ RESERVATION NUMBER: _____

Project Information AUDITOR: _____

Customer (Present):			Date:
Address/ City/ State/ Zip:		Phone Number:	
Installing Contractor:			
Equipment Manufacturer:		SRCC Model:	System Type (drain-back, ICS,…) :
Solar Tank Manufacturer (Elect, Gas):		Model:	Gallons:
Secondary Tank (Elect, Gas):		Model:	Gallons:
Water Temp. at Interior Fixture:	Refract Rating:	Tilt:	Azimuth:

Y	N	N/A		General Requirements
☐	☐	☐	1	System is operating
☐	☐	☐	2	System installation and components are consistent with Incentive application and SRCC approved manual
☐	☐	☐	3	All components are new (tank, collector, plumbing, pumps, controls)
☐	☐	☐	4	SRCC approved manual is available
Plumbing/Piping				
☐	☐	☐	5	Piping is adequately and appropriately supported
☐	☐	☐	6	Pipe insulation with a min. R-2.6 is installed on all hot water pipes and first 5 feet of exposed cold water inlet piping. All exterior piping insulation shall be protected from UV and moisture damage
☐	☐	☐	7	Expansion tank is installed on collector loop piping if applicable
☐	☐	☐	8	Collectors are pitched at least 1/4 inch per foot and piping is continuously pitched between collector(s) and drain-back reservoir with a minimum 1/4 inch per foot if applicable
Solar Storage Ta				
☐	☐	☐	9	Water tanks installed in or above living space shall be on a drip pan with drain line to a safe location
☐	☐	☐	10	Temperature and pressure relief valve is installed on tank to comply with ASME Boiler and Pressure Vessel Code, Division 1, Section VIII
Valves				
☐	☐	☐	11	Tempering valve(s) are installed and a) On the downstream side of the primary water heater(s), b) Located after anti-convective plumbing, and c) and shall include a set point of 122 °F
☐	☐	☐	12	All isolation valves shall be labeled with the normal operating position indicated on durable and waterproof labels
☐	☐	☐	13	Label shall mark all drain and fill valve(s). Label shall identify fluid in that loop. Label shall contain warning:"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."
☐	☐	☐	14	Pressure relief valve is installed on the collector loop if applicable
☐	☐	☐	15	Pressure relief valve is installed on drain-back tank if it can be isolated
Controls				
☐	☐	☐	16	Electrical tape, zip ties, and low temperature insulation are not used
☐	☐	☐	17	Sensor wiring and control sensor (when outdoor) has a UV-rated exterior jacketing, is continuously attached, and is protected from abrasion, high voltage lines, high temperature, and environmental influence
☐	☐	☐	18	If PV powered, a high temperature shutoff function is installed and wired through the circulation pump
Collector(s)				
☐	☐	☐	19	Collectors are substantially un-shaded between 9am and 3pm year-round
☐	☐	☐	20	Tilt and azimuth of collectors are within program requirements

NOTES

	Azimuth*	Tilt	Incentive
	90-180	>0	0%
	30-90	0-33	80%
	0-30	0-17	80%
	0-30	18-47	100%
	0-30	48-75	80%
	30-90	0-33	80%
	90-180	>0	0%

* Defined as Variation E or W from South

2/22/2012 Reference: OG-300 Operating Guidelines and Minimum Standards for Certifying Solar Water Heating Systems; http://www.solar-rating.org/certification/standards.html

Checklist

1. System is operating

Visual Guides

Gauge system pressure,
Gauges temperatures,
Piping,
Pumps,
Sensors properly attached or covered

All systems should have visuals showing they are functioning, exception is the ICS systems

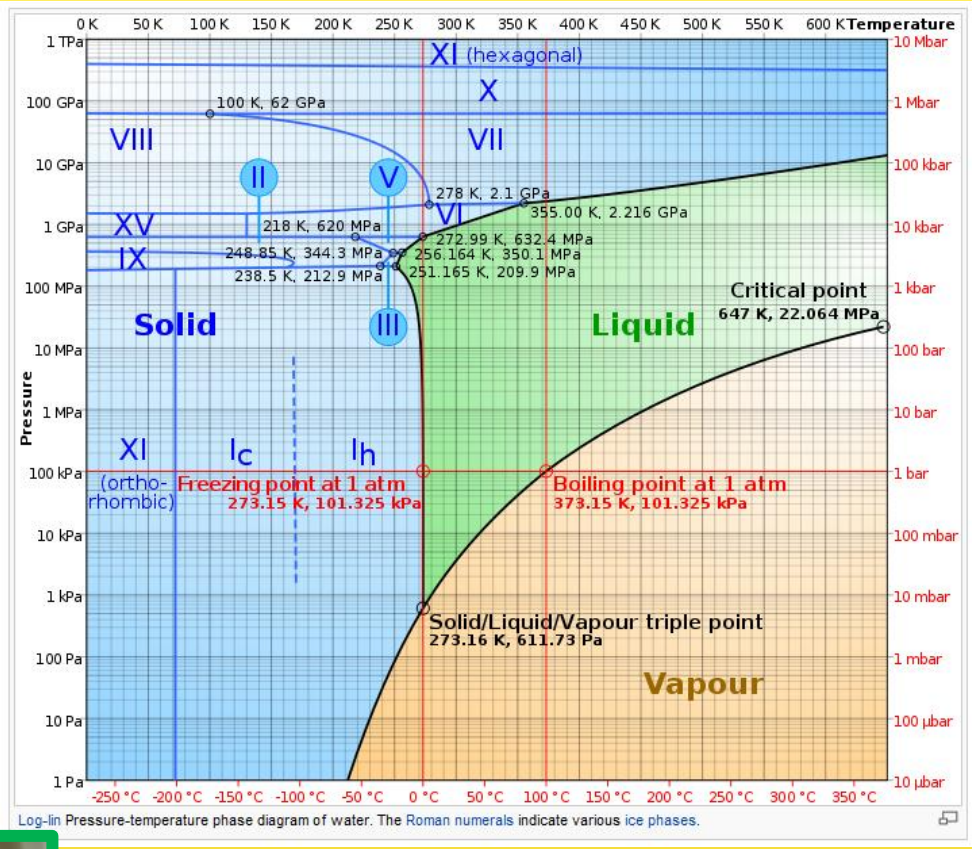
Checklist

1 System is operating continued

PRESSURE

- Vapor pockets (liquid not air) can form if pressure drops. Most prevalent before pump or at restrictions (valves)
- Get a popping sound, cavitation
- Pump will overheat and erode impellers

