City of Belle Isle

Universal Engineering Sciences 3532 Maggie Blvd., Orlando, FL 32811
Tel 407-581-8161 * Fax 407-581-0313 * www.universalengineering.com

PERMIT CARD – PLEASE POST AT JOB SITE

THIS DOCUMENT BECOMES YOUR PERMIT WHEN PROPERLY VALIDATED

Per FBC 105.3.3: An enforcing authority may not issue a building permit for any building construction, erection, alteration, modification, repair or addition unless the permit either includes on its face or there is attached to the permit the following statement: "**NOTICE: In addition to the requirements of this permit, there may be additional restrictions applicable to this property that may be found in the public records of this county, and there may be additional permits required from other governmental entities such as water management districts, state agencies, or federal agencies**." The issuance of this permit does not grant permission to violate any applicable City, Orange County, State of Florida and/or Federal codes and/or ordinances. Separate permits are required for Signs, Roofing, Electrical, Gas, Plumbing and Mechanical services. This permit becomes VOID if the work authorized is not commenced within 6 months, or is suspended or abandoned for a period of 6 months after commencement. WORK SHALL BE CONSIDERED SUSPENDED IF AN APPROVED INSPECTION HAS NOT BEEN MADE WITHIN A 6 MONTH PERIOD. PERMISSION IS GRANTED TO DO THE FOLLOWING WORK ACCORDING TO THE CONDITIONS HEREON AND THE APPROVED PLANS AND SPECIFICATIONS, SUBJECT TO COMPLIANCE WITH THE ORDINANCES OF THE CITY OF BELLE ISLE, FLORIDA.

Scope of Work: ELECTRICAL: Solar for electricity
Comments: None

Project Information
Address: 1307 E. Wallace Street, Belle Isle, FL 32809
Parcel ID: 24-23-29-3400-00-078
Property Owner: Hafley, Michael & Patricia
Phone Number: None

****

Company Name: Solar-Ray Inc
Contractor Name: Weirich, Carl
License Number: CVC56880
Address: 6007 Anno Ave, Orlando, FL 32809
Phone Number: 407-443-4404

Permit Number: 2015-04-017

Date of Application: 04/07/2015
Date Permit Issued: 04/09/2015

WARNING TO OWNER: "YOUR FAILURE TO RECORD A NOTICE OF COMMENCEMENT MAY RESULT IN YOU PAYING TWICE FOR IMPROVEMENTS TO YOUR PROPERTY. IF YOU INTEND TO OBTAIN FINANCING, CONSULT WITH YOUR LENDER OR AN ATTORNEY BEFORE RECORDING YOUR NOTICE OF COMMENCEMENT." ON THE JOB INSPECTION(S) MUST BE MADE BEFORE PROCEEDING WITH SUBSEQUENT WORK. THIS CARD MUST BE DISPLAYED OUTSIDE AND BE PROTECTED FROM THE WEATHER WHILE BEING VISIBLE FROM THE STREET UNTIL THE FINAL INSPECTIONS HAVE BEEN APPROVED.

BUILDING FEATURES

IMPACT FEES
School $
Traffic $

ZONING FEES
Zoning Fee $

UNIVERSAL ENG - BUILDING FEES

Cert of Occ $
Demo $
Building $
Fence $
Driveway $
Shed $
Window(s) $
Door(s) $
PrePower $
Electrical $295.50
Temp Pole $
Plumbing $
Mechanical $
Gas $
Roofing $
Boat Dock $
Screen Encl $
Swimming Pool $
Sign $

SURCHARGE FEES

Surcharge Fee $4.43
Surcharge Fee $4.43

TOTAL FEES $304.36

Date Paid 4-17-15
CC or Check # VISA 8271
Amount Paid 304-36

The person accepting this permit shall conform to the terms of the application on file and construction shall conform to the requirements of the Florida Building Code (FS 553).

BUILDING INSPECTOR USE ONLY

IF APPLICABLE:
Have Zoning Approval Conditions Been Met? YES NO **Have Stormwater Approval Conditions Been Met?** YES NO **Silt fencing in place?** YES NO **Turbidity Barrier in place?** YES NO

BUILDING
1st ________ (Footing/Foundation)
Survey specific foundation plan must be onsite before slab pour. Approved Plan on Site? ____
2nd ________ (Slab)
3rd ________ (Lintel)(Wall Reinforcing on Masonry Building)
4th ________ (Exterior Framing)(Roof/Wall Sheathing)
5th ________ (Framing) (To be made after Plumbing/ Mechanical/ Electrical Rough-Ins & Windows/Doors Installed)
6th ________ (Insulation to be Made After Roof Installed)
7th ________ (Drywall)
8th ________ (Sidewalk/Driveway)
9th ________ (Other)
10th ________ (Final – After MEP and Other Applicable Finals)

ROOFING
1ST ROOFING Deck Nailing/Dry-in/Flashing ________
2nd ROOFING Covering In-Progress ________
3rd ROOFING Covering Final ________

PLUMBING (Pool-Piping, Solar, Irrigation, Water Treatment Equip, Etc...)
1ST ________ (Underground) 2nd ________ (Sewer)
3rd ________ (Rough-In/Tub Set) 4th ________ (Final)

CHECK APPROPRIATE BOX
☐ **GAS** __**Natural** ___**LP** ☐ **MECHANICAL** ☐ **ELECTRICAL** ☐ **LOW VOLTAGE**
1st ________ (Rough-In) 2nd ________ (Final)

Inspection requests are to be emailed to BIDscheduling@UniversalEngineering.com; a confirmation email will be sent back to you upon scheduling. Next-Day Inspection requests must be made by 1pm. Please include the following in your request: Permit #, project address, type of inspection, date of the requested inspection, a contact name & a contact phone number. AM or PM may be requested but cannot be guaranteed.

For a copy of your permit, or to check inspection results, please visit https://universalengineering.sharefile.com/f/fo94edc4-832d-44bd-9809-ecf32f9e2e63
login ID = cobi@universalengineering.com password = universal13

PROJECT NUMBER 0115.1300623.0000

TASK NUMBER 1b

CITY OF BELLE ISLE

Permit Application Review Sheet

Permit Number	2015-04-017
Property Owner	HAFLEY
Address	1307 E. Wallace St.
Nature of Improvement	Solar: for electricity
Received Application	4-7-15
Sent for Stormwater Review	✓
Stormwater Approved	
Sent for Zoning Review	✓
Zoning Approved	
Applied for Variance	
Variance Approved	
Sent to BO for Review	4-7-15
Building Official Approved	4-8-15 RY

Comments	
1. Susan 4-7-15	review WO# 49293
2. got it	Need NOC sent email ✓
3. 4-7-15 RY	NEED SOLAR PANEL ATTACHMENT
4.	DETAILS PREPARED BY A FLORIDA
5.	DESIGN PROFESSIONAL. ALSO NEED
6.	CUT SHEETS FOR INVERTER + ASSOCIATED
7.	ELECTRICAL EQUIP.
8. Susan 4-7-15	emailed above comments ✓
9. Susan 4-8-15	See info that arrived WO# 49315
10. Susan 4-9-15	Worked no permit investigation NEGATIVE
11.	no double fees - emailed permit ready
12. (picking up w/ check in person)	permit typed

City of Belle Isle

Universal Engineering Sciences 3532 Maggie Blvd., Orlando, FL 32811
Tel 407-581-8161 * Fax 407-581-0313 * www.universalengineering.com

RECEIVED 4-7-15

APPLICATION FOR ELECTRICAL PERMIT

WARNING TO OWNER: YOUR FAILURE TO RECORD A NOTICE OF COMMENCEMENT MAY RESULT IN YOUR PAYING TWICE FOR IMPROVEMENTS TO YOUR PROPERTY. A NOTICE OF COMMENCEMENT MUST BE RECORDED AND POSTED ON THE JOB SITE BEFORE THE FIRST INSPECTION. IF YOU INTEND TO OBTAIN FINANCING, CONSULT WITH YOUR LENDER OR AN ATTORNEY BEFORE RECORDING YOUR NOTICE OF COMMENCEMENT.

DATE OF APPLICATION: April 6, 2015 PERMIT NUMBER 2015-04-017

The undersigned hereby applies for a permit to make electrical installations as indicated below. PLEASE PRINT

Project Address 1307 E. Wallace St. Belle Isle FL ☑ 32809 ☐ 32812

Property Owner Michael & Patricia Hafley Phone 727-687-2518

Property Owner's Mailing Address 1307 E. Wallace St. City Belle Isle

State Florida Zip Code 32809 Parcel Id Number: 24-23-29-3400-00-078

To obtain this information, please visit http://www.ocpafl.org/Searches/ParcelSearch.aspx

Class of Building: Old ☑ New ☐ Type of Building: Residential ☑ Commercial ☐ Other ☐
Type of Work: New ☐ Alteration ☐ Addition ☐ Repair ☐ Low Voltage New ☑ Existing ☑

INDICATE THE QUANTITY OF ALL EQUIPMENT TO BE INSTALLED

Dishwasher ____	Exhaust Fan ____	Disposal ____	Water Heater ____
Hood Fan ____	Dryer ____	Paddle Fan ____	Outlets ____
Fixtures ____	Spa ____	Pool ____	Switches ____
Electric Signs ____	Meter Reset ____	Low Voltage ____	Stoves ____
Pumps ____	Motors ____	Air Conditioning (tons) ____	Furnace (KW) ____

Temporary Construction Pole ____ One (1) New Meter Service ____ Amperage/Voltage/Phase

Meter Service Upgrade from ____ (Amperage/Voltage/Phase) to ____ (Amperage/Voltage/Phase) = ____ (Difference in Size)

Relocate Existing Meter Service (No Service Size Change) ____

Other: Attach solar photovoltaic modules to roof and inverter(s) to electric service panel.

☐ PERMIT FEE BASED ON METER SERVICE SIZE SCHEDULE . $____
(IF NO METER SERVICE WORK BEING DONE, USE VALUATION OF JOB FOR PERMIT FEE)

☐ VALUATION OF JOB (VALUATION OF ALL MATERIALS, LABOR, AND FIXTURES INSTALLED $ 32,3000.00

Building Official: [signature] Date 4-8-15
Verified Contractor's Licenses & Insurance are on file SW Date 4-7-15

Permit Fee = $ 197.00
Review Fee = $ 98.50
3% FL Surcharge = $ 8.86
TOTAL Permit = $ 304.36

I hereby certify that the above is true and correct to the best of my knowledge.

I hereby make Application for Permit as outlined above, and if same is granted I agree to conform to all Florida Building Code Regulations and City Ordinances regulating same and in accordance with plans submitted. The issuance of this permit does not grant permission to violate any applicable Town and/or State of Florida codes and/or ordinances.

LICENSE HOLDER SIGNATURE [signature] LICENSE # CVC 56880

LICENSE HOLDER NAME Carl Weirich COMPANY NAME Solar-Ray Inc.

Street Address 6007 Anno Ave

City Orlando State FL Zip Code 32809 Phone Number 407-443-4404

Email Address carl@solar-ray.net

NOTE: The Building Permit Number is required if the Electrical Installation is associated with any construction or alteration where a Building Permit has been issued.

Building Permit Number ____

COBI Permit Fee Calculation Form

Reviewer Signature: ______ Date: 4-8-15

Permit Type: ELECTRICAL Job Cost: $ 32,300

Permit Fee: $ 197.00

Plans Review Fee: $ 98.50 (50% of permit fee – excluding ReRoofs)

197.00
98.50
295.50

1.5% State Fee: $ 4.43

1.5% State Fee: $ 4.43

4.43
4.43
8.86

TOTAL BUILDING FEE: $ 304.36 (does not include Zoning fees or Deposits)

Note: Total gets doubled for SWO/AFT permits

1ST 1000 = 37.00

5.00 / ADDITIONAL 1000 OR FRACTION 32 X 5 = 160.00

160.00 + 37 = 197.00 PERMIT

197 ÷ 2 = 98.50 REVIEW

2955 x 0.015 4.43 1.5% SURCHARGE

197.00 + 98.50 + 4.43 + 4.43 = 304.36 TOTAL

Permit Number:
Folio/Parcel ID #: 24-23-29-3400-00-078
Prepared by: Solar-Ray, INC
6007 Anno Ave
Orlando, FL 32809
Return to: Solar-Ray, INC
6007 Anno Ave
Orlando, FL 32809

DOC# 20150170069 B: 10899 P: 8731
04/07/2015 12:05:58 PM Page 1 of 1
Rec Fee: $10.00
Martha O. Haynie, Comptroller
Orange County, FL
MB - Ret To: SOLAR RAY INC

NOTICE OF COMMENCEMENT

State of Florida, County of Orange

The undersigned hereby gives notice that improvement will be made to certain real property, and in accordance with Chapter 713, Florida Statutes, the following information is provided in this Notice of Commencement.

