

SnapNrack™

PV Mounting System

Ground Mount



The Only Wholesale
Distributor You'll Ever Need

2009

Ground Mount Manual

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Letter of Certification



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STRUCTURAL CALCULATIONS

PREPARED FOR:

PROJECT TYPE:

SnapNRack Pipe Ground Mount Racking System

DESIGNER OF RECORD:

AEE Solar, Inc.
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Job No. 7456
January 23, 2008

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1. Introduction

1.1 Overview of the SnapNrack System

The SnapNrack system, from AEE Solar, is a low profile, visually appealing, photovoltaic (PV) module installation system. This innovative suite of racking components simplifies the process of installing solar modules and shortens install times, which lowers installation costs.



SnapNrack systems, when installed in accordance with this manual, will be structurally adequate for the specific installation site and will meet the 2006 International Building Code, as well as local building codes.

The SnapNrack installation system is a set of engineered components that can be assembled into a wide variety of PV mounting structures. It is designed to be installed by qualified solar installation technicians. With SnapNrack you will be able to solve virtually any PV module mounting challenge.

1.2 Overview of this Manual

This manual describes the installation procedures for ground (pipe) mounting for AEE Solar photovoltaic (PV) arrays.

Review this entire manual before installing the SnapNrack system.

Throughout this manual you will see highlighted notes which will provide you with different types of information:



Notices indicate important information to help with the installation or to avoid potential damage to the structure or components.



Cautions indicate a potential for property damage, personal injury, or death.

For questions or to request a pdf version of this manual, call your local AEE Solar representative. Find contact information for all AEE at www.AEEsolar.com.

1.3 Your responsibility as installer

Comply with all applicable local or national building codes, including any that may supersede this manual.

- Make sure that the SnapNrack components and other products are appropriate for the particular installation and the installation environment.
- Use only AEE Solar supplied parts.
- Ensure safe installation of all electrical aspects of the PV array.



If it is raining, or if you anticipate any potentially dangerous conditions, do not proceed with the installation.

1.4 Support

For help with your installation, call the nearest AEE Solar engineering support office.

You can find contact information for AEE Solar support by visiting www.AEEsolar.com and clicking on *Contact Us*.

2. Prepare for the installation

2.1 Introduction

The SnapNrack system is designed to be installed with a minimum number of footings resulting in a significant labor savings over traditional installation methods. The system integrates with ordinary 1-1/2" schedule #40 galvanized pipe. This ground mount solution includes virtually everything needed to install modules with vertical posts up to 5' from grade. You will only need pipe, pipe fittings, concrete and basic construction skills to complete the installation. This fully engineered system utilizes industrial-grade, SnapNrack support rails and module clamps.

2.2 Identify SnapNrack components

Make sure you have all the necessary SnapNrack system components—see photos—needed to complete the installation.



Ground rail



Snap-in channel nut



*SnapNrack pipe to rail clamp
assembly*



Universal end clamp

2.3 Obtain installer supplied tools and materials

Make sure you have all the necessary additional hardware components, tools, and other material that are needed to complete the installation.

These include:

- Post hole digger
- Wheelbarrow / shovel
- String line
- Line level or builder's level
- Framing square
- Tape measure
- Pipe cutter
- Pipe wrenches (x2)
- Mallet or large hammer
- Drill
- Felt-tip marking pen
- ½ inch box / open end wrench
- 3/8 inch ratchet wrench with ½ inch socket
- Tools for attaching grounding hardware
- Reciprocating saw (such as a Saw-z-all) for trimming rails
- Metal file for finishing trimmed rails



Module end clamp assembly



Module mid clamp assembly

2.4 Survey the site

Measure the installation area and develop an accurate drawing identifying any obstacles such as buildings, ditches, and trees.

If plans are available, check to make sure that the plans match the layout.

Review the shading pattern across the installation area from nearby structures, trees, etc.

Identify any restricted access areas as required by the local jurisdiction.



Before you dig any holes, contact all utilities in the area to locate underground lines, pipes, and wiring.

Determine the design wind speed and site specific conditions for the site and reference the Rail Span Calculation table in section 7, *Appendix* to determine the maximum allowable rail span for this site

If you are unsure about the local design wind speed, consult with the local building jurisdiction.

2.5 Lay out system on the ground

Using the information collected in the site survey, complete a system layout showing array location and distances from key features. Include any information necessary for the permitting process.