Black needle



http://en.wikipedia.org/wiki/Triple_point

80C (176F) need pressure of 40 kPa (6psi)

100C (212F) need pressure of 101 kPa (14.6 psi) to stop a vapor pocket

- Read the instruction manual most are in the 30 to 40 psi range

1 System is operating continued

Gauges

- Digital or Analogue
- Gauge gives a good indication where failure is

Failed gauge

Pressure loss

Collector

Tank

Incorrect temperature showing

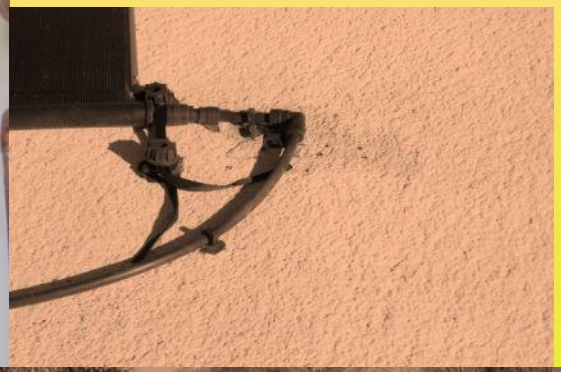
Line failure

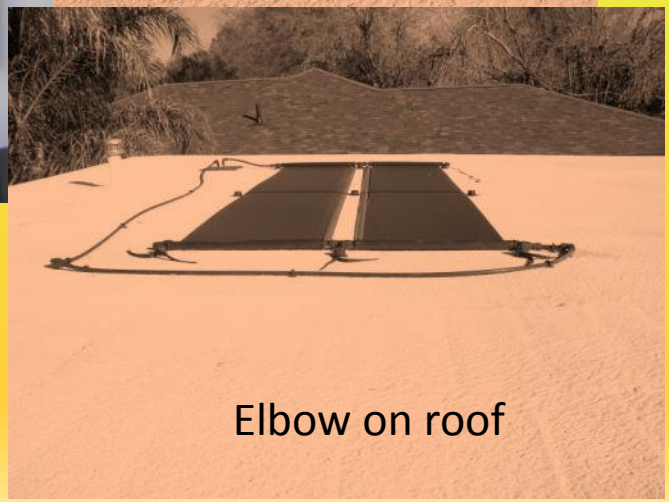
Checklist

1 System is operating continued

Piping

Sight glass is empty





Elbow on roof

Simple

2 System Installation and Components are Consistent with Application

- Need to look a the submittal drawings and match up the system type by the SRCC number to what was installed

- There is no acceptable SunEarth Solaray system that allows 3 collectors in the OG-300 program

TE80P-120-2G SRCC# 2001001S

2 System Installation and Components are Consistent with Application

Location of the OG-300 directory http://www.solar-rating.org/ratings/og300.html

SOLAR WATER HEATING CERTIFICATION AND RATING

SRCC OG-300

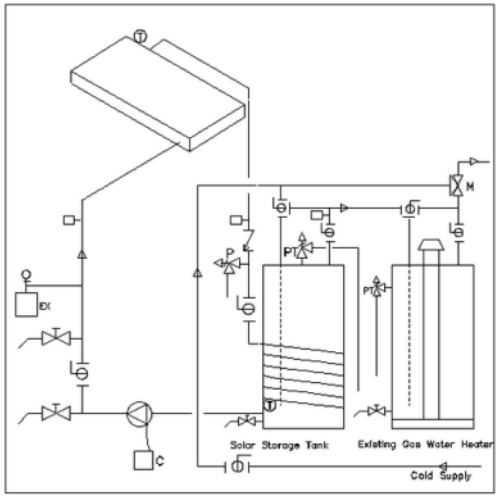
CERTIFIED SOLAR WATER HEATING SYSTEM

SUPPLIER: **SunEarth, Inc.**
8425 Almeria Avenue
Fontana, CA 92335 USA
(909) 434-3100
(909) 434-3101 Fax

SYSTEM NAME: SolaRay
SYSTEM TYPE: Indirect Forced Circulation
LOCATION: AZ-PHOENIX

Description: Glazed Flat-Plate, Differential Temperature - Constant flow, Tank Wrap Around Heat Exchanger with a Double Wall and Positive Leak Detection, , Freeze Tolerance: -60 F, Fluid Class II, Gas Auxiliary Tank With Reflective 5/16" (0.8 Cm) Insulation Blanket

System Model_name	Cert 300#	Cert Date	Collector Panel Manufacturer	Collector Panel Name	Total Panel area(Sq-m)	Total Panel area(Sq-ft)	Solar Tank Vol(l)	Solar Tank Vol(g)	Aux Tank Vol(l)	Aux Tank Vol(g)	SEF	Annual Savings (thm)	Annual Solar Fraction
TE40P-80-2G	2001001A	10-APR-01	SunEarth, Inc.	EP-40	3.8	40.9	303	80	189	50	1.1	140	.76
TE40C-80-2G	2001001B	10-APR-01	SunEarth, Inc.	EC-40	3.8	40.9	303	80	189	50	1.1	144	.78
TE32C-120-2G	2001001J	22-MAR-10	SunEarth, Inc.	EC-32	3.1	32.8	454	120	189	50	1	128	.69
TE40P-120-2G	2001001P	22-MAR-10	SunEarth, Inc.	EP-40	3.8	40.9	454	120	189	50	1	137	.74
TE80P-120-2G	2001001S	22-MAR-10	SunEarth, Inc.	EP-40	3.8	40.9	454	120	189	50	1.6	163	.88
TE32C-80-2G	2001001H	22-MAR-10	SunEarth, Inc.	EC-32	3.1	32.8	303	80	189	50	1	131	.71
TE32P-80-2G	2001001I	22-MAR-10	SunEarth, Inc.	EP-32	3.1	32.8	303	80	189	50	1	125	.68
TE40C-120-2G	2001001K	22-MAR-10	SunEarth, Inc.	EC-40	3.8	40.9	454	120	189	50	1.1	142	.77
TE32P-120-2G	2001001O	22-MAR-10	SunEarth, Inc.	EP-32	3.1	32.8	454	120	189	50	1	122	.66