1. **Description of property** (legal description of the property, and street address if available)
SUB OF Herney Homestead C/53 From SW COR OF Lot 10 RUN E 763 Ft
2. **General description of improvement**
Photovoltaic Module on Roof, Inverters Mounted near utility me
3. **Owner information or Lessee information if the Lessee contracted for the improvement**
Name Patricia Hafley
Address 1307 E Wallace St. Belle Isle, FL 32809
Interest in Property owner
Name and address of fee simple titleholder (if different from Owner listed above)
Name SAME
Address
4. **Contractor**
Name SOLAR-RAY INC / FUQUA ELECTRIC
Telephone Number 407 443-4404
Address 6007 ANNO AVE ORLANDO FL 32809
5. **Surety** (if applicable, a copy of the payment bond is attached)
Name NA
Telephone Number
Address
Amount of Bond $
6. **Lender**
Name NA
Telephone Number
Address
7. **Persons within the State of Florida designated by Owner upon whom notices or other documents may be served as provided by §713.13(1)(a)7, Florida Statutes.**
Name NA
Telephone Number
Address
8. **In addition to himself or herself, Owner designates the following to receive a copy of the Lienor's Notice as provided in §713.13(1)(b), Florida Statutes.**
Name NA
Telephone Number
Address
9. **Expiration date of notice of commencement** (the expiration date will be 1 year from the date of recording unless a different date is specified) AUG 30, 2015

State of FLORIDA, County of ORANGE
I hereby certify that this is a true copy of the document as reflected in the Official Records.
MARTHA O. HAYNIE, COUNTY COMPTROLLER
By: [signature] Deputy Comptroller
Dated: 04-07-15
COUNTY COMPTROLLER SEAL ORANGE COUNTY, FLORIDA

WARNING TO OWNER: ANY PAYMENTS MADE BY THE OWNER AFTER THE EXPIRATION OF THE NOTICE OF COMMENCEMENT ARE CONSIDERED IMPROPER PAYMENTS UNDER CHAPTER 713, PART I, SECTION 713.13, FLORIDA STATUTES, AND CAN RESULT IN YOUR PAYING TWICE FOR IMPROVEMENTS TO YOUR PROPERTY. A NOTICE OF COMMENCEMENT MUST BE RECORDED AND POSTED ON THE JOB SITE BEFORE THE FIRST INSPECTION. IF YOU INTEND TO OBTAIN FINANCING, CONSULT WITH YOUR LENDER OR AN ATTORNEY BEFORE COMMENCING WORK OR RECORDING YOUR NOTICE OF COMMENCEMENT.

Patricia M. Hafley
Signature of Owner or Lessee, or Owner's or Lessee's Authorized Officer/Director/Partner/Manager

owner
Signatory's Title/Office

The foregoing instrument was acknowledged before me this 2 day of 04/15 (month/year) by Patricia Hafley (name of person)

as owner (Type of authority, e.g., officer, trustee, attorney in fact) for Self (Name of party on behalf of whom instrument was executed)

[signature]
Signature of Notary Public - State of Florida

JANERY FRUTO
Commission # FF 142524
Expires July 16, 2018

Print, type, or stamp commissioned name of Notary Public

Personally Known OR Produced ID X
Type of ID Produced Drivers license

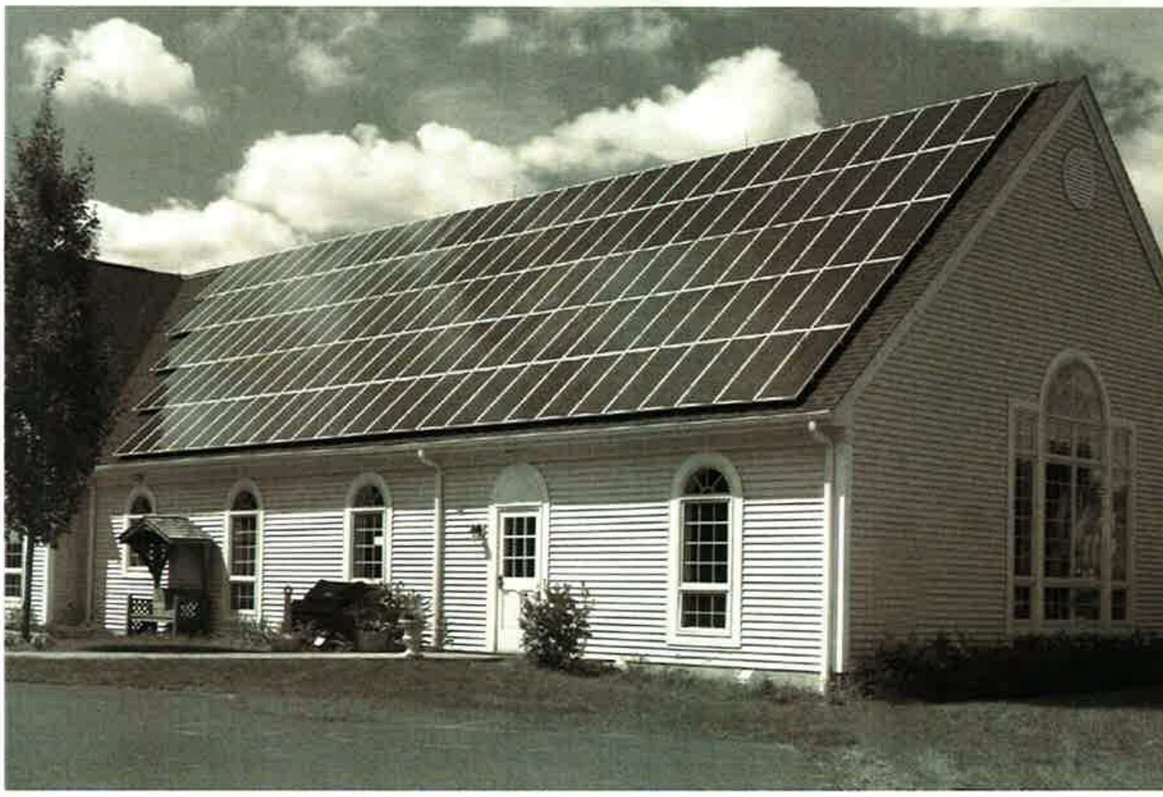
Form content revised: 01/23/14

SM SOLAR MOUNT

Code-Compliant Installation Manual 227.3

For ASCE 7-05 or ASCE 7-10

U.S. Des. Patent No. D496,248S, D496,249S. Other patents pending.



Unirac Code-Compliant Installation Manual

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UNIRAC®
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Pub 140130 -1cc

Unirac welcomes input concerning the accuracy and user-friendliness of this publication. Please write to **publications@unirac.com.**

i. Installer's Responsibilities

Please review this manual thoroughly before installing your SOLARMOUNT system.

This manual provides (1) supporting documentation for building permit applications relating to Unirac's SOLARMOUNT Universal PV Module Mounting system, and (2) planning and assembly instructions for SOLARMOUNT

SOLARMOUNT products, when installed in accordance with this bulletin, will be structurally adequate and will meet the structural requirements of the IBC 2009 and IBC 2012, ASCE 7-05, ASCE 7-10 and California Building Code 2013 (collectively referred to as "the Code").

SOLARMOUNT is much more than a product.

It's a system of engineered components that can be assembled into a wide variety of PV mounting structures. With SOLARMOUNT you'll be able to solve virtually any PV module mounting challenge.

It's also a system of technical support: complete installation and code compliance documentation, an on-line SOLARMOUNT Estimator, person-to-person customer service, and design assistance to help you solve the toughest challenges.

This is why SOLARMOUNT is PV's most widely used mounting system.

The installer is solely responsible for:

- Complying with all applicable local or national building codes, including any that may supersede this manual;
- Ensuring that Unirac and other products are appropriate for the particular installation and the installation environment;
- Ensuring that the roof, its rafters, connections, and other structural support members can support the array under all code level loading conditions (this total building assembly is referred to as the building structure);
- Using only Unirac parts and installer-supplied parts as specified by Unirac (substitution of parts may void the warranty and invalidate the letters of certification in all Unirac publications);
- Ensuring that lag screws have adequate pullout strength and shear capacities as installed;
- Verifying the strength of any alternate mounting used in lieu of the lag screws;
- Maintaining the waterproof integrity of the roof, including selection of appropriate flashing;
- Ensuring safe installation of all electrical aspects of the PV array;
- Ensuring correct and appropriate design parameters are used in determining the design loading used for design of the specific installation. Parameters, such as snow loading, wind speed, exposure and topographic factor should be confirmed with the local building official or a licensed professional engineer.

NOTE - If you have run our U-Builder at www.design.unirac.com/tool/project_info/solarmount/?pitched=true turn to page 29 for installation instructions.

Part I. Procedure to Determine the Design Wind Load

[1.1.1.] Using the Simplified Method - ASCE 7-05

The procedure to determine Design Wind Load is specified by the American Society of Civil Engineers and referenced in the International Building Code 2009. For purposes of this document, the values, equations and procedures used in this document reference ASCE 7-05, Minimum Design Loads for Buildings and Other Structures. ***Please refer to ASCE 7-05 if you have any questions about the definitions or procedures presented in this manual.*** Unirac uses Method 1, the Simplified Method, for calculating the Design Wind Load for pressures on components and cladding in this document.

The method described in this document is valid for flush, no tilt, SOLARMOUNT Series applications on either roofs or walls. Flush is defined as panels parallel to the surface (or with no more than 3" difference between ends of assembly) with no more than 10" space between the roof surface, and the bottom of the PV panels.

This method is not approved for open structure calculations. ***Applications of these procedures is subject to the following ASCE 7-05 limitations:***

1. The building height must be less than 60 feet, h < 60. See note for determining h in the next section. For installations on structures greater than 60 feet, contact your local design professional.

2. The building must be enclosed, not an open or partially enclosed structure, for example a carport.

3. The building is regular shaped with no unusual geometrical irregularity in spatial form, for example a geodesic dome.

4. The building is not in an extreme geographic location such as a narrow canyon or steep cliff.

5. The building has a flat or gable roof with a pitch less than 45 degrees or a hip roof with a pitch less than 27 degrees.

6. If your installation does not conform to these requirements please contact your local Unirac distributor or a local professional engineer.

If your installation is outside the United States or does not meet all of these limitations, consult a local professional engineer or your local building authority. Consult ASCE 7-05 for more clarification on the use of Method I. Lower design wind loads may be obtained by applying Method II from ASCE 7-05. Consult with a licensed engineer if you want to use Method II procedures.

The equation for determining the Design Wind Load for components and cladding is:

$$p_{net}\,(psf) = \lambda K_{zt} I\, p_{net30}$$

p_{net} *(psf) = Design Wind Load*

λ *= adjustment factor for building height and exposure category*

K_{zt} *= Topographic Factor at mean roof height, h (ft)*

I = Importance Factor

p_{net30} *(psf) = net design wind pressure for Exposure B, at height = 30 feet, I = 1.0*

You will also need to know the following information:

Basic Wind Speed = V (mph), the largest 3 second gust of wind in the last 50 years.

h (ft) = total roof height for flat roof buildings or mean roof height for pitched roof buildings

Roof Pitch (degrees)

This manual will help you determine:

Effective Wind Area (sf) = minimum total continuous area of modules being installed (Step 2)

Roof Zone = the area of the roof you are installing the pv system according to Step 3.

Roof Zone Dimension = a (ft) (Step 3)

Exposure Category (Step 6)

[1.1.2.] Using the Low Rise Buildings (Simplified) - ASCE 7-10

The procedure to determine Design Wind Load is specified by the American Society of Civil Engineers and referenced in the International Building Code 2012 and California Building Code 2013. For purposes of this document, the values, equations and procedures used in this document reference ASCE 7-10, Minimum Design Loads for Buildings and Other Structures. ***Please refer to ASCE 7-10 if you have any questions about the definitions or procedures presented in this manual.*** Unirac uses Part 2, The Simplified Method, for low rise buildings to calculate the Design Wind Load for pressures on components and cladding in this document.

The method described in this document is valid for flush, no tilt, SOLARMOUNT Series applications on either roofs or walls. Flush is defined as panels parallel to the surface (or with no more than 3" difference between ends of assembly) with no more than 10" space between the roof surface, and the bottom of the PV panels.

This method is not approved for open structure calculations. ***Applications of these procedures is subject to the following ASCE 7-10 limitations:***

1. The building height must be less than 60 feet, h < 60. See note for determining h in the next section. For installations on structures greater than 60 feet, contact your local design professional.

2. The building must be enclosed, not an open or partially enclosed structure, for example a carport.

3. The building is regular shaped with no unusual geometrical irregularity in spatial form, for example a geodesic dome.

4. The building is not in an extreme geographic location such as a narrow canyon or steep cliff.

5. The building has a flat or gable roof with a pitch less than 45 degrees or a hip roof with a pitch less than 27 degrees.

6. If your installation does not conform to these requirements please contact your local professional engineer.

If your installation is outside the United States or does not meet all of these limitations, consult a local professional engineer or your local building authority. Consult ASCE 7-10 for more clarification on the use of Part 2.

The equation for determining the Design Wind Load for components and cladding is:

$$p_{net}\ (psf) = \lambda K_{zt}\, p_{net30}$$

p_{net} *(psf) = Design Wind Load*

λ = adjustment factor for building height and exposure category

K_{zt} *= Topographic Factor = 1*

p_{net30} *(psf) = net design wind pressure for Exposure B, at height = 30 feet*

You will also need to know the following information:

Basic Wind Speed = V (mph), the largest 3 second gust of wind in the last 50 years.

h (ft) = total roof height for flat roof buildings or mean roof height for pitched roof buildings

Roof Pitch (degrees)

This manual will help you determine:

Effective Wind Area (sf) = minimum total continuous area of modules being installed (Step 2)

Roof Zone = the area of the roof you are installing the pv system according to Step 3.