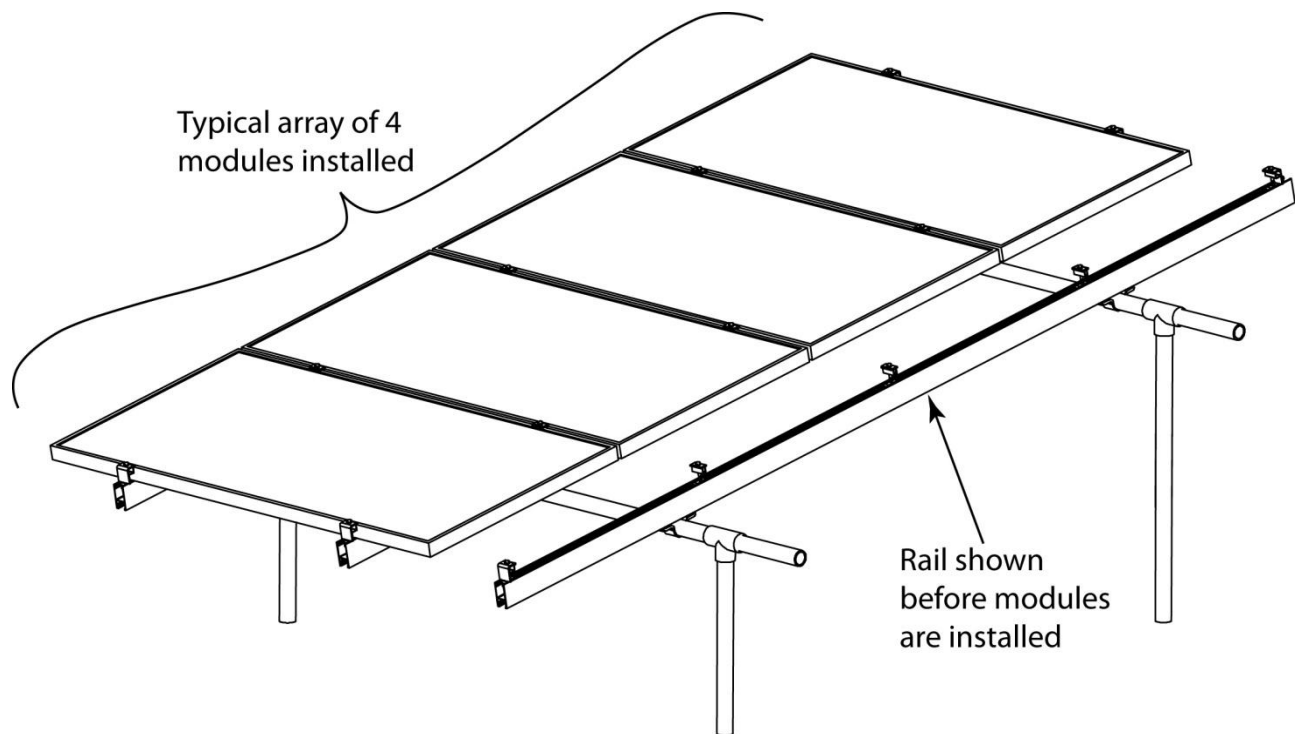
The following definitions are used to describe array layout designs:

- Module length—the measurement along the longest side of the module frame
- Module width—the measurement along the shorter side of the module frame
- Module thickness—the measurement of the thickness of the module

Typically, most ground-mount arrays are installed in a *landscape* configuration, with the long side of the PV modules horizontal and the rails running up the slope. This is different from roof mount installations which typically are in a *portrait* configuration with the long side of the module running up slope and the rails running horizontally.

When laying out the array, be sure to leave space for the module clamps on the rails.

Module mid clamps (see photo on page 5) are installed between modules in a row and require $\frac{1}{2}$ inch of space between the modules.