OG-300 System Reference:2001001A

July, 2012
Certification must be renewed annually, For current status contact:
SOLAR RATING & CERTIFICATION CORPORATION
400 High Point Drive, Suite 400 ♦ Cocoa, Florida 32926 ♦ (321) 213-6037 ♦ Fax (321) 821-0910

Note the drawing is incorrect on SRCC website

3 All Components are new

- Are Components New: The incentive is paid for the utility acquiring the environmental attributes (RECs) of the system. The systems are packaged, for the performance rating and as such need to be new

4 SRCC approved manual is available

- Manuals need to be readily accessible, this includes if needed the booklet for the controller
- SRCC will not release what an approved manual is; Contact manufacture or dealer
- In one case the distributor modified the drawing, if in doubt contact them
- Read them and ask questions

All manufactures will have Installation manuals

A.R.S. 44-1762: have a statement of warranty

5 Piping is adequately and appropriately supported

- UPC 313.2, undue strains or stresses
- UPC 314.2, prevent sagging

- Piping will conform to the IPC Table 308.5 or UPC Table 3-2 for hanger spacing/supports. Compression or damage to insulation is to be avoided

- Copper 6’ horizontal and 10’ vertical
- PEX 32” horizontal 10’ vertical with mid-story guides

6 Piping Insulation

Temperature

- Needs to be a high temperature EPDM or fiber type based insulation with a R-2.6 or better

6 Piping Insulation

UV Protection

- Utility is purchasing RECs

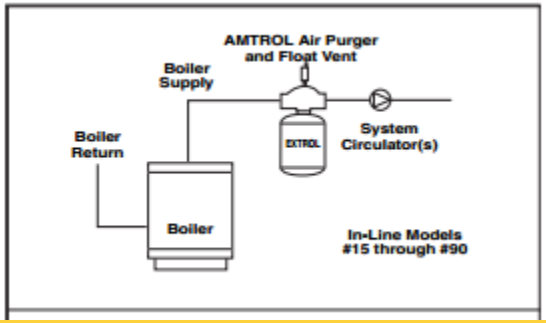
- SS Clamp

- Will not warranty untreated “UV Resistant” insulation

7 Expansion Tank

- For pressurized closed loop systems
- Expansion tanks are subjected to heat and pressure, use correctly sized expansion tank
- Stagnation over 200F will break down buffers, causing acidity
- Pressure relief line is second line of defense, should be close to collectors if possible
- Amtrol THERM-X-TROL line uses a Polypropylene liner and a Butyl diaphragm to combat corrosion and heat

Figure 1.



WARNING: Mount vertically only. Do not mount on dead-end pipe.

2. Install the EXTROL on the supply side of the boiler, on the suction-side of the heating circulator(s) (see Figure 1).
3. Do not place the EXTROL on a dead-end pipe. Air can collect in the EXTROL, causing internal corrosion and possible leakage.

http://ecomfort.com/PDF_files/Amtrol/Extrol_Expansion_Tank_Installation_Manual.pdf

7 Expansion Tank

- Expansion tanks installed and properly supported, read manual

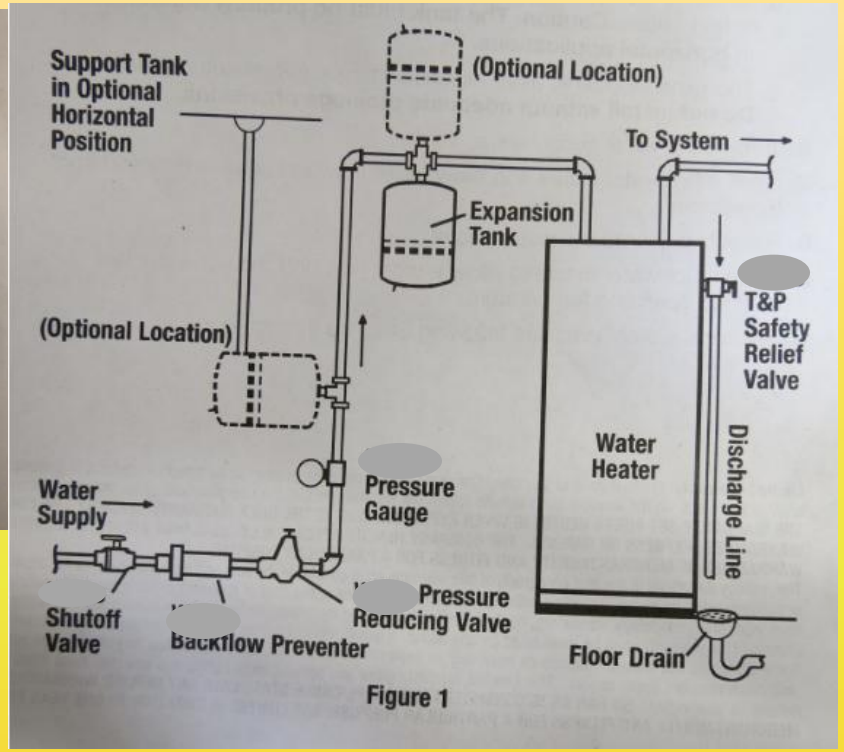


Figure 1

This Expansion Tank is designed and intended for water storage at a maximum pressure of 150psi (10.3 bar) and a maximum temperature of 200°F (93°C). Any use other than for potable water or a sustained or instantaneous pressure in excess of 150psi (10.3 bar) or 200°F (93°C) is **UNSAFE** and can cause property damage, serious bodily injury or result in death.