Roof Zone Dimension = a (ft) (Step 3)

Exposure Category (Step 6)

[1.2.1.] Procedure to Calculate Total Design Wind per ASCE 7-05

See page 11 for ASCE 7-10 procedure.

The procedure for determining the Design Wind Load can be broken into steps that include looking up several values in different tables. Table 5 has been provided as a worksheet for the following 9 steps (page 9)

Step 1: Determine *Basic Wind Speed, V (mph)*

Determine the *Basic Wind Speed, V (mph)* by consulting your local building department or locating your installation on the maps in Figure 1, page 5.

Step 2: Determining *Effective Wind Area*

Determine the smallest area of continuous modules you will be installing. This is the smallest area tributary (contributing load) to a support or to a simple-span of rail. That area is the Effective Wind Area, the total area of the fewest number of modules on a run of rails. If the smallest area of continuous modules exceeds 100 sq ft, use 100 sq ft (See Table 2). If less, round down to values available in Table 2.

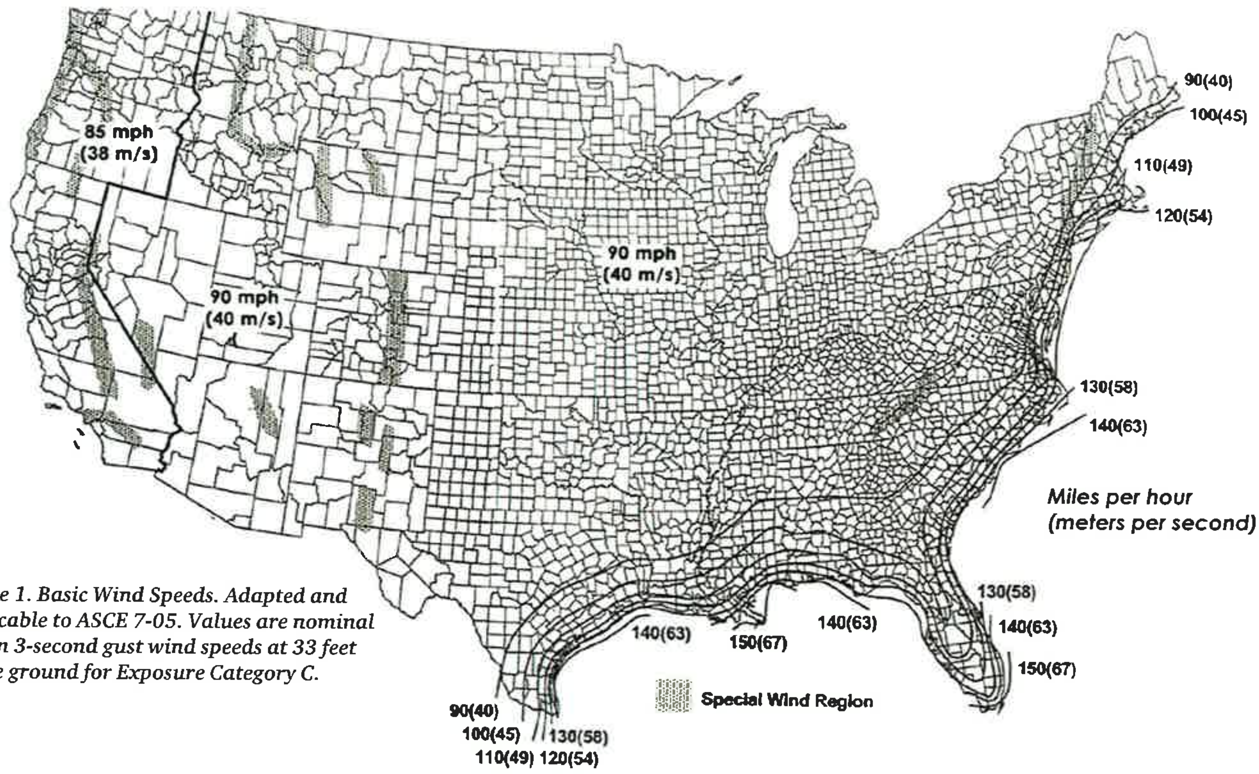


Figure 1. Basic Wind Speeds. Adapted and applicable to ASCE 7-05. Values are nominal design 3-second gust wind speeds at 33 feet above ground for Exposure Category C.

ASCE 7-05.

Step 3: Determine *Roof/Wall Zone*

The *Design Wind Load* will vary based on where the installation is located on a roof. Arrays may be located in more than one roof zone.

Using Table 1, determine the *Roof Zone Dimension Length, a (ft),* according to the width and height of the building on which you are installing the pv system.

Table 1. Determine Roof/Wall Zone, dimension (**a**) according to building width and height

a = 10 percent of the least horizontal dimension or 0.4h, whichever is smaller, but not less than either 4% of the least horizontal dimension or 3 ft of the building.

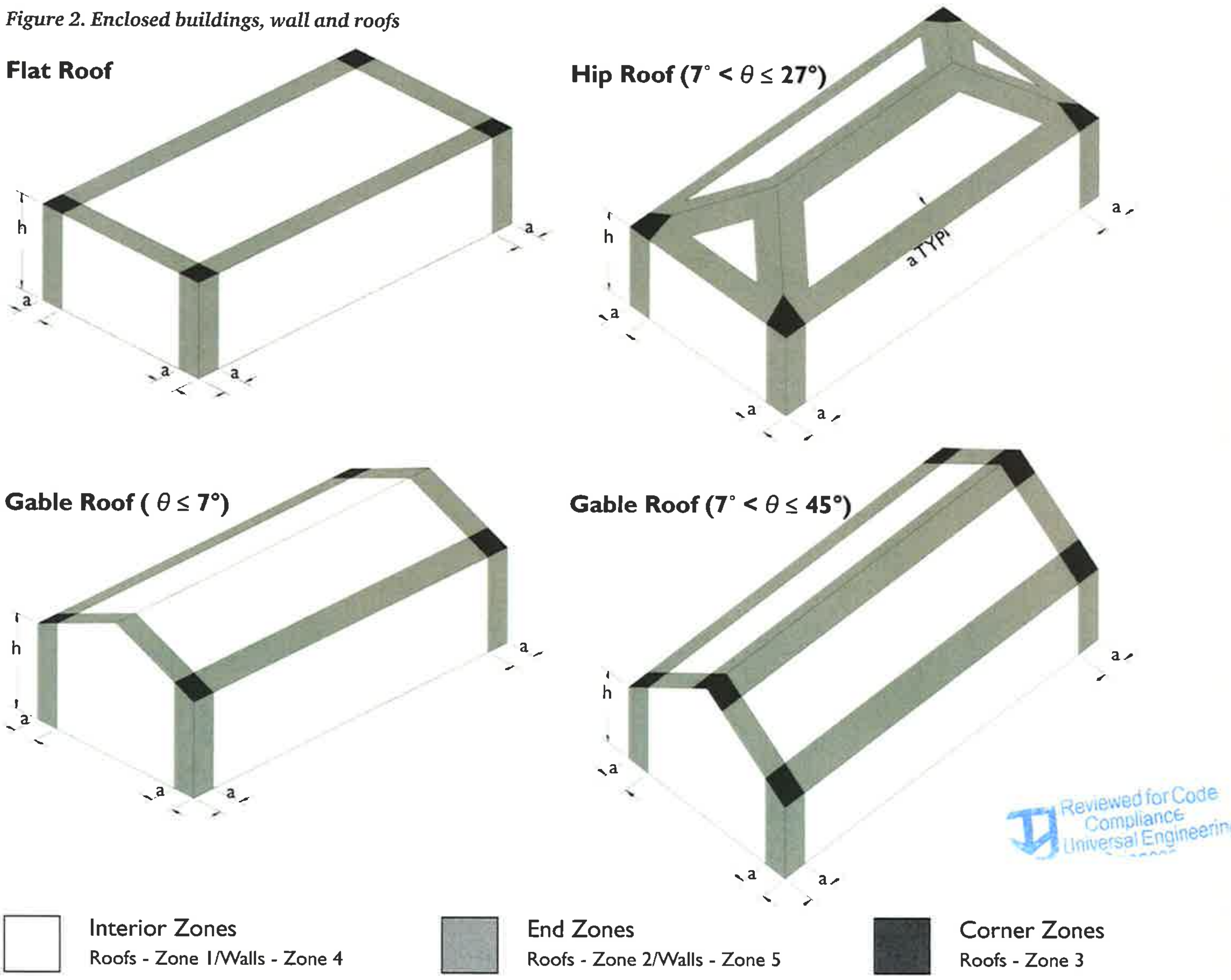
Roof Height (ft)	*Least Horizontal Dimension (ft)*																		
	10	***15***	***20***	***25***	***30***	***40***	***50***	***60***	***70***	***80***	***90***	***100***	***125***	***150***	***175***	***200***	***300***	***400***	***500***
10	3	3	3	3	3	4	4	4	4	4	4	4	5	6	7	8	12	16	20
15	3	3	3	3	3	4	5	6	6	6	6	6	6	6	7	8	12	16	20
20	3	3	3	3	3	4	5	6	7	8	8	8	8	8	8	8	12	16	20
25	3	3	3	3	3	4	5	6	7	8	9	10	10	10	10	10	12	16	20
30	3	3	3	3	3	4	5	6	7	8	9	10	12	12	12	12	12	16	20
35	3	3	3	3	3	4	5	6	7	8	9	10	12.5	14	14	14	14	16	20
40	3	3	3	3	3	4	5	6	7	8	9	10	12.5	15	16	16	16	16	20
45	3	3	3	3	3	4	5	6	7	8	9	10	12.5	15	17.5	18	18	18	20
50	3	3	3	3	3	4	5	6	7	8	9	10	12.5	15	17.5	20	20	20	20
60	3	3	3	3	3	4	5	6	7	8	9	10	12.5	15	17.5	20	24	24	24

Source: ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures, Chapter 6, Figure 6-3, p. 41.

Step 3: Determine *Roof Zone* (continued)

Using *Roof Zone Dimension Length*, a, determine the roof zone locations according to your roof type, gable, hip or monoslope. Determine in which roof zone your pv system is located, Zone 1, 2, or 3 according to Figure 2.

Figure 2. Enclosed buildings, wall and roofs



Source: ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures, Chapter 6, p. 41.

ASCE 7-05

Step 4: Determine *Net Design Wind Pressure*, p_{net30} *(psf)*

Using the *Effective Wind Area* **(Step 2)**, *Roof Zone Location* **(Step 3)**, and *Basic Wind Speed* **(Step 1)**, look up the appropriate *Net Design Wind Pressure* in **Table 2, page 7**. Use the *Effective Wind Area* value in the table which is smaller than the value calculated in **Step 2**. If the installation is located on a roof overhang, use **Table 3, page 8**.

Both downforce and uplift pressures must be considered in overall design. Refer to **Section II, Step 1** for applying downforce and uplift pressures. Positive values are acting toward the surface. Negative values are acting away from the surface.

Table 2. p_{net30} (psf) Roof and Wall

Basic Wind Speed, V (mph)