Array installation showing landscape orientation

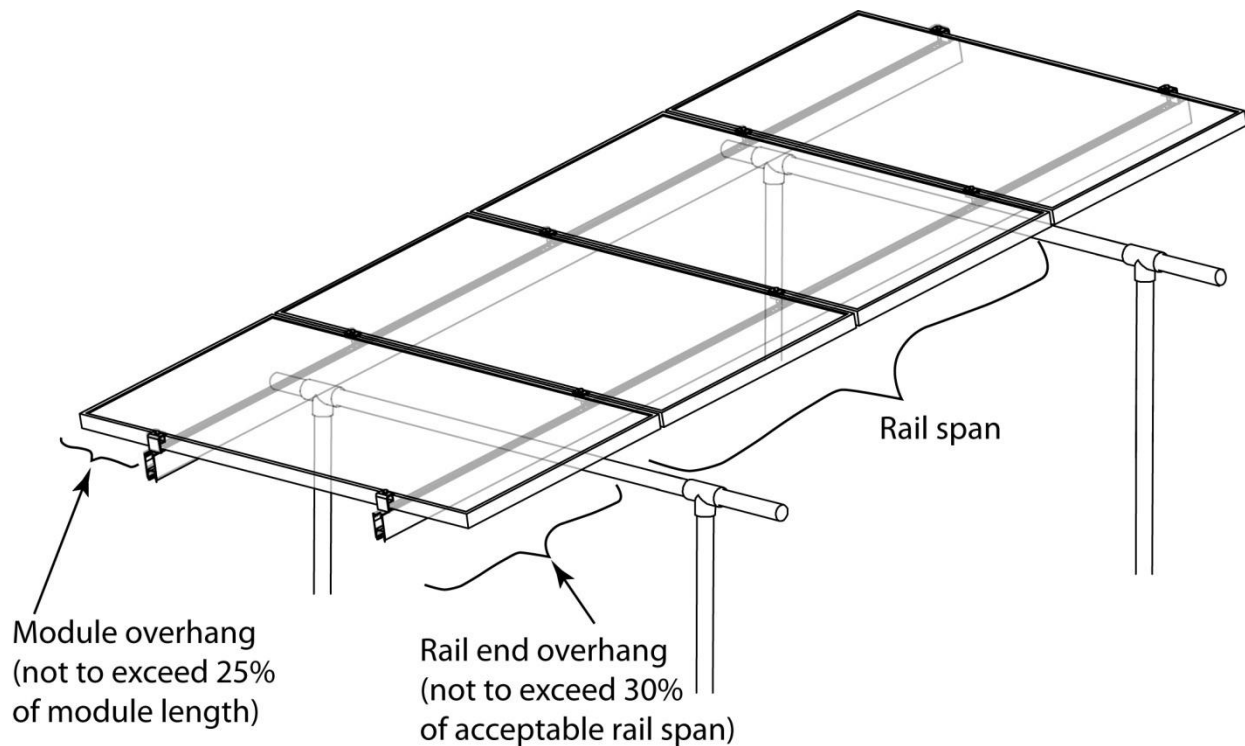
Standard module end clamps (see photo on page 5) require 1½ inches of extra rail to extend past the end of the module frame. If you are using universal end clamps (see photo on page 4), the rail can be trimmed flush with the module frame. The space between rows of modules is not critical, but it is common for rows of modules to be installed so that the modules are flush with each other.

Layout rails such that module frame ends do not overhang mounting rails by more than 25% of total module frame length.

Verify that mounting rail spans are in accordance with the Rail Span Calculations table in the section 7, *Appendix* at the back of this manual.

Verify that rail ends do not overhang by a distance greater than 30% of the acceptable rail span specified in the same table.

Submit array plans to local permitting jurisdiction and proceed with the layout only when all permits for the project have been granted by the authority having jurisdiction.



Locations of rail end and module overhang

3. Install pipe frame

3.1 Excavation of the footings

Excavate core footings—typically 12 inches in diameter by 42 inches deep. See engineering design plans in the back of this manual for recommended hole depth.

Footing size may vary depending on job specific conditions. All conditions should be reviewed by customer's site engineer.



To speed up installation, it is recommended to use a 12 inch power auger to dig the footings.



Before you dig any holes, make certain you have contacted all utilities in the area and have them mark underground lines, pipes, and wiring.



Digging holes with power auger



Install vertical pipes in concrete footings

3.2 Set grade stakes for vertical pipe

Determine the proper angle for the module array and install grade stakes. Do not exceed 5 feet of vertical post length from grade.

Install supports braces to hold the pipe at the proper fixed angle until the footings are poured.