- Read the manufactures literature

8 Collectors and Piping are pitched

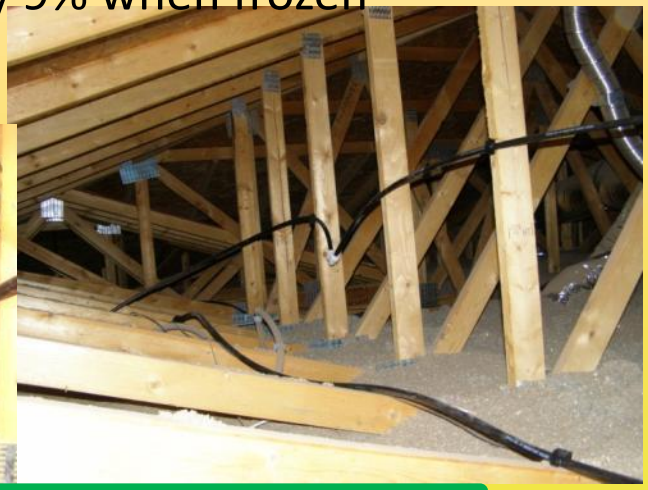
Collectors

- Should be ¼ inch per foot as a minimum, **it can be more**
- For non-glycol drain-backs
- Note that a collector that is horizontal (Landscape) the riser tubes might sag

8 Collectors and Piping are pitched

Piping

- Should be continuous
- Be ¼ inch per foot minimum
- Piping should not have sags, traps, etc…
- Water expands by 9% when frozen



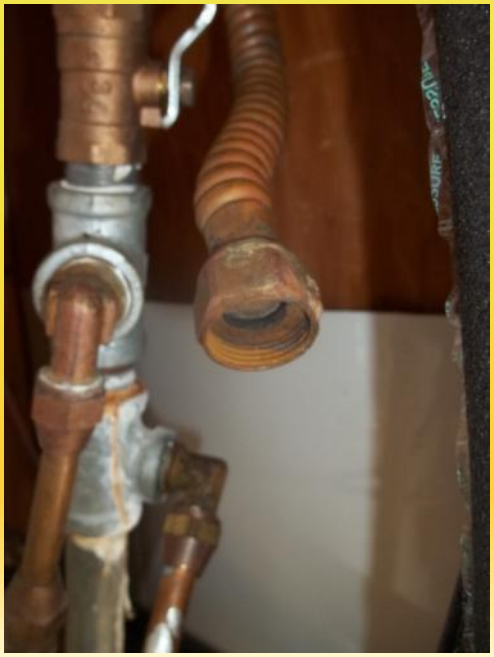
9 Water tank drip pans

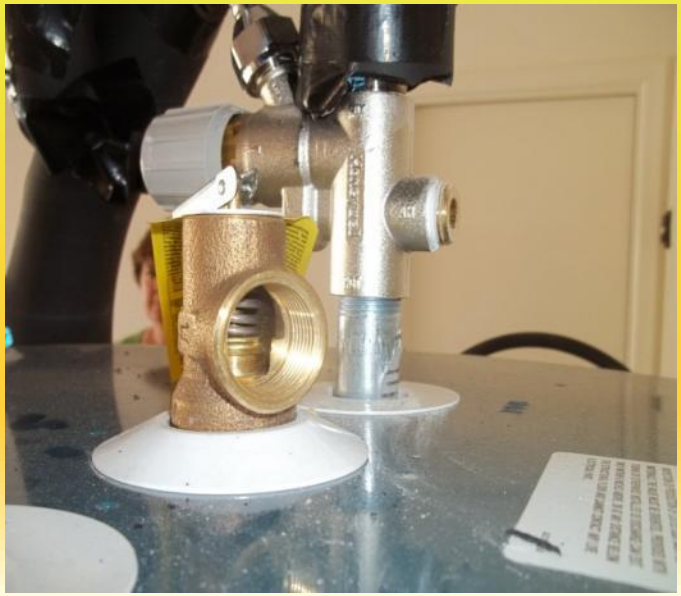
- To be installed where damage can occur
- Required in codes
- Drain shall terminate to a suitable location
- Pans are around $15

- Waiver letters
- Water sensor alarms

10 Temperature and Pressure Relief Valves

- Required under plumbing codes
- 2006 UPC 508.5 prohibits relief valve discharge into the drain pan
- 2009 IPC 504.5 temperature setting no higher than 210F or 150psi, unless tank manufacture calls for it to be lower
- Beware of the list of requirements, including but not limited to, line diameter, single purpose, discharge height off floor, acceptable waste receptor (drain pan), traps, threaded ends…





11 Tempering valves

- Downstream from the primary tank
- Have a set point of 122F
- Is for the safety of the occupants especially for the young, old and infirmed
- 150F (66C) will give 1st degree burns in 1.5 secs

195F (90C)

Honeywell AM102 or Watts MMV are listed as mixing valves
Note check valve

Installed wrong

11 Tempering valves

Watts 70A Extender Tempering Valve

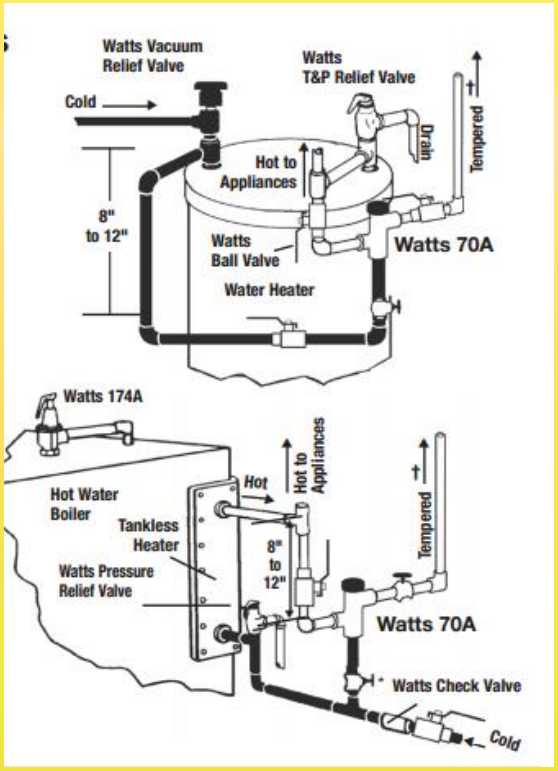
⚠ WARNING

Watts Hot Water Master Tempering Valves cannot be used for tempering water temperature at fixtures. Severe bodily injury (i.e., scalding or chilling) and/or death may result depending upon system water pressure changes and/or supply water temperature changes. ASSE standard 1016, 1069 or 1070 listed devices such as Watts Series MMV, USG, and L111 valves should be used at fixtures to prevent possible injury.