	Zone	Effective Wind Area (sf)	90 Downforce	90 Uplift	100 Downforce	100 Uplift	110 Downforce	110 Uplift	120 Downforce	120 Uplift	130 Downforce	130 Uplift	140 Downforce	140 Uplift	150 Downforce	150 Uplift	170 Downforce	170 Uplift
Roof 0 to 7 degrees	1	10	5.9	-14.6	7.3	-18.0	8.9	-21.8	10.5	-25.9	12.4	-30.4	14.3	-35.3	16.5	-40.5	21.1	-52.0
	1	20	5.6	-14.2	6.9	-17.5	8.3	-21.2	9.9	-25.2	11.6	-29.6	13.4	-34.4	15.4	-39.4	19.8	-50.7
	1	50	5.1	-13.7	6.3	-16.9	7.6	-20.5	9.0	-24.4	10.6	-28.6	12.3	-33.2	14.1	-38.1	18.1	-48.9
	1	100	4.7	-13.3	5.8	-16.5	7.0	-19.9	8.3	-23.7	9.8	-27.8	11.4	-32.3	13.0	-37.0	16.7	-47.6
	2	10	5.9	-24.4	7.3	-30.2	8.9	-36.5	10.5	-43.5	12.4	-51.0	14.3	-59.2	16.5	-67.9	21.1	-87.2
	2	20	5.6	-21.8	6.9	-27.0	8.3	-32.6	9.9	-38.8	11.6	-45.6	13.4	-52.9	15.4	-60.7	19.8	-78.0
	2	50	5.1	-18.4	6.3	-22.7	7.6	-27.5	9.0	-32.7	10.6	-38.4	12.3	-44.5	14.1	-51.1	18.1	-65.7
	2	100	4.7	-15.8	5.8	-19.5	7.0	-23.6	8.3	-28.1	9.8	-33.0	11.4	-38.2	13.0	-43.9	16.7	-56.4
	3	10	5.9	-36.8	7.3	-45.4	8.9	-55.0	10.5	-65.4	12.4	-76.8	14.3	-89.0	16.5	-102.2	21.1	-131.3
	3	20	5.6	-30.5	6.9	-37.6	8.3	-45.5	9.9	-54.2	11.6	-63.6	13.4	-73.8	15.4	-84.7	19.8	-108.7
	3	50	5.1	-22.1	6.3	-27.3	7.6	-33.1	9.0	-39.3	10.6	-46.2	12.3	-53.5	14.1	-61.5	18.1	-78.9
	3	100	4.7	-15.8	5.8	-19.5	7.0	-23.6	8.3	-28.1	9.8	-33.0	11.4	-38.2	13.0	-43.9	16.7	-56.4
Roof >7 to 27degrees	1	10	8.4	-13.3	10.4	-16.5	12.5	-19.9	14.9	-23.7	17.5	-27.8	20.3	-32.3	23.3	-37.0	30.0	-47.6
	1	20	7.7	-13.0	9.4	-16.0	11.4	-19.4	13.6	-23.0	16.0	-27.0	18.5	-31.4	21.3	-36.0	27.3	-46.3
	1	50	6.7	-12.5	8.2	-15.4	10.0	-18.6	11.9	-22.2	13.9	-26.0	16.1	-30.2	18.5	-34.6	23.8	-44.5
	1	100	5.9	-12.1	7.3	-14.9	8.9	-18.1	10.5	-21.5	12.4	-25.2	14.3	-29.3	16.5	-33.6	21.1	-43.2
	2	10	8.4	-23.2	10.4	-28.7	12.5	-34.7	14.9	-41.3	17.5	-48.4	20.3	-56.2	23.3	-64.5	30.0	-82.8
	2	20	7.7	-21.4	9.4	-26.4	11.4	-31.9	13.6	-38.0	16.0	-44.6	18.5	-51.7	21.3	-59.3	27.3	-76.2
	2	50	6.7	-18.9	8.2	-23.3	10.0	-28.2	11.9	-33.6	13.9	-39.4	16.1	-45.7	18.5	-52.5	23.8	-67.4
	2	100	5.9	-17.0	7.3	-21.0	8.9	-25.5	10.5	-30.3	12.4	-35.6	14.3	-41.2	16.5	-47.3	21.1	-60.8
	3	10	8.4	-34.3	10.4	-42.4	12.5	-51.3	14.9	-61.0	17.5	-71.6	20.3	-83.1	23.3	-95.4	30.0	-122.5
	3	20	7.7	-32.1	9.4	-39.6	11.4	-47.9	13.6	-57.1	16.0	-67.0	18.5	-77.7	21.3	-89.2	27.3	-114.5
	3	50	6.7	-29.1	8.2	-36.0	10.0	-43.5	11.9	-51.8	13.9	-60.8	16.1	-70.5	18.5	-81.0	23.8	-104.0
	3	100	5.9	-26.9	7.3	-33.2	8.9	-40.2	10.5	-47.9	12.4	-56.2	14.3	-65.1	16.5	-74.8	21.1	-96.0
Roof >27 to 45 degrees	1	10	13.3	-14.6	16.5	-18.0	19.9	-21.8	23.7	-25.9	27.8	-30.4	32.3	-35.3	37.0	-40.5	47.6	-52.0
	1	20	13.0	-13.8	16.0	-17.1	19.4	-20.7	23.0	-24.6	27.0	-28.9	31.4	-33.5	36.0	-38.4	46.3	-49.3
	1	50	12.5	-12.8	15.4	-15.9	18.6	-19.2	22.2	-22.8	26.0	-26.8	30.2	-31.1	34.6	-35.7	44.5	-45.8
	1	100	12.1	-12.1	14.9	-14.9	18.1	-18.1	21.5	-21.5	25.2	-25.2	29.3	-29.3	33.6	-33.6	43.2	-43.2
	2	10	13.3	-17.0	16.5	-21.0	19.9	-25.5	23.7	-30.3	27.8	-35.6	32.3	-41.2	37.0	-47.3	47.6	-60.8
	2	20	13.0	-16.3	16.0	-20.1	19.4	-24.3	23.0	-29.0	27.0	-34.0	31.4	-39.4	36.0	-45.3	46.3	-58.1
	2	50	12.5	-15.3	15.4	-18.9	18.6	-22.9	22.2	-27.2	26.0	-32.0	30.2	-37.1	34.6	-42.5	44.5	-54.6
	2	100	12.1	-14.6	14.9	-18.0	18.1	-21.8	21.5	-25.9	25.2	-30.4	29.3	-35.3	33.6	40.5	43.2	-52.0
	3	10	13.3	-17.0	16.5	-21.0	19.9	-25.5	23.7	-30.3	27.8	-35.6	32.3	-41.2	37.0	-47.3	47.6	-60.8
	3	20	13.0	-16.3	16.0	-20.1	19.4	-24.3	23.0	-29.0	27.0	-34.0	31.4	-39.4	36.0	-45.3	46.3	-58.1
	3	50	12.5	-15.3	15.4	-18.9	18.6	-22.9	22.2	-27.2	26.0	-32.0	30.2	-37.1	34.6	-42.5	44.5	-54.6
	3	100	12.1	-14.6	14.9	-18.0	18.1	-21.8	21.5	-25.9	25.2	-30.4	29.3	-35.3	33.6	-40.5	43.2	-52.0
Wall	4	10	14.6	-15.8	18.0	-19.5	21.8	-23.6	25.9	-28.1	30.4	-33.0	35.3	-38.2	40.5	-43.9	52.0	-56.4
	4	20	13.9	-15.1	17.2	-18.7	20.8	-22.6	24.7	-26.9	29.0	-31.6	33.7	-36.7	38.7	-42.1	49.6	-54.1
	4	50	13.0	-14.3	16.1	-17.6	19.5	-21.3	23.2	-25.4	27.2	-29.8	31.6	-34.6	36.2	-39.7	46.6	-51.0
	4	100	12.4	-13.6	15.3	-16.8	18.5	-20.4	22.0	-24.2	25.9	-28.4	30.0	-33.0	34.4	-37.8	44.2	-48.6
	4	500	10.9	-12.1	13.4	-14.9	16.2	-18.1	19.3	-21.5	22.7	-25.2	26.3	-29.3	30.2	-33.6	38.8	-43.2
	5	10	14.6	-19.5	18.0	-24.1	21.8	-29.1	25.9	-34.7	30.4	-40.7	35.3	-47.2	40.5	-54.2	52.0	-69.6
	5	20	13.9	-18.2	17.2	-22.5	20.8	-27.2	24.7	-32.4	29.0	-38.0	33.7	-44.0	38.7	-50.5	49.6	-64.9
	5	50	13.0	-16.5	16.1	-20.3	19.5	-24.6	23.2	-29.3	27.2	-34.3	31.6	-39.8	36.2	-45.7	46.6	-58.7
	5	100	12.4	-15.1	15.3	-18.7	18.5	-22.6	22.0	-26.9	25.9	-31.6	30.0	-36.7	34.4	-42.1	44.2	-54.1
	5	500	10.9	-12.1	13.4	-14.9	16.2	-18.1	19.3	-21.5	22.7	-25.2	26.3	-29.3	30.2	-33.6	38.8	-43.2

Source: ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures, Chapter 6, Figure 6-3, p. 42-43.

Table 3. p_{net30} (psf) Roof Overhang

	Zone	Effective Wind Area (sf)	Basic Wind Speed, V (mph) 90	100	110	120	130	140	150	170
Roof 0 to 7 degrees	2	10	-21.0	-25.9	-31.4	-37.3	-43.8	-50.8	-58.3	-74.9
	2	20	-20.6	-25.5	-30.8	-36.7	-43.0	-49.9	-57.3	-73.6
	2	50	-20.1	-24.9	-30.1	-35.8	-42.0	-48.7	-55.9	-71.8
	2	100	-19.8	-24.4	-29.5	-35.1	-41.2	-47.8	-54.9	-70.5
	3	10	-34.6	-42.7	-51.6	-61.5	-72.1	-83.7	-96.0	-123.4
	3	20	-27.1	-33.5	-40.5	-48.3	-56.6	-65.7	-75.4	-96.8
	3	50	-17.3	-21.4	-25.9	-30.8	-36.1	-41.9	-48.1	-61.8
	3	100	-10.0	-12.2	-14.8	-17.6	-20.6	-23.9	-27.4	-35.2
Roof >7 to 27degrees	2	10	-27.2	-33.5	-40.6	-48.3	-56.7	-65.7	-75.5	-96.9
	2	20	-27.2	-33.5	-40.6	-48.3	-56.7	-65.7	-75.5	-96.9
	2	50	-27.2	-33.5	-40.6	-48.3	-56.7	-65.7	-75.5	-96.9
	2	100	-27.2	-33.5	-40.6	-48.3	-56.7	-65.7	-75.5	-96.9
	3	10	-45.7	-56.4	-68.3	-81.2	-95.3	-110.6	-126.9	-163.0
	3	20	-41.2	-50.9	-61.6	-73.3	-86.0	-99.8	-114.5	-147.1
	3	50	-35.3	-43.6	-52.8	-62.8	-73.7	-85.5	-98.1	-126.1
	3	100	-30.9	-38.1	-46.1	-54.9	-64.4	-74.7	-85.8	-110.1
Roof >27 to 45degrees	2	10	-24.7	-30.5	-36.9	-43.9	-51.5	-59.8	-68.6	-88.1
	2	20	-24.0	-29.6	-35.8	-42.6	-50.0	-58.0	-66.5	-85.5
	2	50	-23.0	-28.4	-34.3	-40.8	-47.9	-55.6	-63.8	-82.0
	2	100	-22.2	-27.4	-33.2	-39.5	-46.4	-53.8	-61.7	-79.3
	3	10	-24.7	-30.5	-36.9	-43.9	-51.5	-59.8	-68.6	-88.1
	3	20	-24.0	-29.6	-35.8	-42.6	-50.0	-58.0	-66.5	-85.5
	3	50	-23.0	-28.4	-34.3	-40.8	-47.9	-55.6	-63.8	-82.0
	3	100	-22.2	-27.4	-33.2	-39.5	-46.4	-53.8	-61.7	-79.3

Source: ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures, Chapter 6, p. 44.

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Step 5: Determine the Topographic Factor, K_{zt}

For the purposes of this code compliance document, the *Topographic Factor*, K_{zt}, is taken as equal to one (1), meaning, the installation is surrounded by level ground (less than 10% slope). If the installation is not surrounded by level ground, please consult ASCE 7-05, Section 6.5.7 and the local building authority to determine the *Topographic Factor*.

Step 6: Determine *Exposure Category (B, C, D)*

Determine the *Exposure Category* by using the following definitions for Surface Roughness Categories.

The ASCE/SEI 7-05 defines wind surface roughness categories as follows:

SURFACE ROUGHNESS B: is urban and suburban areas, wooded areas, or other terrain with numerous closely spaced obstructions having the size of single family dwellings.

SURFACE ROUGHNESS C: has open terrain with scattered obstructions having heights generally less than 30 feet. This category includes flat open country, grasslands, and all water surfaces in hurricane prone regions.

SURFACE ROUGHNESS D: has flat, unobstructed areas and water surfaces outside hurricane prone regions. This category includes smooth mud flats, salt flats, and unbroken ice.

Also see ASCE 7-05 pages 287-291 for further explanation and explanatory photographs, and confirm your selection with the local building authority.

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Step 7: Determine adjustment factor for height and exposure category, λ

Using the *Exposure Category* (**Step 6**) and the *roof height, h (ft)*, look up the *adjustment factor for height and exposure* in **Table 4**.

Step 8: Determine the Importance Factor, I

Determine if the installation is in a hurricane prone region. Look up the *Importance Factor, I*, Table 6, page 10, using the occupancy category description and the hurricane prone region status.

Step 9: Calculate the Design Wind Load, p_{net} (psf)

Multiply the *Net Design Wind Pressure*, p_{net30} (psf) (**Step 4**) by the *adjustment factor for height and exposure*, λ (**Step 7**), the *Topographic Factor*, K_{zt} (**Step 5**), and the *Importance Factor, I* (**Step 8**) using the following equation, or Table 5 Worksheet.

$$p_{net}\ (psf) = \lambda K_{zt} I\ p_{net30}$$

p_{net} *(psf) = Design Wind Load (10 psf minimum)*

λ = *adjustment factor for height and exposure category* (**Step 7**)

K_{zt} = *Topographic Factor at mean roof height, h (ft)* (**Step 5**)

I = Importance Factor (**Step 8**)

p_{net30} *(psf) = net design wind pressure for Exposure B, at height = 30, I = 1* (**Step 4**)

Or use **Table 5** below to calculate Design Wind Load.

The Design Wind Load will be used in **Part II** to select the appropriate SOLARMOUNT Series rail, rail span and foot spacing.

In **Part II**, use both the positive (downforce) and the negative (uplift) results from this calculation.

Table 4. Adjustment Factor (λ) for Roof Height & Exposure Category

Mean roof height (ft)	Exposure B	Exposure C	Exposure D
15	1.00	1.21	1.47
20	1.00	1.29	1.55
25	1.00	1.35	1.61
30	1.00	1.40	1.66
35	1.05	1.45	1.70
40	1.09	1.49	1.74
45	1.12	1.53	1.78
50	1.16	1.56	1.81
55	1.19	1.59	1.84
60	1.22	1.62	1.87

Source: ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures, Chapter 6, Figure 6-3, p. 44.