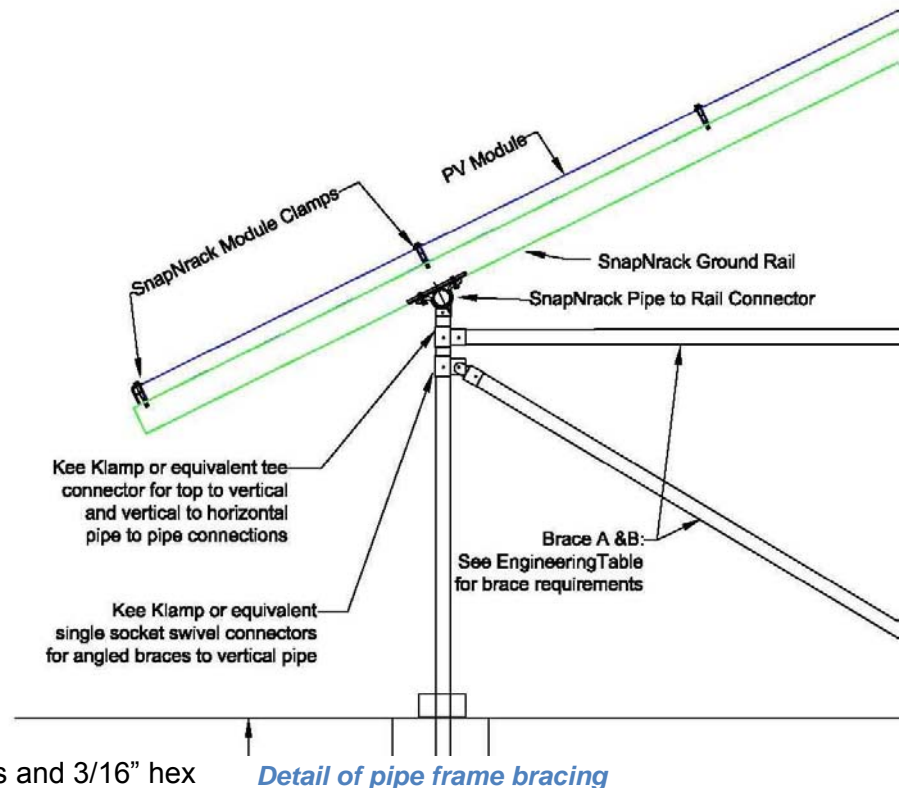


Check pipe frame levels

We recommend the use of a horizontal brace until concrete sets. Install the end braces and then set up a string line to insure alignment. Place supports at a distance that will allow the pipe beam to be supported without sagging.

3.3 Install pipe

Pipe support beams and vertical post supports can now be assembled and rest on the support bracing. Using two pipe wrenches and 3/16" hex wrench, the pipe and support legs can be assembled.



3.4 Set concrete footings

Align the end of the channel using a string line. Tighten all the pipe connections and cross brace hardware and re-check alignment of the vertical pipe supports.

Pour concrete into the footings. Tap the concrete to ensure contact with the vertical pipe support. Remove the support bracing after the concrete sets. Concrete requires 28 days to reach full strength or rated PSI.



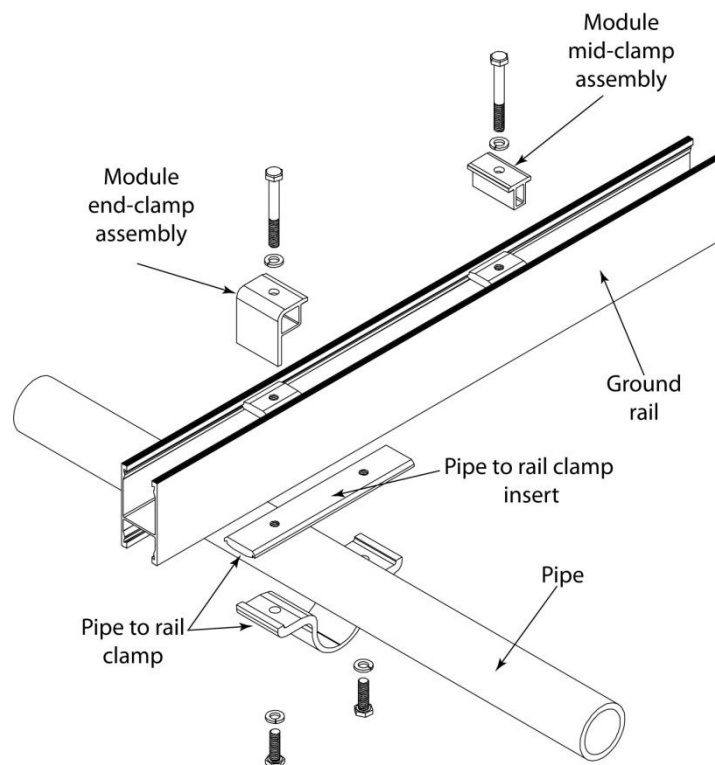
4. Install rails

4.1 Attach pipe clamps

Snap in SnapNrack pipe to rail clamp insert and attach rails to pipe frame as shown in the detail diagram.

Inserts are designed to snap in and out of rail channels. This enables you to quickly assemble systems without having to slide inserts from the end of the rail.

**★ Always cut rails to the needed length.
Never use a rail splice to join two shorter
rails in a ground mount installation.**



Detail of pipe to rail connection



Attach rails to pipe frame



Attach rails using SnapNrack pipe clamps

5. Install modules on rails

5.1 Prepare clamping hardware

Preassemble module clamping hardware. Each clamp assembly consists of a module clamp, a channel nut, and a 5/16 inch bolt and split lock washer.

