

March 22nd, 2017

Rick Gentry, Executive Vice President
Quickscrew International Inc. (SolarRoofHook)
5830 Las Positas Road
Livermore, CA 94551
800-743-6916

SUBJECT: SolarRoofHook Products Compatibility with Commercially Available Solar Racking Systems

Dear Mr. Gentry,

It is common in the solar industry to use several different roof attachment methods, also known as stanchions or mounts, to connect a racking system to the roof. Due to the various types of roof structures and roof coverings, a single solution for attaching a racking system to all roofs is not feasible. For this reason, many racking system manufacturers do not provide any or all the mounting solutions required to install their products. Over the years, mount manufacturers have worked closely with racking manufacturers to ensure properly engineered connections between products. This compatibility evaluation is a continuation of that trend.

The connection of the racking system to the roof structure consists of the following components, starting from the top down:

1. Solar racking system,
2. Hardware to attach the racking system to the stanchion,
3. Stanchion, mount or tile hook,
4. Hardware to attach the mount to the roof.

The purpose of this report is to evaluate the connection between the racking systems (1) and the SolarRoofHook mounting products (3). For all instances, the hardware (2) that attaches the racking system (1) to the mount (3) is provided by the racking manufacturer. Any modifications other than those set forth in this evaluation will void all conclusions and compliance approvals of this report.

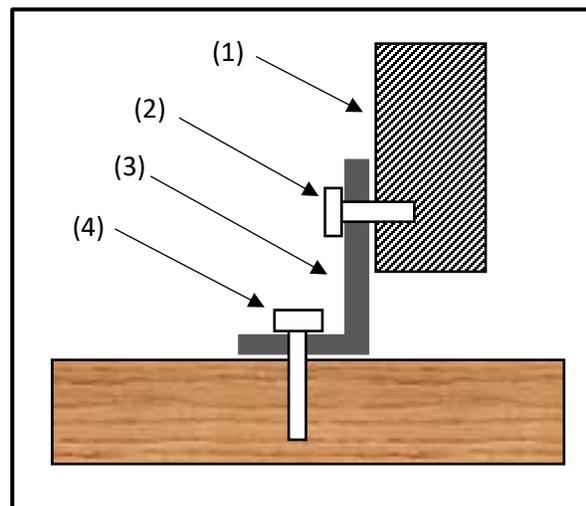


Table 1 lists all the SolarRoofHook (SRH) products reviewed. A compatibility matrix for these products and the evaluated rail systems is shown in Table 2. The SolarRoofHook products from Table 1 are compatible with all the solar racking products in Table 2. However, Table 2 includes exceptions, modifications, and limitations that must be adhered to in order to maintain compatibility. Compatibility was evaluated for physical fit and load limits not for electrical or NEC compliance. All of the products in table 1 utilize a slot to allow for vertical alignment of the racking system. The load limit of this connection was determined by the slip friction capacity of the connection. This is a conservative analysis, because if slip were to occur the motion would be ultimately resisted when the bolt makes contact with the end of the slot. The failure mode would then transition to yielding of the base material. Table 3 shows the critical slip forces associated with each racking manufacturer based upon the published torque requirement and material contact surfaces between the fastening hardware (2) or the mounts (3).

15894 17667 	15987 15987B 	17508 17509 17510 17511 	17520 17521 17522 17523 	17540 17541 17608 17609 	17548 17549 17550 17551 
17568 17569 17572 17573 	17574 17575 17576 17577 	17585 17586 17587 17588 	17592 17590 17591 	17626 17627 17628 17629 	17632 17633 17636 17637 

Table 1.

Racking Manufacturer	Racking Model Number	Solar Roof Hook Product Compatibility	Exceptions & Modifications	limitations
Snap-N-Rack	100	Compatible	Min 0.1" thick washer, tighten to max published torque value	Use the lowest value from SRH pull test data or Table 3.
IronRidge	X10, X100, X1000	Compatible	None	Use the lowest value from SRH pull test data or Table 3.
Unirac	SolarMount, SunFrame	Compatible	None	None
Everest	CrossRail	Compatible	None	Bolt must fit in slot

Table 2.