Table 5. Worksheet for Components and Cladding Wind Load Calculation: IBC 2009, ASCE 7-05

Variable Description	Symbol	Value	Unit	Step	Reference
Building Height	*h*		ft		
Building, Least Horizontal Dimension			ft		
Roof Pitch			degrees		
Exposure Category				6	
Basic Wind Speed	*V*		mph	1	Figure 1
Effective Wind Area			sf	2	
Roof Zone Setback Length	*a*		ft	3	Table 1
Roof Zone Location				3	Figure 2
Net Design Wind Pressure	p_{net30}		psf	4	Table 2, 3
Topographic Factor	K_{zt}	x		5	
Adjustment factor for height and exposure category	λ	x		7	Table 4
Importance Factor	*I*	x		8	Table 5
Total Design Wind Load	p_{net}		psf	9	

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Table 6. Occupancy Category Importance Factor

Category	Category Descirption	Building Type Examples	Non-Hurricane Prone Regions and Hurricane Prone Regions with Basic Wind Speed, V = 85-100 mph, and Alaska	Hurricane Prone Regions with Basic Wind Speed, V > 100mph
I	Buildings and other structures that represent a low hazard to human life in the event of failure, including, but limited to:	• Agricultural facilities • Certain Temporary facilities • Minor Storage facilities	0.87	0.77
II	All buildings and other structures except those listed in Occupancy Categories I, III, and IV.		1	1
III	Buildings and other structures that represent a substantial hazard to human life in the event of a failure, including, but not limited to:	• Buildings where more than 300 people congregate • Schools with a capacity more than 250 • Day Cares with a capacity more than 150 • Buildings for colleges with a capacity more than 500 • Health Care facilities with a capacity more than 50 or more resident patients • Jails and Detention Facilities • Power Generating Stations • Water and Sewage Treatment Facilities • Telecommunication Centers • Buildings that manufacture or house hazardous materials	1.15	1.15
IV	Buildings and other structures designated as essential facilities, including, but not limited to:	• Hospitals and other health care facilities having surgery or emergency treatment • Fire, rescue, ambulance and police stations • Designated earthquake, hurricane, or other emergency shelters • Designated emergency preparedness communication, and operation centers • Power generating stations and other public utility facilities required in an emergency • Ancillary structures required for operation of Occupancy Category IV structures • Aviation control towers, air traffic control centers, and emergency aircraft hangars • Water storage facilities and pump structures required to maintain water pressure for fire suppression • Buildings and other structures having critical national defense functions	1.15	1.15

Source: IBC 2009, Table 1604.5, Occupancy Category of Buildings and other structures, p. 281; ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures, Table 6-1, p. 77

[1.2.2.] Procedure to Calculate Total Design Wind per ASCE 7-10

See page 4 for ASCE 7-05 procedure.

Step 1. Determine risk category, See Table 6

Buildings and other structures shall be classified, based on the risk to human life, health and welfare associated with their damage or failure by nature of their occupancy or use. For the purpose of applying flood, wind, snow, ice, and earthquake provisions. See Table 7 on page 11.

Table 7: Risk Category of Buildings and Other Structures for Flood, Wind, Snow, Earthquake, and Ice Loads

Use or Occupancy of Buildings and Structures	Risk Category
Buildings and other structures that represent a low risk to human life in the event of failure.	I
All buildings and other structures except those listed in Risk Categories I, III, and IV.	II
□ Buildings and other structures, the failure of which could pose a substantial risk to human life □ Buildings and other structures, not included in Risk Category IV, with potential to cause a substantial economic impact and/or mass disruption of day-to-day civilian life in the event of failure. □ Buildings and other structures, not included in Risk Category IV (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing toxic or explosive substances where their quantity exceeds a threshold quantity established by authority having jurisdiction and is sufficient to pose a threat to the public if released.	III
□ Buildings and other structures designated as essential facilities. □ Buildings and other structures, the failure of which could pose a substantial hazard to the community. □ Buildings and other structures (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, or hazardous chemicals or hazardous waste) containing sufficient quantities of highly toxic substances where the quantity exceeds a threshold quantity established by the authority having jurisdiction to be dangerous to the public if released and is sufficient to pose a threat to the public if released.[a] □ Buildings and other structures required to maintain the functionality of other Risk Category IV structures.	IV

[a]Buildings and other structures containing toxic, highly toxic, or explosive substances shall be eligible for classification to a lower Risk Category if it can be demonstrated to the satisfaction of the authority having jurisdiction by a hazard assessment as described in Section 1.5.2 of ASCE 7-10 that a release of the substances is commensurate with the risk associated with that Risk Category.

Step 2. Determine the Basic Wind Speed, V (mph)

Determine the basic wind speed, V (mph) by consulting your local department or by locating your installation on the maps in Figures 26.5 1a through 1c, pages 12 - 17. Please note that the wind speeds are dependent on the Risk (Occupancy) category determined in Step 1.

Miles per hour (Meters per second)

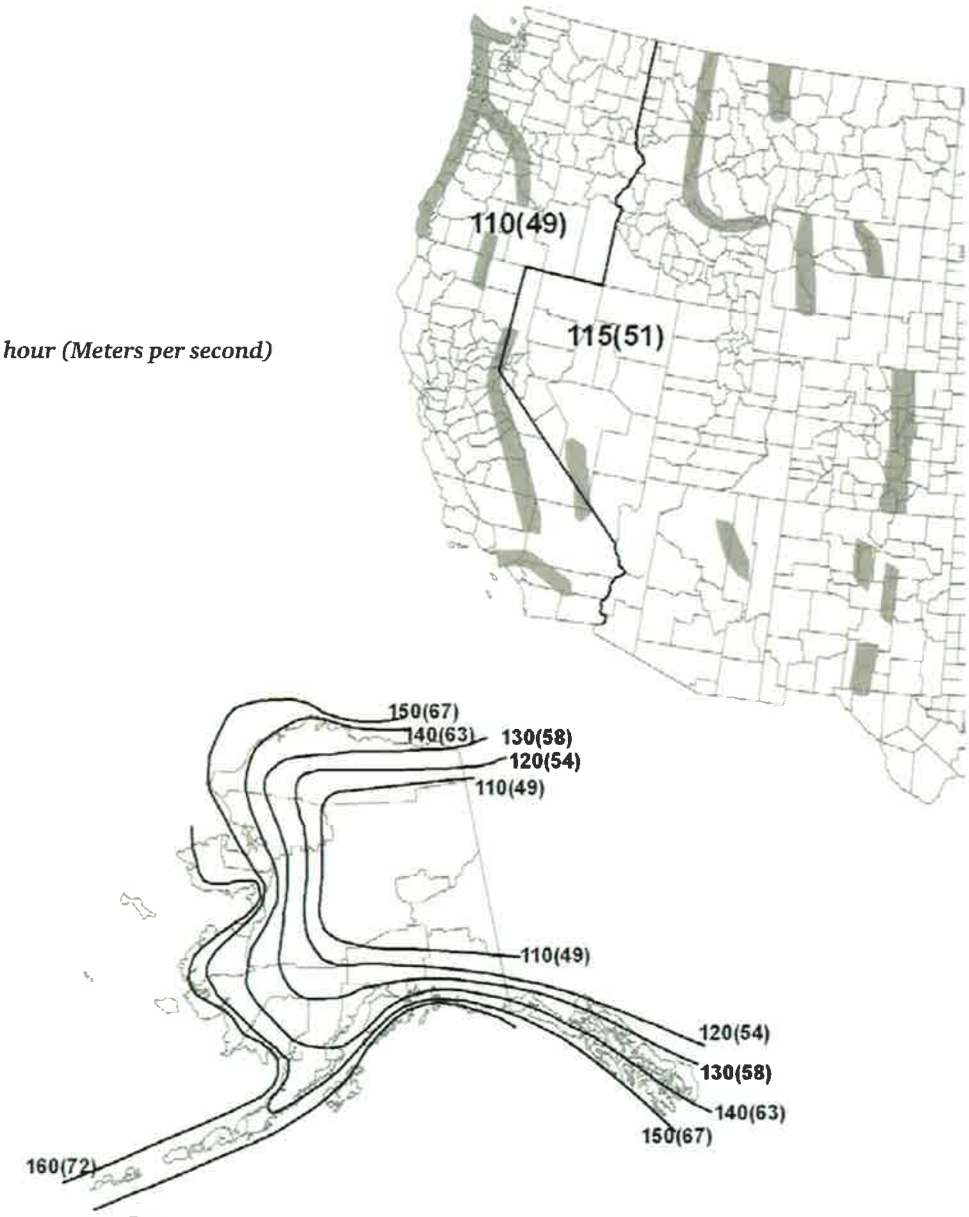

FIGURE 26.5-1A Basic Wind Speeds for Risk Category II Buildings and Other Structures

Notes:
1. Values are design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (annual exceedance probability = 0.00143, MRI = 700 years).

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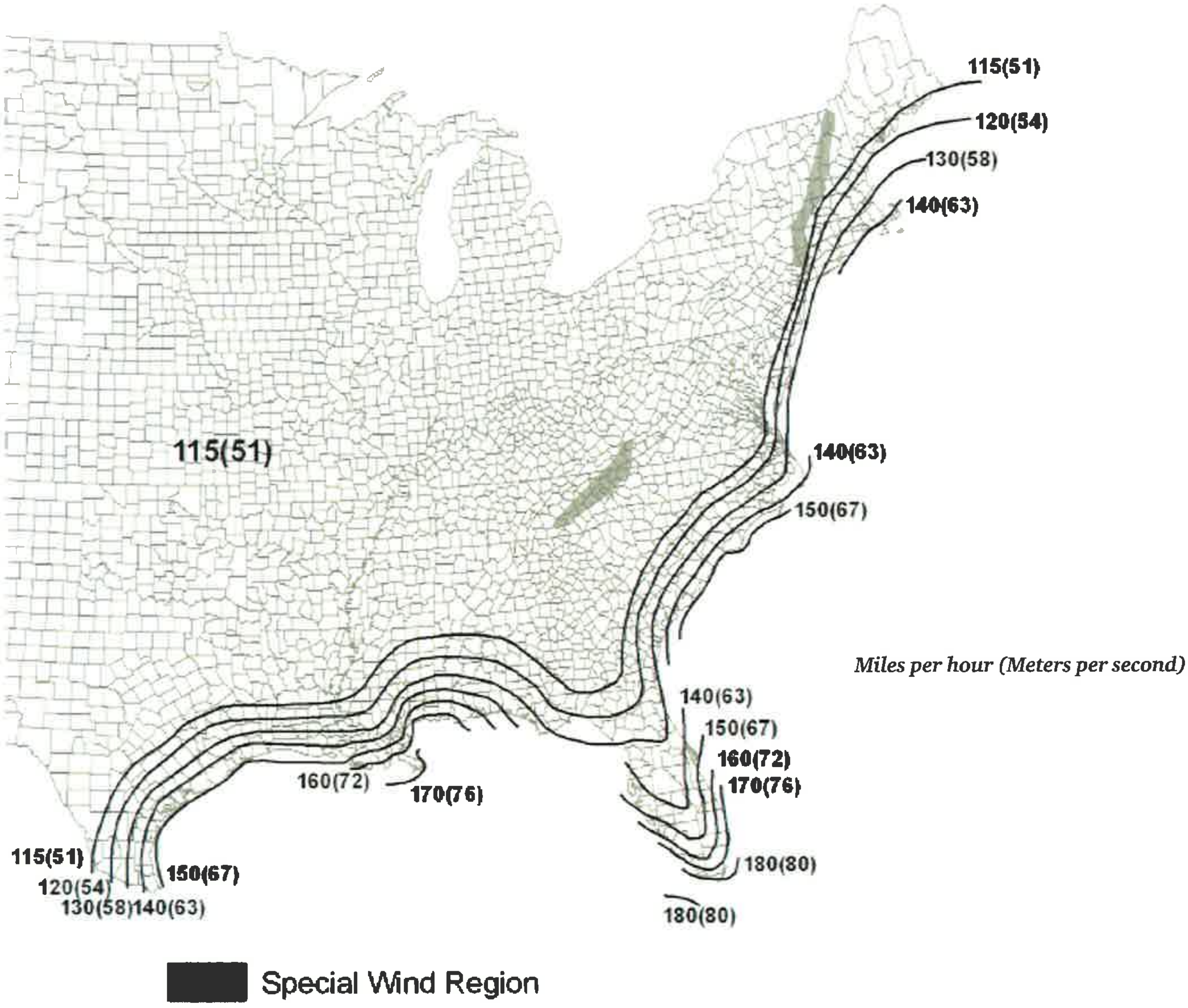
Source: ASCE 7-10 Minimum Design Loads for Buildings and Other Structures, Chapter 26



Location	Vmph	(m/s)
Guam	195	(87)
Virgin Islands	165	(74)
American Samoa	160	(72)
Hawaii – Special Wind Region Statewide	130	(58)

Puerto Rico

Figure 26.5-1A (*Continued*)

Source: ASCE 7-10 Minimum Design Loads for Buildings and Other Structures, Chapter 26