The Watts Hot Water Tempering Valves are designed to be installed at or near the boiler or water heater. They are not designed to compensate for system pressure fluctuations and should not be used where ASSE standard 1016, 1069 or 1070 devices are required. These Watts valves should never be used to provide "anti-scald" or "anti-chill" service.

IMPORTANT: BE SURE TO REMOVE THERMOSTATIC ASSEMBLY from valve before sweating connections, otherwise it will become damaged.

http://media.wattswater.com/1910210.pdf



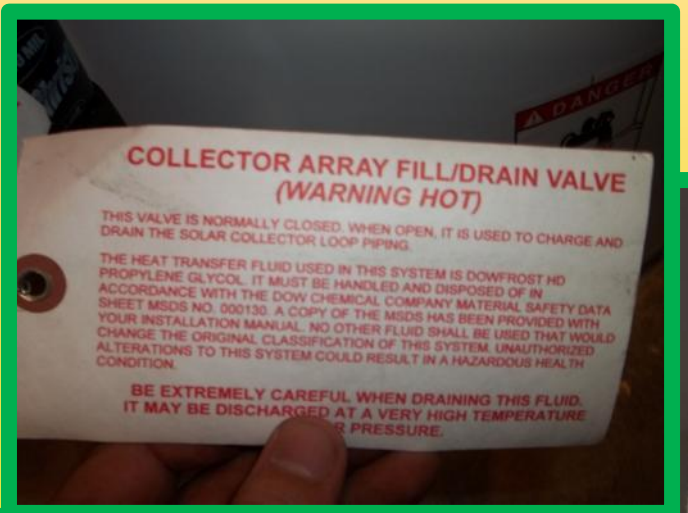
Checklist

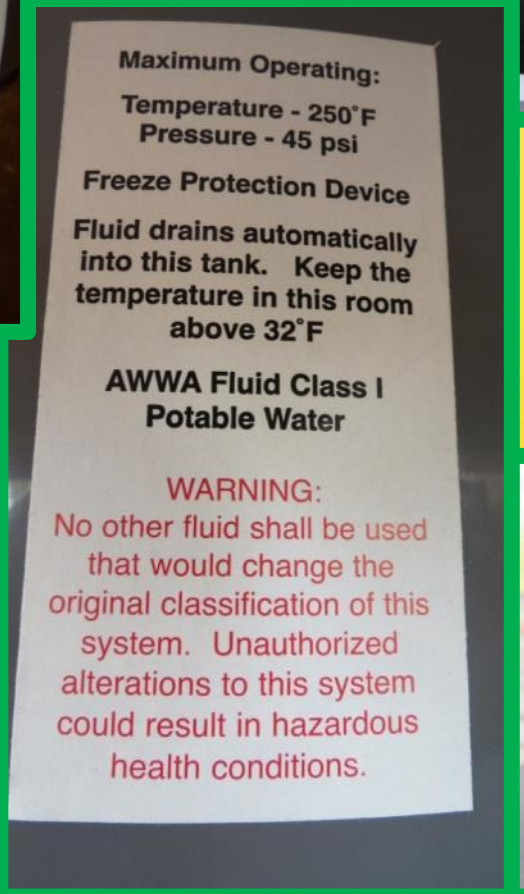
12 Isolation valve labels

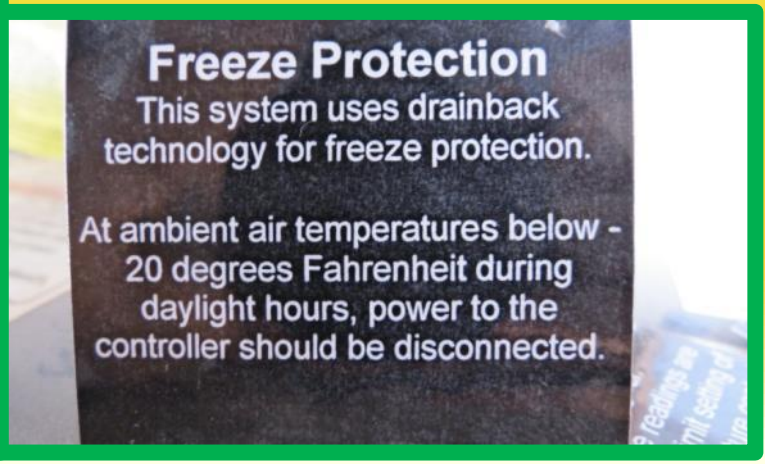
- Need to be labeled
- Show operating position
- Durable and Waterproof labels
- White on Black not necessary