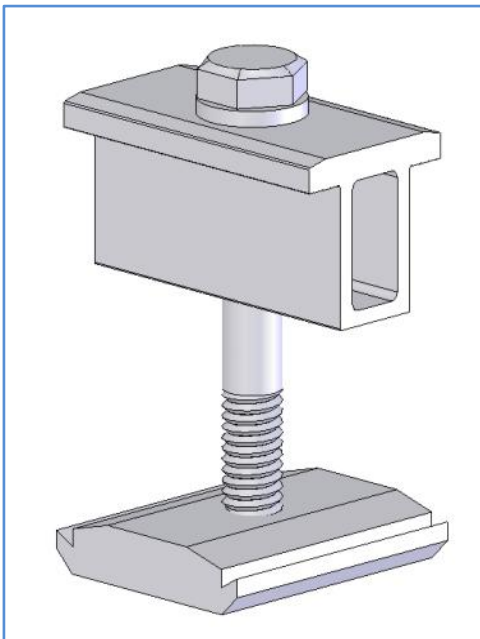
The end clamp size and bolt length are specific to the thickness of the module. Make sure you have the right size of each of these components for the modules being installed.

To speed the installation, measure out the location of mid-clamps and end clamps on rails with a tape measure.

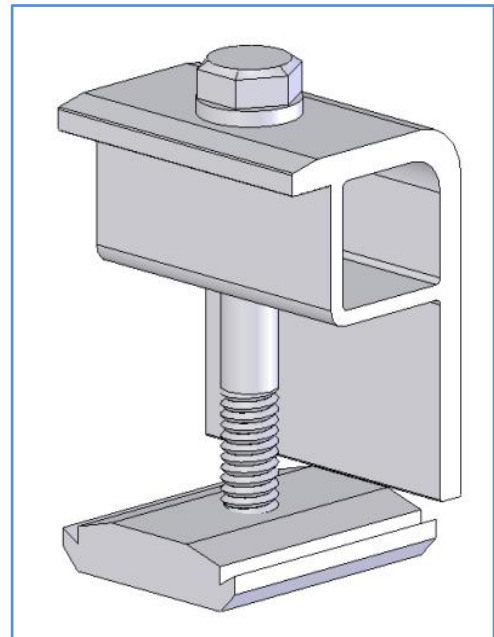
Snap in clamps on all the rails so the clamps will be ready when you place the modules.



SnapNrack ground mount rail and module clamps



Module mid clamp



Module end clamp

5.2 Set first module

Place the first module, taking care to line the module up to the rails.



The rest of the installation will go more smoothly if you take the time to get the first module lined up properly.

Tighten the two end clamps on the first module and snap in the next two clamps, which will typically be mid clamps, to prepare to receive the next module.

Place all the bottom modules first and align them with a string line or laser. We recommend you leave a 1/8" gap between the rows of modules to allow for thermal expansion.

Proceed to the next row and work your way up.

When you place the last module in the row, secure it with end clamps to finish the row and repeat the process for the next row of modules.



Aligning first row of modules



First row of modules installed



Three rows of modules installed

5.3 Connect wiring

Connect module leads and train the wires into the rail channels as the modules are being installed. This will ensure a clean electrical installation with no dangling wires. Use module lead clips as necessary to insure that module leads are secured to module frames until they drop into the rail channel.

5.4 Connect grounds

Install grounding hardware per PV module manufacturer's specifications.

It is often convenient to install grounding hardware as modules are being installed but this will vary with the type of PV modules used.

5.5 Trim rails

If you are using standard end clamps, trim rail ends to leave about 1½ inches of extra rail extending past the end of the module frame. If you are using universal end clamps, the rail can be trimmed flush with the module frame.

File off rail ends with a hand file and clean up metal shavings.



Connect grounds



Careful array layout planning will enable you to cut rails to the correct length before they are installed and eliminate the need for trimming.

6. Final check

6.1 Kick the tires

Grab module frames and gently push up and down in various locations around the array to ensure that nothing moves.

6.2 Check tightness of all bolts

Check all bolt torques to ensure that all 5/16 inch hardware is tightened to 10 ft-lbs.

6.3 Check wires and grounds

Check under the array to ensure all wires are tucked up with module clips along the module frames and trained into the cable channels in the rails.