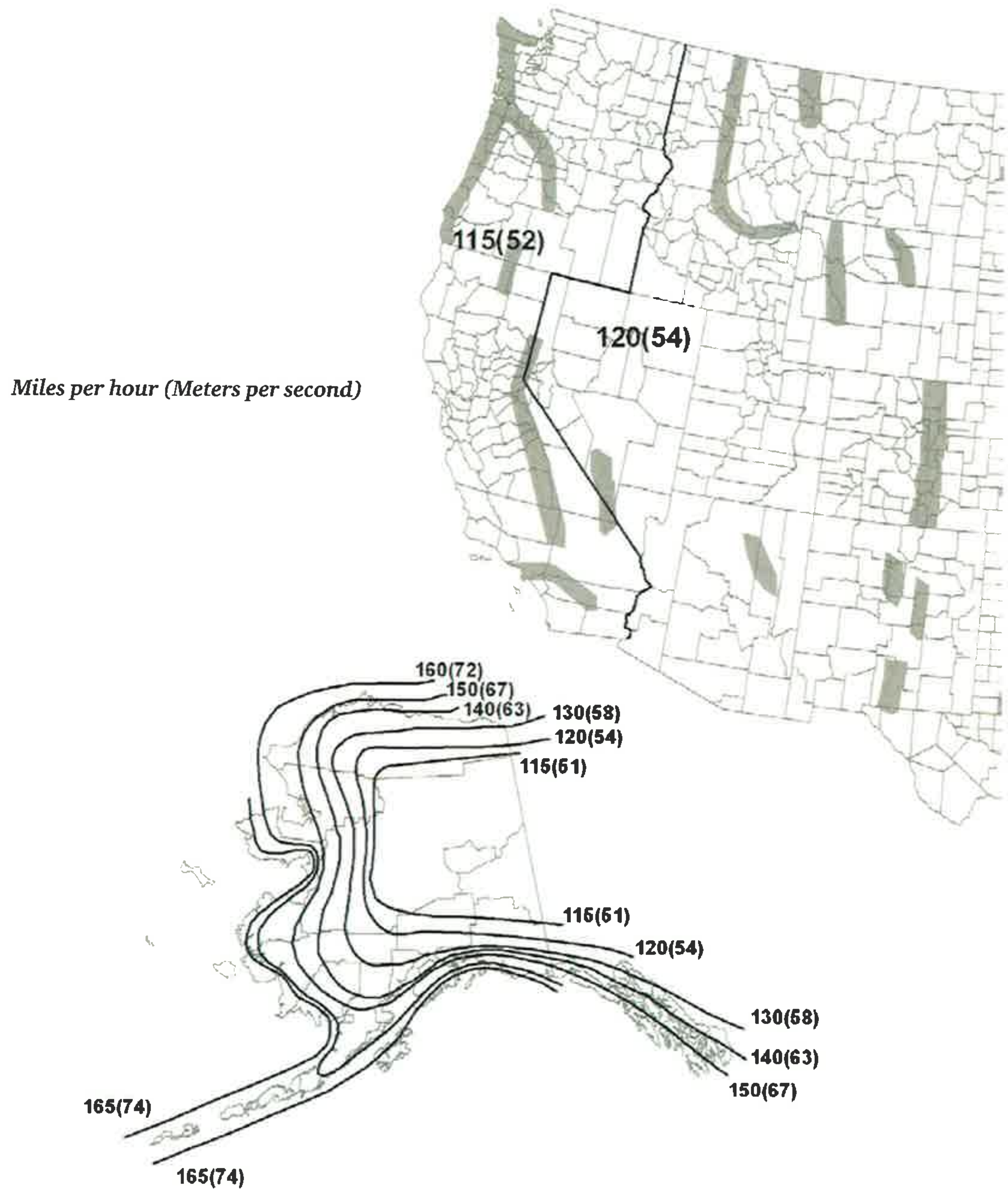
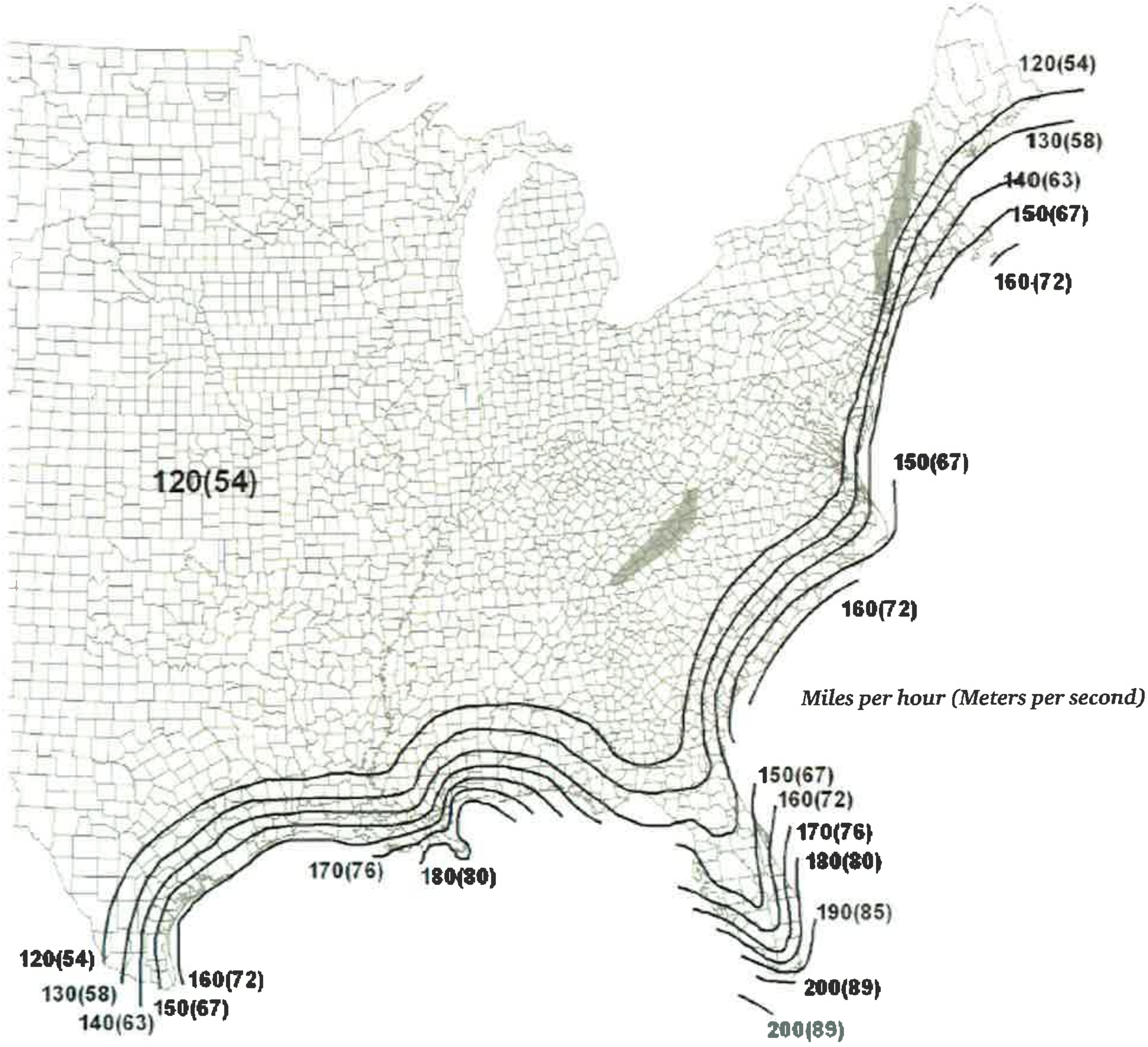


FIGURE 26.5-1B Basic Wind Speeds for Risk Category III and IV Buildings and Other Structures

Notes:

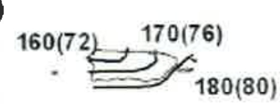
1. Values are design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 3% probability of exceedance in 50 years (annual exceedance probability = 0.000588, MRI = 1700 years).

Source: ASCE 7-10 Minimum Design Loads for Buildings and Other Structures, Chapter 26



Special Wind Region

Location	Vmph	(m/s)
Guam	210	(94)
Virgin Islands	175	(78)
American Samoa	170	(76)
Hawaii – Special Wind Region Statewide	145	(65)



Puerto Rico

Figure 26.5-1B *(Continued)*

Source: ASCE 7-10 Minimum Design Loads for Buildings and Other Structures, Chapter 26

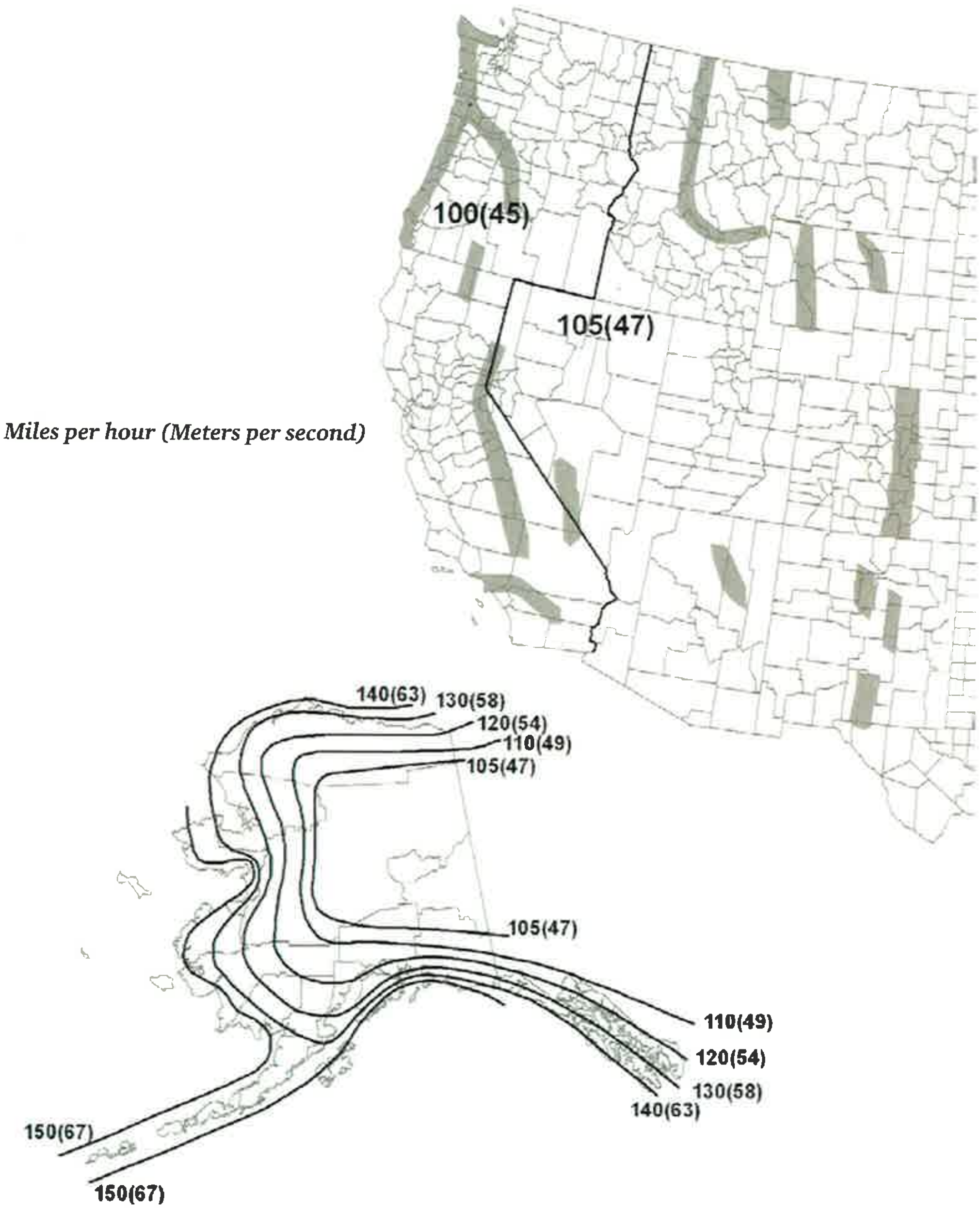
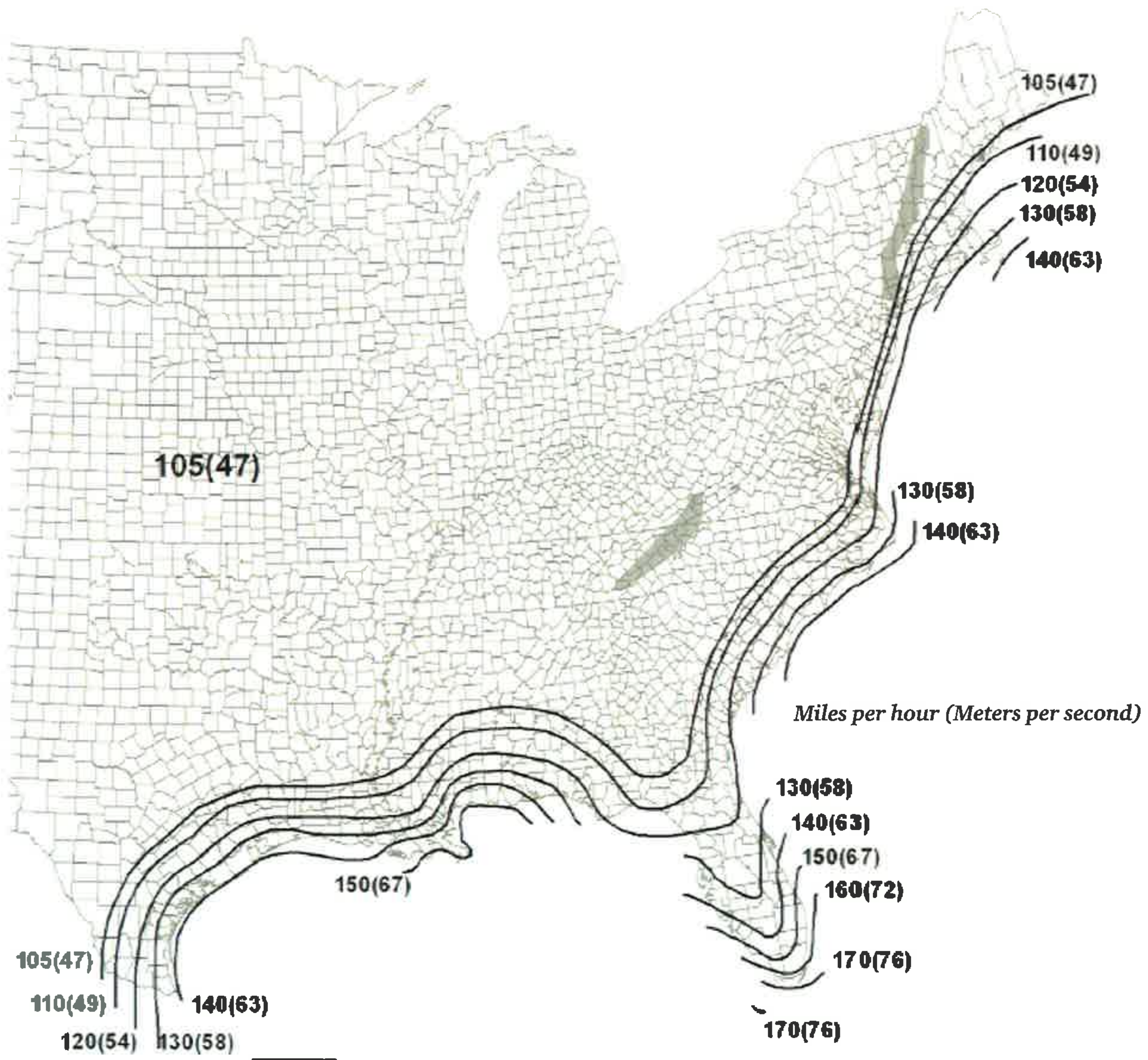