13 Drain and Fill Valve Labels

- Fluid type needs to be identified
- Shall contain SRCC warning on fluid



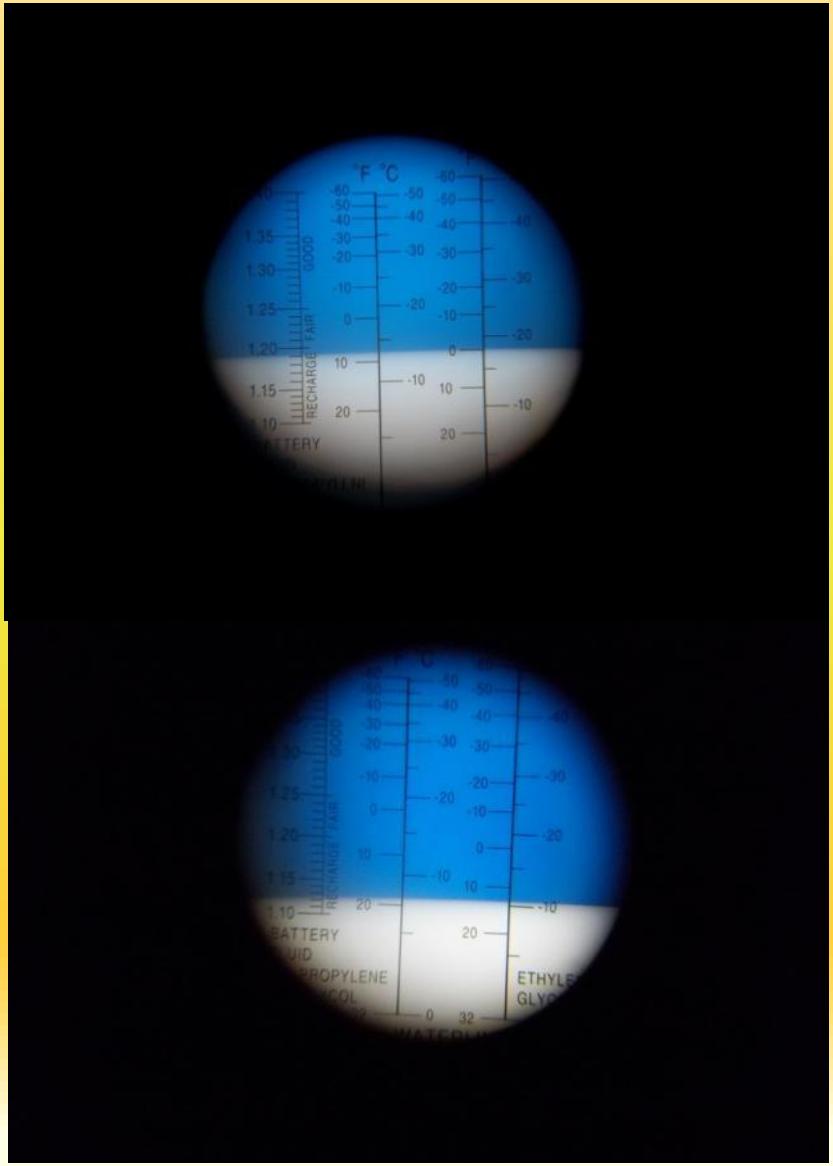




13 Drain and Fill Valve Labels

Refractometer is used to make sure that glycol is present in the system to the lowest recorded historical low temperature (15F in PHX)

Used on the glycol drainback systems



14 Pressure Relief Valve on Collector Loop

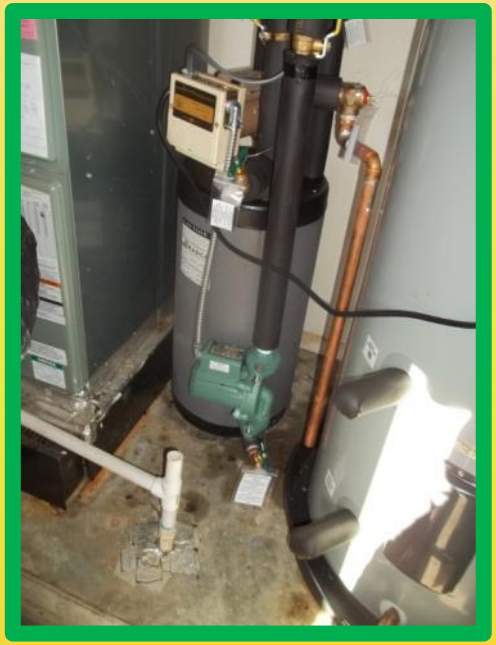
- Set to system design pressure
- No temperature relief valve

State Water Heaters SS X 01ACI501-80

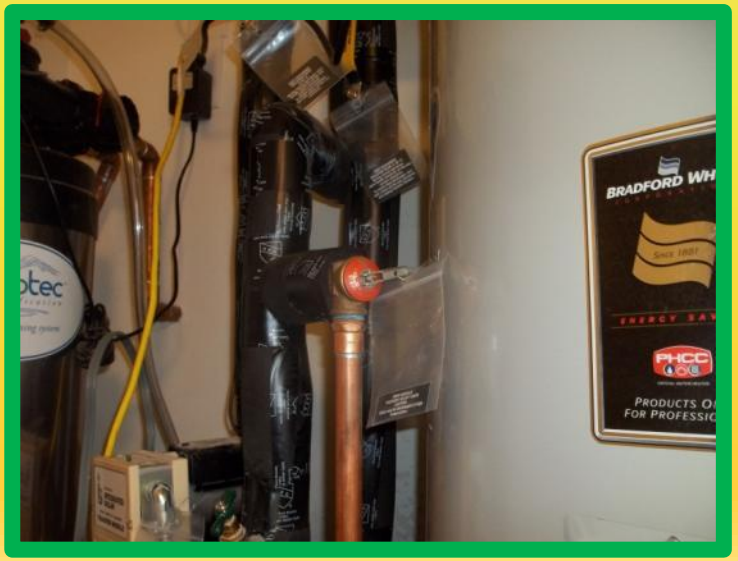
15 Pressure relief valve on Drainback Tank

- Set to system design pressure
- No temperature relief valve

AET DX-80-40



Aqua Del Sol R-DBHX-8-80S-40P



Integrated Solar ASDX-80-40C

16 Electrical Tape, Zip Ties, Low Temperature Insulation not used

- Electrical Tape the upper limit is ~176F (80C) then the glue starts to fail

http://solutions.3m.com/wps/portal/3M/en_US/EMDCI/Home/Products/Catalog/?N=4294599174+5432987&loc=en_US&plmlblid=1273696351712&rt=c3&sorttype=list