Check all bolts



Check under the array for loose wires

7. Appendix

7.1 Rail span tables



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SnapNRack Pipe Ground Mount Racking System

Date: January 23, 2009
To: Tim Vaughn
AEE Solar, Inc.
From: Matthew Gilliss
Taylor & Syfan Consulting Engineers
Project: Various Ground Mount Configurations
T&S Job No.: 7456

Subject: Project Summary, SnapNRack Ground Mount Racking System

Tim,

The attached pages contain the structural calculations for the adequacy of the proposed ground mount solar racking system. This calculation packet validates the design of AEE's racking system as proposed in their drawing(s) (GND PIPE 01, 02, & 03 dated July 23, 2008). The calculations have been performed in accordance to the 2007 California Building Code (CBC), the governing structural code in California which is based on the 2006 International Building Code (IBC) and also references the ASCE 7-05 Standard. Several factors contained within these codes govern the overall design of the racking system which has been designed (under certain conditions to be discussed later) to withstand forces due to the racking systems own weight, the weight of the solar panels, and wind forces which may induce both compressive and uplift forces on the panels and the racking system (Because of the structures light weight and larger surface area, wind governs over seismic by inspection).

In terms of variable conditions for the racking system, the follow page contains a chart that can be used to determine maximum spans and spacings based on the solar array's overall size and tilt angle. This chart is a summary of the following pages which include the calculations for each component under each condition.

Every possible racking configuration labeled in the following chart has been analyzed and is summarized within this chart. Because there are so many different possible configurations, the most common, and/or the governing cases have been provided in this report as example calculations. Site specific racking configurations with calculations producing the exact numbers shown in the following chart can be provided upon request.

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SnapNrack Pipe Ground Mount Racking System

Please note that all sizes, material specifications, and weights have been provided by AEE Solar. AEE Solar has also provided estimated soil values used to calculate the size and depths of the footings. It is the responsibility of AEE Solar to verify that the site specific soil conditions match or exceed the estimated values given within this report. All waterproofing issues involved with the racking system are the responsibility of AEE Solar.

Please feel free to contact me with any questions or concerns. Thank you.

Sincerely,

A handwritten signature in blue ink that reads "Matthew B. Gilliss".

Matthew B. Gilliss
Project Engineer
Taylor & Syfan Consulting Engineers

GROUND MOUNT DESIGN CHART

DATED ISSUED: 7-22-08

LAYOUT DETAILS 85 MPH DESIGN WIND SPEED									
TILT ANGLE	MAX RL	MAX RS	MAX RO	MAX PS	MAX PO	PIER DEPTH (SHORT/TALL LEG)	A Req'd	B Req'd	C SPACING
0-15 DEG	135"	10'	32"	10'	2'	3' / 3'	NO	NO	NOT REQ'D
16-30 DEG	135"	10'	32"	10'	2'	3' / 4'	YES	NO	EVERY 3RD BAY
31-45 DEG	135"	9'	32"	8'	2'	3' / 4'	YES	YES	EVERY OTHER BAY
0-15 DEG	172"	10'	32"	8'	2'	3' / 4'	YES	NO	EVERY 3RD BAY
16-30 DEG	172"	10'	32"	8'	2'	3' / 4'	YES	NO	EVERY OTHER BAY
LAYOUT DETAILS 105 MPH DESIGN WIND SPEED									
0-15 DEG	135"	10'	32"	8'	2'	4' / 3'	NO	NO	NOT REQ'D
16-30 DEG	135"	8'	32"	8'	2'	3' / 4'	YES	NO	EVERY 3RD BAY
31-45 DEG	135"	8'	32"	8'	2'	4' / 5'	YES	YES	EVERY OTHER BAY
0-15 DEG	172"	9'	32"	8'	2'	3' / 4'	YES	NO	EVERY 3RD BAY
16-30 DEG	172"	9'	32"	8'	2'	4' / 5'	YES	NO	EVERY OTHER BAY

Rail Span Calculations

CASE	v	Kd	I	Kh	Kzt	q	G	Cn	Af	F	F (normal)	lbs./Panel	F (Vert.)	Max Uplift	Max Comp./Panel	Max Comp./Pl.	Max Uplift/ Pl.
1	85	0.85	0.87	0.85	1.00	11.63	0.85	2.6	-	25.69	6.65	99.06	25.64	-0.16	68.64	34.32	-0.08
2	85	0.85	0.87	0.85	1.00	11.63	0.85	2.6	-	25.69	11.66	173.76	78.88	53.08	121.88	60.94	26.54
3	85	0.85	0.87	0.85	1.00	11.63	0.85	2.6	-	25.69	18.17	270.63	191.36	165.56	234.36	117.18	82.78
4	105	0.85	0.87	0.85	1.00	17.74	0.85	2.6	-	39.21	10.15	151.16	39.12	13.32	82.12	41.06	6.66
5	105	0.85	0.87	0.85	1.00	17.74	0.85	2.6	-	39.21	17.80	265.14	120.37	94.57	163.37	81.69	47.29
6	105	0.85	0.87	0.85	1.00	17.74	0.85	2.6	-	39.21	27.72	412.97	292.01	266.21	335.01	167.51	133.11