FIGURE 26.5-1C Basic Wind Speeds for Risk Category I Buildings and Other Structures

Notes:

1. Values are design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 15% probability of exceedance in 50 years (annual exceedance probability = 0.00333, MRI = 300 years).

Source: ASCE 7-10 Minimum Design Loads for Buildings and Other Structures, Chapter 26



Special Wind Region

Location	Vmph	(m/s)
Guam	180	(80)
Virgin Islands	150	(67)
American Samoa	150	(67)
Hawaii – Special Wind Region Statewide	115	(51)

Figure 26.5-1c (*Continued*)

Source: ASCE 7-10 Minimum Design Loads for Buildings and Other Structures, Chapter 26

ASCE 7-10

Step 3. Determine Wind Load Parameters

Step 3a: Determine the proper Exposure Category (B, C, or D) for the project by using the following definitions for Surface Roughness Categories.
ASCE 7-10 defines wind surface roughness categories as follows:
Surface Roughness B: Urban and suburban areas, wooded areas, or other terrain with numerous closely
spaced obstructions having the size of single-family dwellings or larger.

Surface Roughness C: Open terrain with scattered obstructions having heights generally less than 30 ft (9.1 m). This category includes flat open country and grasslands.

Surface Roughness D: Flat, unobstructed areas and water surfaces. This category includes smooth mud flats, salt flats, and unbroken ice.

Step 3b: Determine the Topographic Factor, K_{zt}.
For the purposes of this code compliance document, the Topographic Factor, K_{zt}, is taken as equal to one (1) as per Section 26.8-2 or as determined by Figure 26.8-1 in ASCE 7-10.

Step 4. Determine Effective Wind Area

Determine the smallest area of continuous modules you will be installing. This is the smallest area tributary (contributing load) to a support or to a simple-span of rail. That area is the Effective Wind Area, the total area of the fewest number of modules on a run of rails. If the smallest area of continuous modules exceeds 100 sq ft, use 100 sq ft, if less round down to values available in Table 9, page 21.

Step 5. Determine the appropriate roof zone for the installation.

The *Design Wind Load* will vary based on where the installation is located on a roof. Arrays may be located in more than one roof zone.

Using Table 8, page 19, determine the *Roof Zone Dimension Length, a (ft)*, according to the width and height of the building on which you are installing the pv system.

Table 8. Determine Roof/Wall Zone, dimension (**a**) according to building width and height

a = 10 percent of the least horizontal dimension or 0.4h, whichever is smaller, but not less than either 4% of the least horizontal dimension or 3 ft of the building.

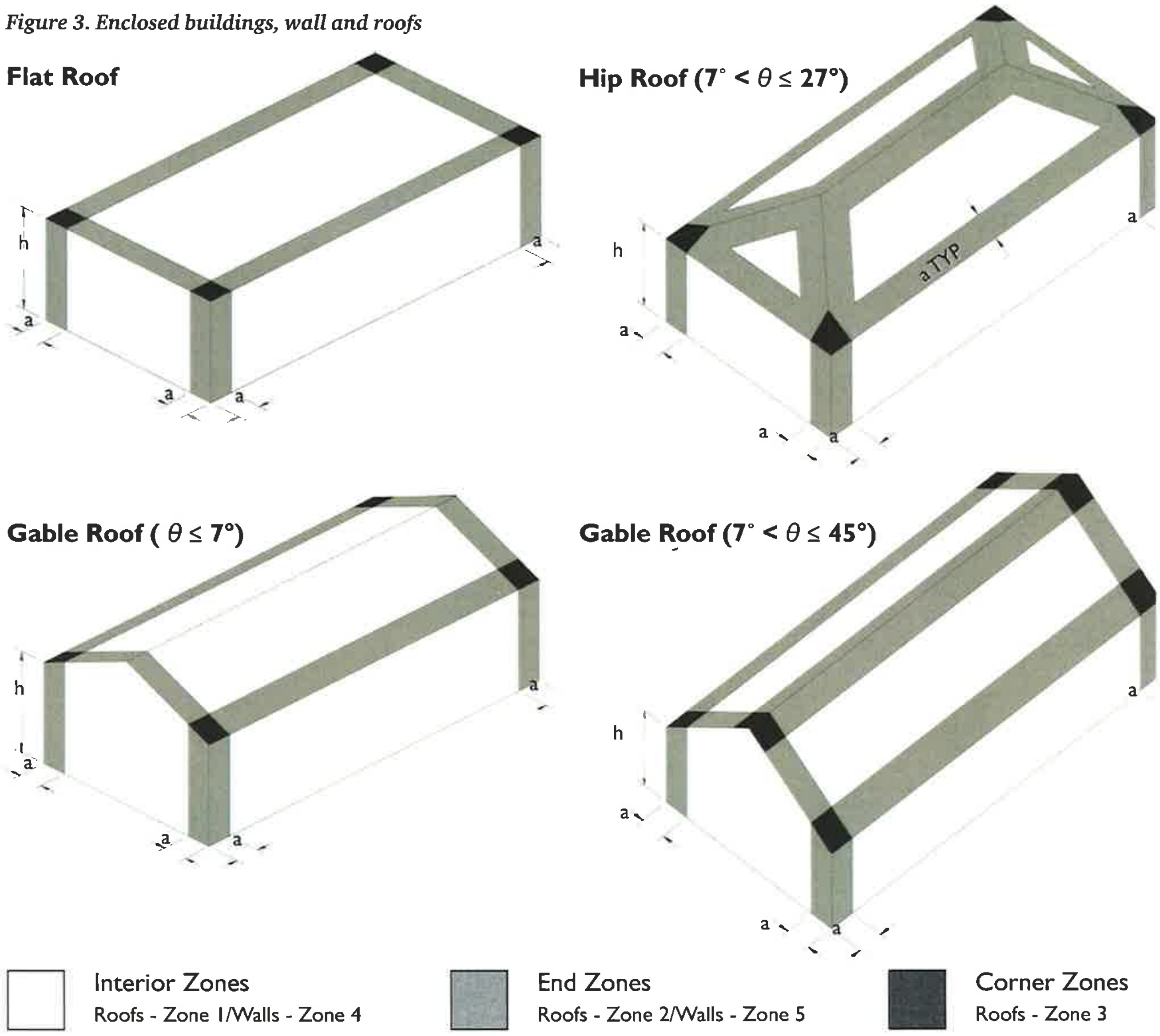
Roof Height (ft)	*Least Horizontal Dimension (ft)*																		
	10	***15***	***20***	***25***	***30***	***40***	***50***	***60***	***70***	***80***	***90***	***100***	***125***	***150***	***175***	***200***	***300***	***400***	***500***
10	3	3	3	3	3	4	4	4	4	4	4	4	5	6	7	8	12	16	20
15	3	3	3	3	3	4	5	6	6	6	6	6	6	6	7	8	12	16	20
20	3	3	3	3	3	4	5	6	7	8	8	8	8	8	8	8	12	16	20
25	3	3	3	3	3	4	5	6	7	8	9	10	10	10	10	10	12	16	20
30	3	3	3	3	3	4	5	6	7	8	9	10	12	12	12	12	12	16	20
35	3	3	3	3	3	4	5	6	7	8	9	10	12.5	14	14	14	14	16	20
40	3	3	3	3	3	4	5	6	7	8	9	10	12.5	15	16	16	16	16	20
45	3	3	3	3	3	4	5	6	7	8	9	10	12.5	15	17.5	18	18	18	20
50	3	3	3	3	3	4	5	6	7	8	9	10	12.5	15	17.5	20	20	20	20
60	3	3	3	3	3	4	5	6	7	8	9	10	12.5	15	17.5	20	24	24	24

Step 5. Determine the appropriate roof zone for the installation (continued)

Using the Roof Zone Dimension Length, a, determine the roof zone locations according to your roof type, gable, hip or monoslope. Determine in which roof zone your pv system is located, Zone 1, 2, or 3 according to Figure 3, page 20.

Reviewed for Code Compliance Universal Engineeri

Figure 3. Enclosed buildings, wall and roofs



Source: ASCE/SEI 7-10, Minimum Design Loads for Buildings and Other Structures, Chapter 30, p. 345.

ASCE 7-10

Step 6. Determine Net Design Wind Pressure, p_{net30} (psf)

Using the Effective Wind Area (Step 4), Roof Zone Location (Step 5), and Basic Wind Speed (Step 2), look up the appropriate Net Design Wind Pressure in Table 9, page 21. Use the Effective Wind Area value in the table which is smaller than the value calculated in Step 2. If the installation is located on a roof overhang, use Table 10, page 22. Both downforce and uplift pressures must be considered in overall design. Refer to Section II, Step 1 for applying downforce and uplift pressures. Positive values are acting toward the surface. Negative values are acting away from the surface.

Components and Cladding – Method 1	h ≤ 60 ft.
Figure 30.5-1 (cont'd) — Design Wind Pressures	Walls & Roofs
Enclosed Buildings	

