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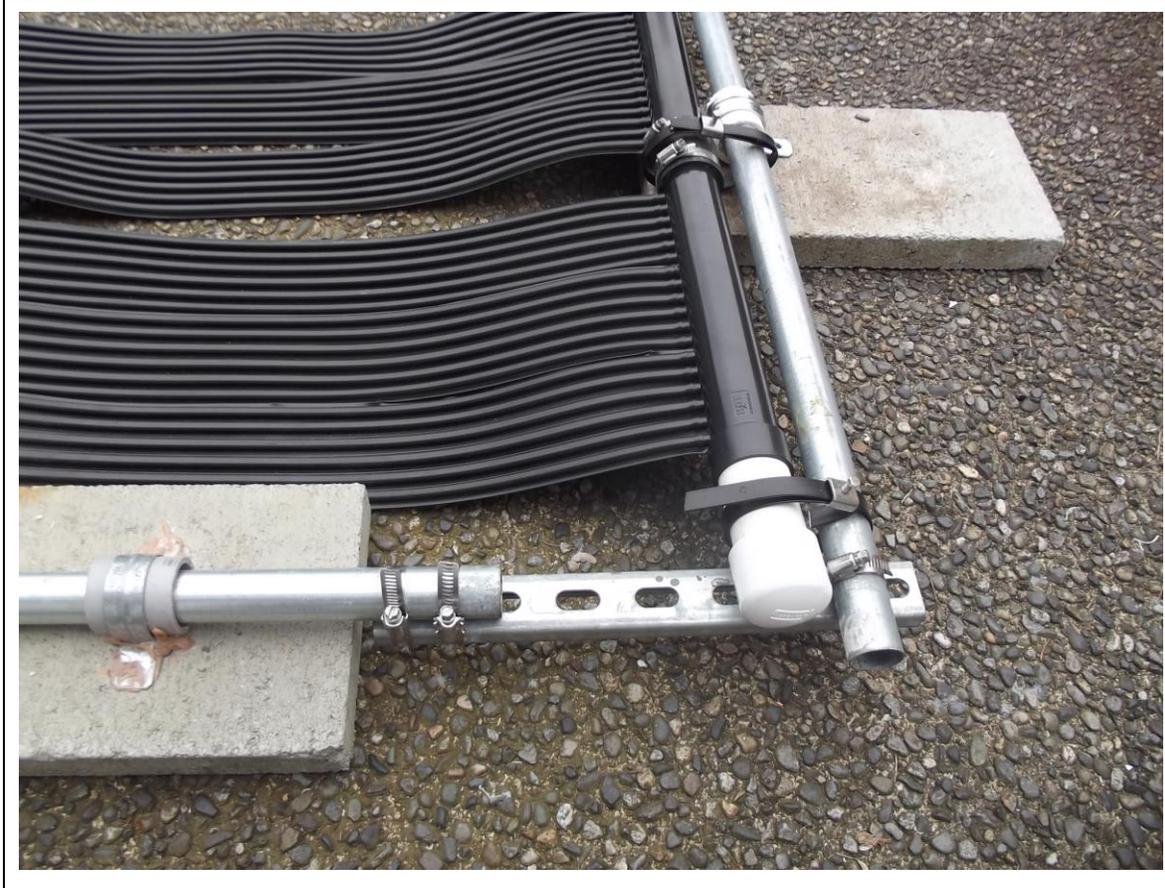
## **Safety First!**

Note: Most occupational health and safety boards require workers to be tied off with safety harnesses when working within a safety zone adjacent to the edge of the roof. Municipal projects often require the solar system to be set back from the roof edge just to prevent workers from veering too close to the edge of the roof. Guardrails are often the best way to safeguard a roof work space. Working on a flat roof can be more dangerous than working on a pitched roof because you are walking around freely and you can forget you are working at height. You will be tempted to walk backwards when taking measurements and unrolling solar panels. Never walk backwards. Fall protection training is available and to use safety equipment you are required to be certified in the use of ladders and fall protection techniques and equipment. These courses are inexpensive and only take one day of your life and they look good on your CV. Hot Sun assumes no responsibility for injury or death caused by the work described in this manual.

## **Ballasted Framework System for Flat Roofs.**

Ballasted means weighted. In this design concrete is used as ballast. A framework made up of 1-3/8" chain link fence top rail is weighed down to the roof with 1.5"x8"x16" patio stones or concrete block caps. Many substitute ballasts are possible.

Drawings of this design are available in the DRAWINGS section of [www.h2otsun.com](http://www.h2otsun.com)  
The direct link is [www.h2otsun.com/drawings.html](http://www.h2otsun.com/drawings.html)



The ballasts are spaced every second header along the top and every 3 feet on the edge bars parallel to the flow.



The edge framework can be clamped to the concrete pads with pipe/conduit clamps and plastic anchors or construction mastic via a sleeve of 1.5" pipe. The two hole pipe clamp and pipe sleeve can simply be glued to the concrete pad using construction mastic. Liquid Nails or Lepages Premium or the same Loctite Powergrab we commonly use when fighting gravity are brands of construction mastic. Do that gluing last. This loose sleeve connection provides some flexibility in positioning relative to the uneven roof surface. These chain link fence top rails can also be bent to follow the roof shape. It's

not a bad idea to glue some Powerstrip material to the underside of the concrete pads using construction mastic. Its best to do that gluing first and let it dry a day before handling. This allows water to run through and it protects the roof surface from direct contact with the concrete.