- UV damage
- Moisture damage
- Insects and birds can get at sensors and wires

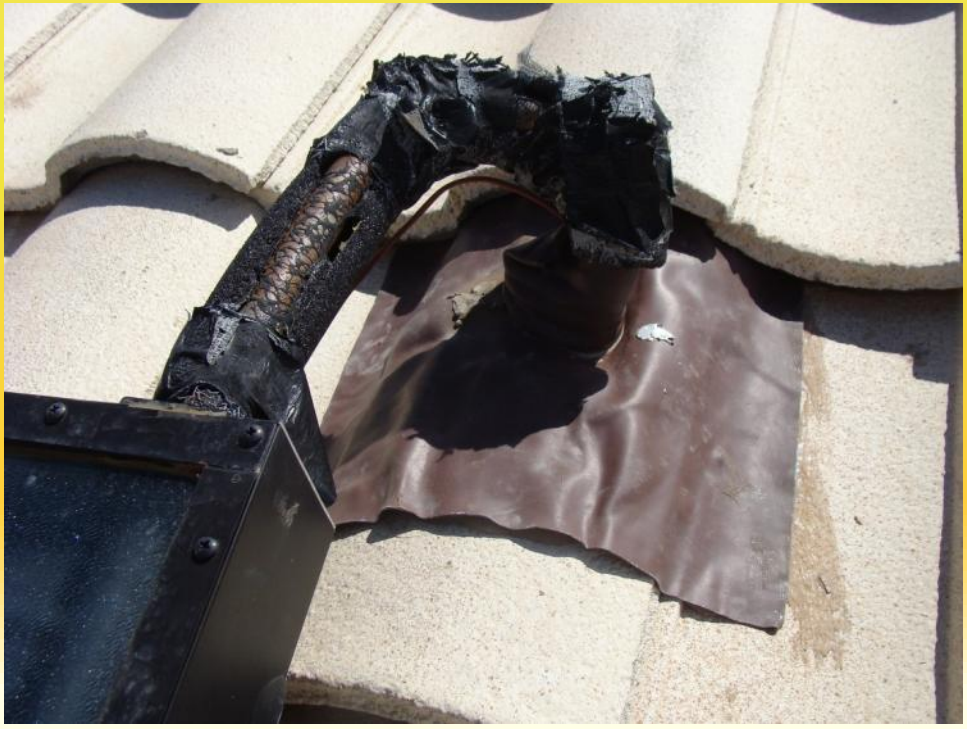
Non UV rated cable

16 Electrical Tape, Zip Ties, Low Temperature Insulation not used

- Zip / Cable Ties

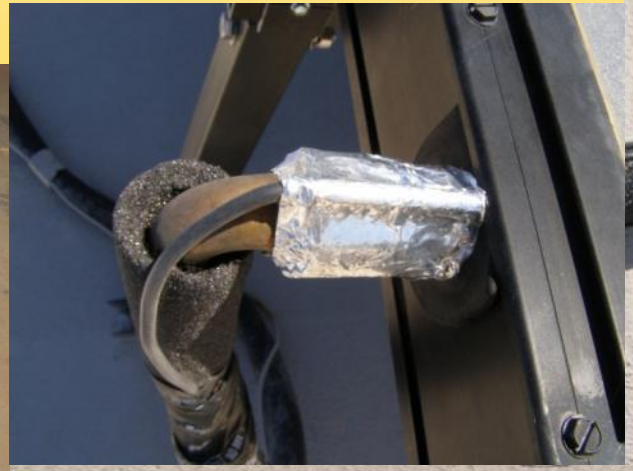
- Are not UV rated will get brittle and crack
- Birds peck at the hot out pipes and the thermistors, if there is a zip / cable tie it will break

- Low Temperature Insulation



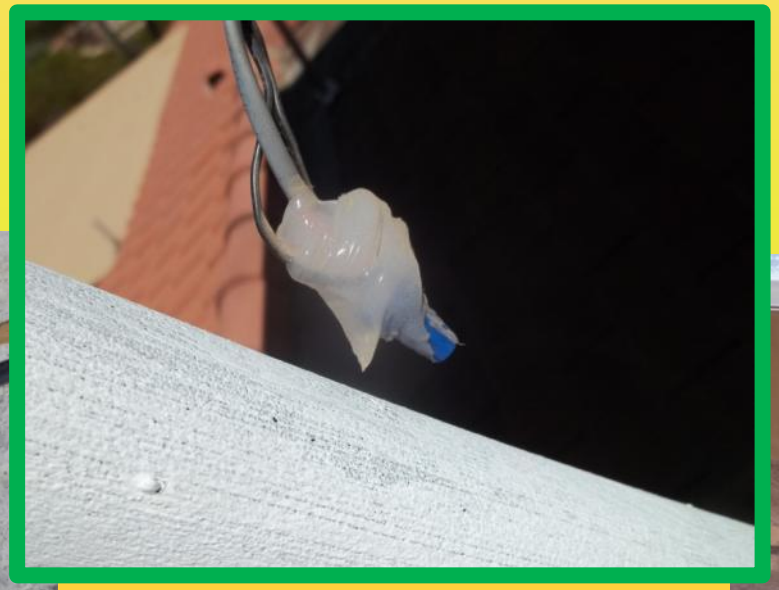
17 Sensor Wire and Control Sensor

- Degradation from the environment or system, incorrect wire sheathing, moisture damage, system operating temperatures, dirt, insects



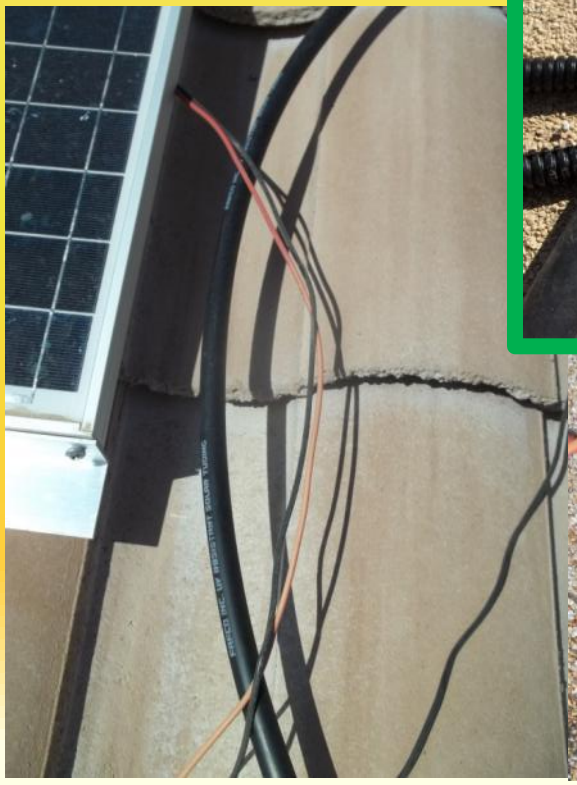
17 Sensor Wire and Control Sensor

- Wire Nuts
- Keep away from moisture
- UV rated Silicone
- Use Cable or Wire that can be used outdoors