Case 1: 85 MPH Wind Speed (3 Second Gust); 15 Degree Panel Tilt

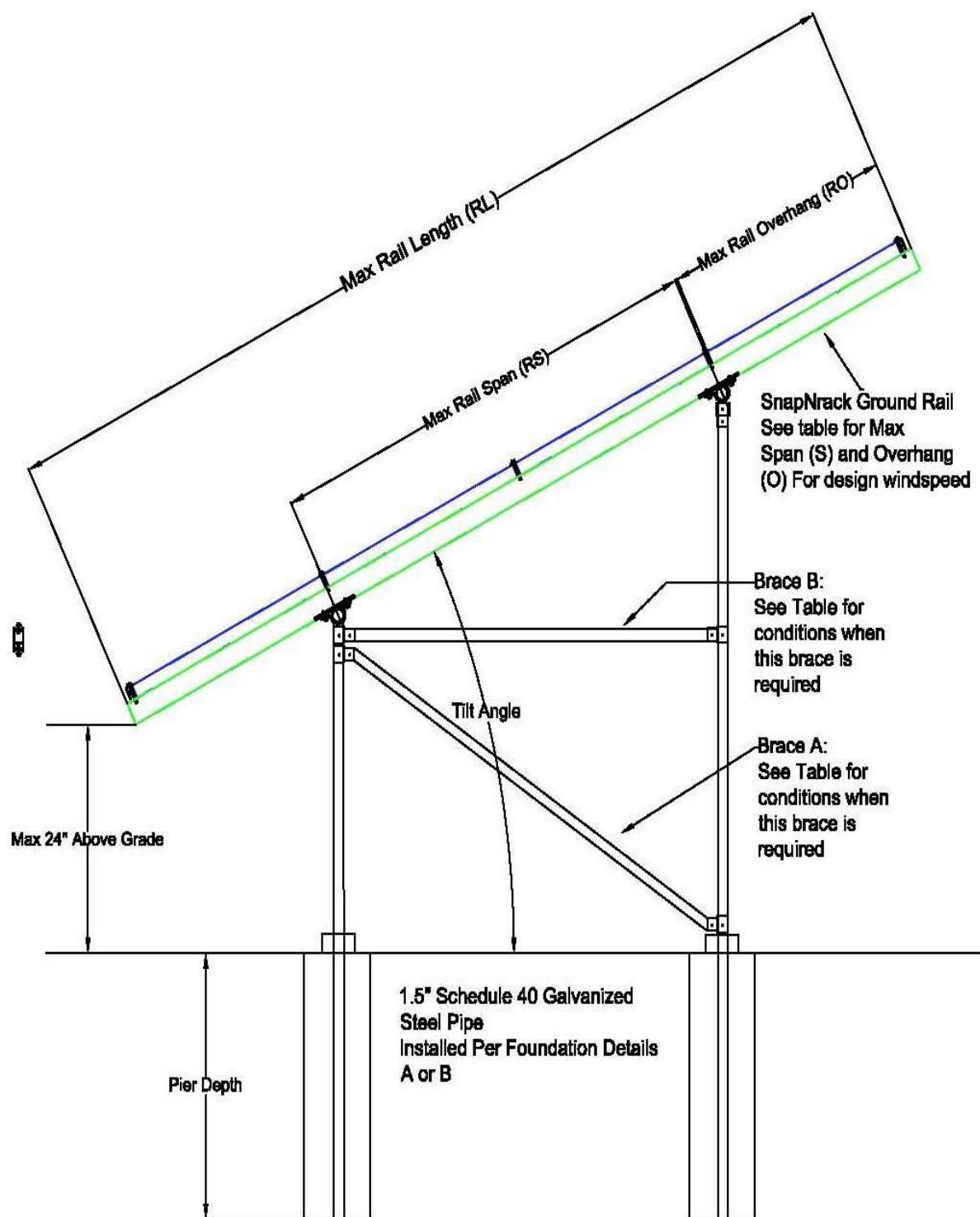
Case 2: 85 MPH Wind Speed (3 Second Gust); 30 Degree Panel Tilt