Table 2’s “Exceptions and Modifications” for the Snap-N-Rack product calls out the requirement of a 0.1” min thick washer. The washer is required because the 5/16” bolt supplied by Snap-N-Rack is small relative to the slots provided by the SolarRoofHook products. The inclusion of a heavy washer allows the fastener and its split washer to seat properly in the slot and provide an adequate bearing surface to transfer loads. The washer is required to have the following characteristics:

- 18-8 or 316 stainless steel
- Max inner diameter of 0.3625”
- Min outer diameter of 0.75”
- Min thickness of 0.1”

The limitations section of Table 2 for Snap-N-Rack and IronRidge, reflects the fact that some slip values from Table 3 are lower than the published maximum values from pull test data for the products in Table 1. For that reason, when determining system capacities the designer needs to use the lesser value from either Table 3 or the published test data for the products in Table 1. Please note, these are ultimate loads and the designer will need to apply all appropriate factors of safety.

The fastening hardware for the Everest racking system uses an M10 bolt. A fit test was conducted with this size bolt and the 10 mm slot of various SolarRoofHook products and the bolt could pass through the slot with no issue. In most circumstances, the Everest M10 bolt is compatible with the SolarRoofHook products. However, due to tolerance stack up, it is possible, however unlikely, that an interference occurs and the bolts do not fit in the slot of the stanchion or tile hook. In that case, those components would fail the compatibility requirement.

Racking Manufacturer	Bolt Size	Published Torque [ft-lbs]	Force applied by bolt [lbs]	Slip force Steel/AL [lbs]	Slip force Steel/Steel [lbs]
Snap-N-Rack	5/16"	16	3072	1874	2396
IronRidge	3/8"	21	3333	2033	2600
Unirac	3/8"	30	4800	2928	3744
Everest	M 10	26	3962	2417	3091

Table 3.

The “Force applied by bolt” values from Table 3 were determined using the following equation:

$$F = 12 * T / (k * D)$$

$$T = \text{Torque}$$

$$k = \text{Torque Coefficient, .20}$$

$$D = \text{Nominal Bolt Diameter}$$

The slip force was calculated using the following equation:

$$F_{slip} = \mu * F$$

$$\mu = \text{Friction Coefficient}$$

$$F = \text{Force Applied by Bolt}$$

The friction coefficient used for the “Slip force” calculations in Table 3 for “Steel/AL” and “Steel/Steel” were 0.61 and 0.78 respectively. These values were provided by Marks’s Standard Handbook for Mechanical Engineers 10th edition.

All testing for the SolarRoofHook products was conducted by Applied Material & Engineering Inc. located at 980 41st St. Oakland, CA 94608. All test reports and load values are available on the SolarRoofHook website.

The fastening hardware for all the racking systems in Table 2 is stainless steel. Mounts 15891, 15894, 15897, 17592 from Table 1 are made of aluminum and therefore their test data is to be compared to the “Steel/AL” column of Table 3, when required by Table 2. All other mounts in Table 1 are stainless steel and therefore their test data is to be compared to the “Steel/Steel” column of Table 3, when required by Table 2.

Please note, the load values discussed in this report are ultimate loads and do not include a factor of safety. All code required factors of safety are to be applied to the values in Table 2 as well as to the SolarRoofHook test data.

This report does not include an evaluation of the racking, the stanchions, or the electrical bonding between components. This report is in no way intended to be a complete engineering analysis of the entire system nor its attachment to the building structure. It does not replace or supersede engineering requirements set forth by the code and local jurisdictions. Finally, this report is only relevant the products and revisions evaluated at the time of the publishing of this report and is not applicable to future derivations of these products.

The compatibility approvals in this report do not provide evidence nor a guarantee that the products themselves, the racking, nor the roofing to which they are attached will not be damaged by loads less than the maximum identified in testing or in Table 3. The products in Table 1 do deflect and yield under load and it is the responsibility of the design engineer of the system to determine the appropriate factors of safety and the allowable deflection for the required design load.

Please feel free to contact me with any questions about the findings or the approach used for this evaluation.

Sincerely,



Samuel Truthseeker P.E.
Founder and Principal Engineer