18 PV powered

- A high temperature shutoff function to the circulation pump
- Systems are rare and are presently only seen from one manufacture in the field
- This is why it is important to use the solar manufactures product



19 Shading

- Collectors should be un-shaded between 9am and 3pm year round

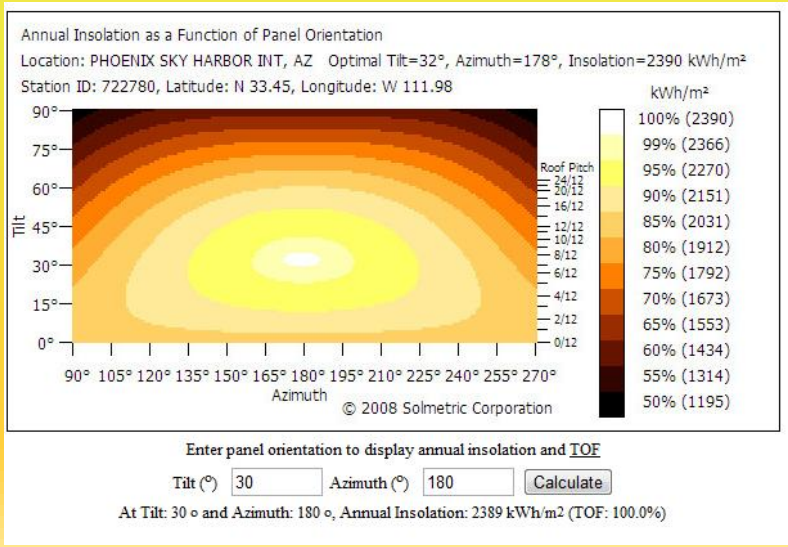
Left around 14:00,
Right around 15:30

- If needs be use a Solmetric SunEye, Solar Pathfinder or other device

20 Tilt and Azimuth

- The incentive payments are based on the OG-300 annual savings for the REC rights

Facing north, lots of shading



http://www1.solmetric.com/cgi/insolation_lookup/lookup.cgi

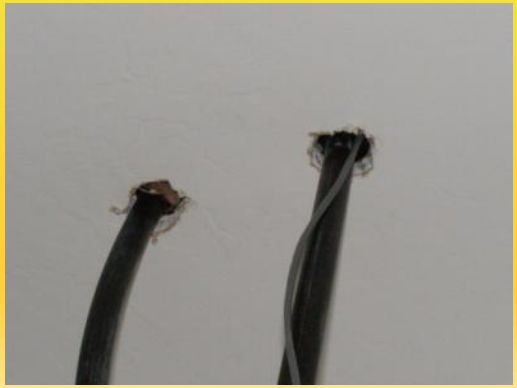
20 Tilt and Azimuth

	Azimuth*	Tilt	Incentive
	90-180	>0	0%
	30-90	0-33	80%
	0-30	0-17	80%
	0-30	18-47	100%
	0-30	48-75	80%
	30-90	0-33	80%
	90-180	>0	0%

* Defined as Variation E or W from South

Fire Stopping

- Required under various codes
- UPC 1506.2 and 1506.3
- Prevents passage of flame and gases
- Controls movement of insects and airflow



Note water damage

Building Penetrations

- Correctly incorporated flashings and sealants in joists, members, wall systems

Homeowner was left with 4 holes

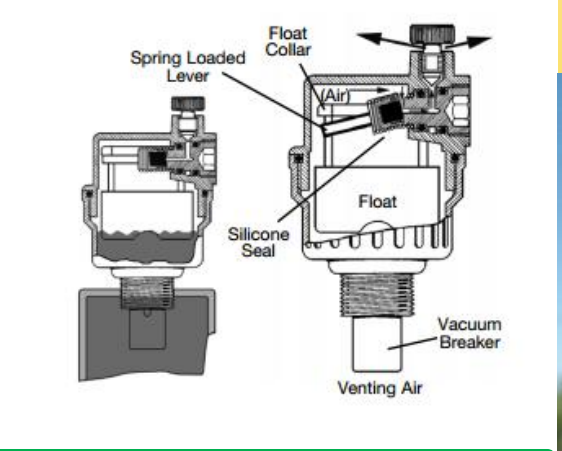
Escutcheons on roof is not an acceptable flashing

Incorrect flashing, including tar

?

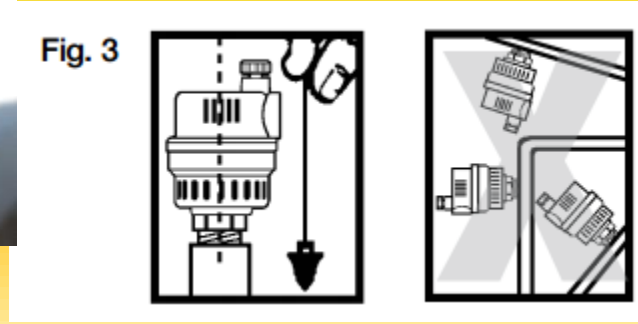
Automatic Air Vents

- Small vent cap on the top needs to be backed off two turns



- Needs to be installed vertical

35 degrees off vertical



http://media.wattswater.com/ES-FV-4M1.pdf

Contact Information

Daniel Aiello, President
Arizona Solar Center
DAiello@azsolarcenter.org

Geoff Sutton, Project Coordinator,
Arizona Solar Center
GSutton@azsolarcenter.org