Case 3: 85 MPH Wind Speed (3 Second Gust); 45 Degree Panel Tilt

Case 4: 105 MPH Wind Speed (3 Second Gust); 15 Degree Panel Tilt

Case 5: 105 MPH Wind Speed (3 Second Gust); 30 Degree Panel Tilt

Case 6: 105 MPH Wind Speed (3 Second Gust); 45 Degree Panel Tilt





10 year Limited Product Warranty and 5 year Limited Finish Warranty

Limited Warranties: AEE Solar, Inc., ("AEE Solar") warrants to the original end-user of the Product ("Purchaser") at the original installation site ("Site") that the SnapNrack™ PV module mounting system (the "Product") shall be free from defects in materials and workmanship for a period of **ten (10) years** (the "Limited Product Warranty"), and the Product's anodized finish shall be free from visible peeling, cracking or chalking under normal atmospheric conditions for a period of **five (5) years** (the "Limited Finish Warranty") (collectively, the "Limited Warranties"). The Limited Warranties shall commence on the earlier of 1) the date the installation of the Product as part of the original solar electric system (the "System") is complete, or 2) thirty (30) days after AEE Solar ships the Product to the authorized distributor or retailer. If within the warranted period the Product is determined by AEE Solar, based on reasonable evidence of a defect provided by Purchaser, AEE Solar will, at its sole option, (a) repair the Product or replace it with an equivalent product, or (b) take back the Product and refund the purchase price to the Purchaser.

Conditions, Limitations and Exclusions: AEE Solar is not responsible for, and Purchaser hereby agrees to bear, the costs of any on-site labor and any costs associated with the installation, removal, reinstallation, shipping or transportation of the Product or any components thereof for replacement or service. (Note: the foregoing may not be applicable to consumer sales in certain jurisdictions.) AEE Solar may, at its sole discretion, use new, remanufactured or refurbished parts or products when repairing or replacing your Product under this warranty. Any exchanged or replaced parts or products will become the property of AEE Solar. This warranty is extended only to the original end-user purchaser and is not transferable, provided that as long as the System has not been physically moved or altered, any subsequent owner of the System shall have the same Limited Warranty rights as the original Purchaser.

The Limited Warranties do not apply to Products installed (a) outside the U.S.A. or Canada, or (b) in corrosive atmospheric conditions, including, but not limited to chemical fumes, salt spray, acidic rain or surface temperatures which exceed 200 degrees Fahrenheit. The Limited Warranties do not cover damage to the Product's anodized finish caused by moisture, condensation, or other contamination resulting from improper storage, packing or handling. The Limited Warranties do not cover damage to the Product that occurs during shipment or prior to or during installation. The Limited Warranties shall be void if the Product is not installed in accordance with AEE Solar's written installation instructions for the Product, or if the Product has been modified, repaired, or reworked in a manner not previously authorized by AEE Solar in writing, or if

SnapNrack Warranty (Feb. 2009)

the Product is installed in an environment for which it was not designed.

As used herein, the term "chalking" refers to the powdery residue formed by the breakdown of the anodized finish, and excludes any foreign residue deposited on the finish by the surrounding atmosphere, including, but not limited to, soot, dust, plaster, cement, etc. The Limited Finish Warranty is void if normal maintenance and cleaning practices are not followed by Purchaser as specified by AAMA 609 & 610-02 — "Cleaning and Maintenance for Architecturally Finished Aluminum," a copy of which is available from AEE Solar or from www.aamanet.org.

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TO THE FULLEST EXTENT PERMITTED BY LAW, AEE SOLAR DISCLAIMS ANY LIABILITY WHATSOEVER FOR ANY SPECIAL, INCIDENTAL, CONSEQUENTIAL OR PUNITIVE DAMAGES ARISING FROM THE USE OF THE PRODUCT, OR FOR OTHER LOSS OR INJURY RESULTING FROM ANY CAUSE OF WHATSOEVER ARISING OUT OF OR RELATED TO THE PRODUCT, INCLUDING BUT NOT LIMITED TO DAMAGE OR INJURY TO PERSONS OR PROPERTY, DAMAGES FOR LOST SERVICES, COST OF SUBSTITUTE SERVICES, LOST PROFITS OR SAVINGS, AND EXPENSES ARISING OUT OF THIRD PARTY CLAIMS.

AEE SOLAR'S MAXIMUM LIABILITY UNDER ANY THEORY OF LIABILITY, WHETHER EXPRESS, IMPLIED OR STATUTORY, OR FOR ANY MANUFACTURING OR DESIGN DEFECTS, IS LIMITED TO THE ORIGINAL PURCHASE PRICE OF THE PRODUCT.

To the fullest extent permitted by law, Purchaser's remedies for breach of warranty, or for manufacturing or design defects, shall be only as stated herein. AEE Solar's Limited Warranty covers only the Product, and not related items such as PV modules, roof flashings and specialized clamps. Manufacturers of such related items typically provide written warranties of their own.

Warranty Procedure: Purchaser should contact the distributor or retailer where the Product was purchased, or if unable to do so, contact AEE Solar customer service at: (800) 777-6609, customerservice@aesolar.com or AEE Solar, Inc., P.O. Box 1155 Redway CA 95560.