Cross members should be spaced about 10 feet starting from the header pipes. Pipe or conduit clamps with #20 all SS hose clamps can lock the cross members in place. U bolts are an option. Pieces of Powerstrip between the crossbar and side rail help to position the crossbar so it contributes to holding the solar panel down. Note the cross bar's purpose is to strengthen the framework. Holding the solar panel's fin-tubing in place is actually done with glue strip. Glue strips are 2 tube wide strips of Powerstrip upside down, perpendicular to and underneath the solar collector. Spacing on the glue strip is midway between cross bars and midway between headers and cross bars. Don't forget to lay out the glue strip before laying out the Powerstrips over top.



The ends of the glue strips go under the concrete ballasts and then tie off to the framework. Once the job is complete arrange all the fin tubing so it is straight and evenly spaced and then glue the glue strip to the underside of the Powerstrips using construction mastic. Construction mastic takes a while to dry.

Its best to attach headers to fin tubing before attaching headers to each other or to the framework. See main installation manual for header to fin tube attachment. When “alternating” headers as in this design (1 row of headers at each end) the female ends of the headers are glued to each other via 2” long pieces of 1.5” sch 40 PVC pipe. using grey PVC cement. It is not necessary to use primer on these glue connections because the glue reacts very strongly with the styrene header material. In fact its important to let the glue joints breathe before final plumbing assembly. If everything is glued up and sealed from air and let to sit the concentrated vapor can actually damage the headers from the inside . Once glued do not move the assembly for 24 hours. Its important the connections are not stressed before they fully set up. Its also very important to paint all PVC pipe and fittings with a brush not with spray paint. Acrylic paint is best for PVC but we have had good success with Tremclad. Oil base paint is not necessary. Use latex for easy clean up. The purpose of the paint is to protect the PVC glue joints from UV. Interestingly UV penetrates white PVC pipe and attacks the glue joints over a fairly short time frame. We speak from extensive experience on this issue. Your local paint expert does not have our level of experience and knowledge on this issue so believe this.



Corner assemblies are done by clamping an 18” piece of slotted unistrut under the two framework top rails (short for chain link fence top rails with a #20 all ss gear clamp. The chain link fence top rail that we use as our “edge rail” is attached to that 18” unistrut using two #32 all stainless steel gear clamps. This creates a space for plumbing to extend out from the headers. Note the two different ways to secure the free end of a panel bank where there is normally a cap. Either extend the cap out with a pipe and loop it same as the removable couplings between headers or hose clamp a strap bracket to the cap and loop around the top a rail and through the strap bracket’s slot.



The above assembly should occur every 10 Powerstrip headers or so. In other words one bank can be 10 or 12 headers but if you did a bank of 20 headers you would add another edge assembly down the middle with ballasts. That would take up a space of 8” for the ballasts. Since this design employs a single row of headers as opposed to staggering where there are two rows, it often makes sense to make two banks of solar panels instead of one big bank when dealing with more than 10 or 12 headers in a row.



Attach the headers to the top rails with loops of ppa coated ss strap and strap clamps to complete the loops. Make sure the headers can move back and forth with temperature change. Rotate the headers so the fin tube does not abrade on the concrete blocks. Leave room to mount plumbing on the ballasts. Don't commit the position of the ballasts until the last step. Don't apply the construction mastic until the system is plumbed and operating. Then and only then can you be sure of the position.

Winterizing a flat roof system is best done with a shop vac. Compressed air does not work because you need high volume and low pressure not the other way around. By blowing the entire system out not just the headers we eliminate the possibility of water expanding in the fin tubes and finding its way into the headers where it then freezes and causes damage.

Pay attention to the slope of the roof surface when designing a flat roof system. All roofs have some pitch. You want the water exiting the highest points and you want to avoid water travelling downhill from one bank to the next. Draw the roof and indicate the roof slopes and Hot Sun will recommend a layout. Sometimes this can be a bit of an art. The good news is that if you make a mistake it can almost always be remedied by venting air from any zone that doesn't flow properly with an automatic air vent. Check flow by checking collector temperature in hot sun. We like to use an infrared thermometer. It will surprise you to discover how many perceived problems don't actually occur. If the air can rise up and out naturally (air likes to rise in water so let it) then these systems tend to balance themselves out quite naturally. If one bank is a lot smaller than others then it may need a flow control valve on it to restrict flow to it and force more flow to the larger banks. Consult with Hot Sun.

Plumbing to and from collectors can often ride on the same ballasts. Use slip collars of pipe sizes one size larger than the pipe you are supporting. Think about pipes needing to be able to expand and contract with temperature. The slip collars only allow movement in one direction so right after a 90 degree bend sometimes you can't use a slip collar.



Notice no pipe support with slip collar here  
Notice piping and framework share ballasts.