Net Design Wind Pressure, p_{net30} (psf) *(Exposure B at h = 30 ft.)*

	Zone	Effective wind area (sf)	Basic Wind Speed V (mph)																	
			110		115		120		130		140		150		160		180		200	
Roof 0 to 7 degrees	1	10	8.9	-21.8	9.7	-23.8	10.5	-25.9	12.4	-30.4	14.3	-35.3	16.5	-40.5	18.7	-46.1	23.7	-58.3	29.3	-72.0
	1	20	8.3	-21.2	9.1	-23.2	9.9	-25.2	11.6	-29.6	13.4	-34.4	15.4	-39.4	17.6	-44.9	22.2	-56.8	27.4	-70.1
	1	50	7.6	-20.5	8.3	-22.4	9.0	-24.4	10.6	-28.6	12.3	-33.2	14.1	-38.1	16.0	-43.3	20.3	-54.8	25.0	-67.7
	1	100	7.0	-19.9	7.7	-21.8	8.3	-23.7	9.8	-27.8	11.4	-32.3	13.0	-37.0	14.8	-42.1	18.8	-53.3	23.2	-65.9
	2	10	8.9	-36.5	9.7	-39.9	10.5	-43.5	12.4	-51.0	14.3	-59.2	16.5	-67.9	18.7	-77.3	23.7	-97.8	29.3	-120.7
	2	20	8.3	-32.6	9.1	-35.7	9.9	-38.8	11.6	-45.6	13.4	-52.9	15.4	-60.7	17.6	-69.0	22.2	-87.4	27.4	-107.9
	2	50	7.6	-27.5	8.3	-30.1	9.0	-32.7	10.6	-38.4	12.3	-44.5	14.1	-51.1	16.0	-58.2	20.3	-73.6	25.0	-90.9
	2	100	7.0	-23.6	7.7	-25.8	8.3	-28.1	9.8	-33.0	11.4	-38.2	13.0	-43.9	14.8	-50.0	18.8	-63.2	23.2	-78.1
	3	10	8.9	-55.0	9.7	-60.1	10.5	-65.4	12.4	-76.8	14.3	-89.0	16.5	-102.2	18.7	-116.3	23.7	-147.2	29.3	-181.7
	3	20	8.3	-45.5	9.1	-49.8	9.9	-54.2	11.6	-63.6	13.4	-73.8	15.4	-84.7	17.6	-96.3	22.2	-121.9	27.4	-150.5
	3	50	7.6	-33.1	8.3	-36.1	9.0	-39.3	10.6	-46.2	12.3	-53.5	14.1	-61.5	16.0	-69.9	20.3	-88.5	25.0	-109.3
	3	100	7.0	-23.6	7.7	-25.8	8.3	-28.1	9.8	-33.0	11.4	-38.2	13.0	-43.9	14.8	-50.0	18.8	-63.2	23.2	-78.1
Roof > 7 to 27 degrees	1	10	12.5	-19.9	13.7	-21.8	14.9	-23.7	17.5	-27.8	20.3	-32.3	23.3	-37.0	26.5	-42.1	33.6	-53.3	41.5	-65.9
	1	20	11.4	-19.4	12.5	-21.2	13.6	-23.0	16.0	-27.0	18.5	-31.4	21.3	-36.0	24.2	-41.0	30.6	-51.9	37.8	-64.0
	1	50	10.0	-18.6	10.9	-20.4	11.9	-22.2	13.9	-26.0	16.1	-30.2	18.5	-34.6	21.1	-39.4	26.7	-49.9	32.9	-61.6
	1	100	8.9	-18.1	9.7	-19.8	10.5	-21.5	12.4	-25.2	14.3	-29.3	16.5	-33.6	18.7	-38.2	23.7	-48.4	29.3	-59.8
	2	10	12.5	-34.7	13.7	-37.9	14.9	-41.3	17.5	-48.4	20.3	-56.2	23.3	-64.5	26.5	-73.4	33.6	-92.9	41.5	-114.6
	2	20	11.4	-31.9	12.5	-34.9	13.6	-38.0	16.0	-44.6	18.5	-51.7	21.3	-59.3	24.2	-67.5	30.6	-85.4	37.8	-105.5
	2	50	10.0	-28.2	10.9	-30.9	11.9	-33.6	13.9	-39.4	16.1	-45.7	18.5	-52.5	21.1	-59.7	26.7	-75.6	32.9	-93.3
	2	100	8.9	-25.5	9.7	-27.8	10.5	-30.3	12.4	-35.6	14.3	-41.2	16.5	-47.3	18.7	-53.9	23.7	-68.2	29.3	-84.2
	3	10	12.5	-51.3	13.7	-56.0	14.9	-61.0	17.5	-71.6	20.3	-83.1	23.3	-95.4	26.5	-108.5	33.6	-137.3	41.5	-169.5
	3	20	11.4	-47.9	12.5	-52.4	13.6	-57.1	16.0	-67.0	18.5	-77.7	21.3	-89.2	24.2	-101.4	30.6	-128.4	37.8	-158.5
	3	50	10.0	-43.5	10.9	-47.6	11.9	-51.8	13.9	-60.8	16.1	-70.5	18.5	-81.0	21.1	-92.1	26.7	-116.6	32.9	-143.9
	3	100	8.9	-40.2	9.7	-44.0	10.5	-47.9	12.4	-56.2	14.3	-65.1	16.5	-74.8	18.7	-85.1	23.7	-107.7	29.3	-132.9
Roof > 27 to 45 degrees	1	10	19.9	-21.8	21.8	-23.8	23.7	-25.9	27.8	-30.4	32.3	-35.3	37.0	-40.5	42.1	-46.1	53.3	-58.3	65.9	-72.0
	1	20	19.4	-20.7	21.2	-22.6	23.0	-24.6	27.0	-28.9	31.4	-33.5	36.0	-38.4	41.0	-43.7	51.9	-55.3	64.0	-68.3
	1	50	18.6	-19.2	20.4	-21.0	22.2	-22.8	26.0	-26.8	30.2	-31.1	34.6	-35.7	39.4	-40.6	49.9	-51.4	61.6	-63.4
	1	100	18.1	-18.1	19.8	-19.8	21.5	-21.5	25.2	-25.2	29.3	-29.3	33.6	-33.6	38.2	-38.2	48.4	-48.4	59.8	-59.8
	2	10	19.9	-25.5	21.8	-27.8	23.7	-30.3	27.8	-35.6	32.3	-41.2	37.0	-47.3	42.1	-53.9	53.3	-68.2	65.9	-84.2
	2	20	19.4	-24.3	21.2	-26.6	23.0	-29.0	27.0	-34.0	31.4	-39.4	36.0	-45.3	41.0	-51.5	51.9	-65.2	64.0	-80.5
	2	50	18.6	-22.9	20.4	-25.0	22.2	-27.2	26.0	-32.0	30.2	-37.1	34.6	-42.5	39.4	-48.4	49.9	-61.3	61.6	-75.6
	2	100	18.1	-21.8	19.8	-23.8	21.5	-25.9	25.2	-30.4	29.3	-35.3	33.6	-40.5	38.2	-46.1	48.4	-58.3	59.8	-72.0
	3	10	19.9	-25.5	21.8	-27.8	23.7	-30.3	27.8	-35.6	32.3	-41.2	37.0	-47.3	42.1	-53.9	53.3	-68.2	65.9	-84.2
	3	20	19.4	-24.3	21.2	-26.6	23.0	-29.0	27.0	-34.0	31.4	-39.4	36.0	-45.3	41.0	-51.5	51.9	-65.2	64.0	-80.5
	3	50	18.6	-22.9	20.4	-25.0	22.2	-27.2	26.0	-32.0	30.2	-37.1	34.6	-42.5	39.4	-48.4	49.9	-61.3	61.6	-75.6
	3	100	18.1	-21.8	19.8	-23.8	21.5	-25.9	25.2	-30.4	29.3	-35.3	33.6	-40.5	38.2	-46.1	48.4	-58.3	59.8	-72.0
Wall	4	10	21.8	-23.6	23.8	-25.8	25.9	-28.1	30.4	-33.0	35.3	-38.2	40.5	-43.9	46.1	-50.0	58.3	-63.2	72.0	-78.1
	4	20	20.8	-22.6	22.7	-24.7	24.7	-26.9	29.0	-31.6	33.7	-36.7	38.7	-42.1	44.0	-47.9	55.7	-60.6	68.7	-74.8
	4	50	19.5	-21.3	21.3	-23.3	23.2	-25.4	27.2	-29.8	31.6	-34.6	36.2	-39.7	41.2	-45.1	52.2	-57.1	64.4	-70.5
	4	100	18.5	-20.4	20.2	-22.2	22.0	-24.2	25.9	-28.4	30.0	-33.0	34.4	-37.8	39.2	-43.1	49.6	-54.5	61.2	-67.3
	4	500	16.2	-18.1	17.7	-19.8	19.3	-21.5	22.7	-25.2	26.3	-29.3	30.2	-33.6	34.3	-38.2	43.5	-48.4	53.7	-59.8
	5	10	21.8	-29.1	23.8	-31.9	25.9	-34.7	30.4	-40.7	35.3	-47.2	40.5	-54.2	46.1	-61.7	58.3	-78.0	72.0	-96.3
	5	20	20.8	-27.2	22.7	-29.7	24.7	-32.4	29.0	-38.0	33.7	-44.0	38.7	-50.5	44.0	-57.5	55.7	-72.8	68.7	-89.9
	5	50	19.5	-24.6	21.3	-26.9	23.2	-29.3	27.2	-34.3	31.6	-39.8	36.2	-45.7	41.2	-52.0	52.2	-65.8	64.4	-81.3
	5	100	18.5	-22.6	20.2	-24.7	22.0	-26.9	25.9	-31.6	30.0	-36.7	34.4	-42.1	39.2	-47.9	49.6	-60.6	61.2	-74.8
	5	500	16.2	-18.1	17.7	-19.8	19.3	-21.5	22.7	-25.2	26.3	-29.3	30.2	-33.6	34.3	-38.2	43.5	-48.4	53.7	-59.8

Note: For effective areas between the those given above the load may be interpolated, otherwise use the load associated with the lower effective area.

Table 9. p_{net30} (psf) Roof and Wall

Roof Overhang Net Design Wind Pressure, p_{net30} (psf)

(Exposure B at h = 30 ft.)

	Zone	Effective Wind Area (sf)	Basic Wind Speed V (mph) 110	115	130	140	150	160	180	200
Roof 0 to 7 degrees	2	10	-31.4	-34.3	-43.8	-50.8	-58.3	-66.3	-84.0	-103.7
	2	20	-30.8	-33.7	-43.0	-49.9	-57.3	-65.2	-82.5	-101.8
	2	50	-30.1	-32.9	-42.0	-48.7	-55.9	-63.6	-80.5	-99.4
	2	100	-29.5	-32.3	-41.2	-47.8	-54.9	-62.4	-79.0	-97.6
	3	10	-51.6	-56.5	-72.1	-83.7	-96.0	-109.3	-138.3	-170.7
	3	20	-40.5	-44.3	-56.6	-65.7	-75.4	-85.8	-108.6	-134.0
	3	50	-25.9	-28.3	-36.1	-41.9	-48.1	-54.7	-69.3	-85.5
	3	100	-14.8	-16.1	-20.6	-23.9	-27.4	-31.2	-39.5	-48.8
Roof > 7 to 27 degrees	2	10	-40.6	-44.4	-56.7	-65.7	-75.5	-85.9	-108.7	-134.2
	2	20	-40.6	-44.4	-56.7	-65.7	-75.5	-85.9	-108.7	-134.2
	2	50	-40.6	-44.4	-56.7	-65.7	-75.5	-85.9	-108.7	-134.2
	2	100	-40.6	-44.4	-56.7	-65.7	-75.5	-85.9	-108.7	-134.2
	3	10	-68.3	-74.6	-95.3	-110.6	-126.9	-144.4	-182.8	-225.6
	3	20	-61.6	-67.3	-86.0	-99.8	-114.5	-130.3	-164.9	-203.6
	3	50	-52.8	-57.7	-73.7	-85.5	-98.1	-111.7	-141.3	-174.5
	3	100	-46.1	-50.4	-64.4	-74.7	-85.8	-97.6	-123.5	-152.4
Roof > 27 to 45 degrees	2	10	-36.9	-40.3	-51.5	-59.8	-68.6	-78.1	-98.8	-122.0
	2	20	-35.8	-39.1	-50.0	-58.0	-66.5	-75.7	-95.8	-118.3
	2	50	-34.3	-37.5	-47.9	-55.6	-63.8	-72.6	-91.9	-113.4
	2	100	-33.2	-36.3	-46.4	-53.8	-61.7	-70.2	-88.9	-109.8
	3	10	-36.9	-40.3	-51.5	-59.8	-68.6	-78.1	-98.8	-122.0
	3	20	-35.8	-39.1	-50.0	-58.0	-66.5	-75.7	-95.8	-118.3
	3	50	-34.3	-37.5	-47.9	-55.6	-63.8	-72.6	-91.9	-113.4
	3	100	-33.2	-36.3	-46.4	-53.8	-61.7	-70.2	-88.9	-109.8

Table 10. p_{net30} (psf) Roof Overhang

Step 7. Determine adjustment factor for height and exposure category, I

Using the Exposure Category (Step 3) and the roof height, h (ft), look up the adjustment factor for height and exposure (λ) in Table 11, page 23.

Table 11. **Adjustment Factor (λ) for Roof Height & Exposure Category**

Mean roof height (ft)	Exposure B	Exposure C	Exposure D
15	1.00	1.21	1.47
20	1.00	1.29	1.55
25	1.00	1.35	1.61
30	1.00	1.40	1.66
35	1.05	1.45	1.70
40	1.09	1.49	1.74
45	1.12	1.53	1.78
50	1.16	1.56	1.81
55	1.19	1.59	1.84
60	1.22	1.62	1.87

Step 8. Calculate the adjusted wind pressures, p_{net}, (psf)

Multiply the Net Design Wind Pressure, p_{net30} by the adjustment factor for height and exposure, I, the Topographic Factor, K_{zt}.

Where
I = adjustment factor for building height and exposure (Step 7)
K_{zt} = For the purposes of this code compliance document, the Topographic Factor, K_{zt}, is taken as equal to one (1) as per Section 26.8-2 or as determined by Figure 26.8-1 in ASCE 7-10.
P_{net30} = net design wind pressure for Exposure B, at h = 30 ft (Step 6)

The adjusted wind pressures will be used to select the appropriate SOLARMOUNT rail, rail span and attachment spacing.
Use both the positive (downforce) and the negative (uplift) results from this calculation.

Part II. Procedure to Select Rail Span and Rail Type

ASCE 7-05

[2.1.1.] Using Standard Beam Calculations, Structural Engineering Methodology ASCE 7-05

The procedure to determine the Unirac SOLARMOUNT series rail type and rail span uses standard beam calculations and structural engineering methodology. The beam calculations are based on a simply supported beam conservatively, ignoring the reductions allowed for supports of continuous beams over multiple supports. Please refer to **Part I** for more information on beam calculations, equations and assumptions. If beams are installed perpendicular to the eaves on a roof steeper than a 4/12 pitch in an area with a ground snow load greater than 30psf, then additional analysis is required for side loading on the roof attachment and beam.

In using this document, obtaining correct results is dependent upon the following:

1. Obtain the *Snow Load* for your area from your local building official.

2. Obtain the *Design Wind Load*, p_{net}. See **Part I** (Procedure to Determine the Design Wind Load) for more information on calculating the *Design Wind Load*.

3. ***Please Note:*** The terms rail span and footing spacing are interchangeable in this document. See **Figure 4** for illustrations.

4. To use **Table 14** the *Dead Load* for your specific installation must be less than or equal to 5 psf, including modules and Unirac racking systems.

The following procedure will guide you in selecting a Unirac rail for a flush mount installation. It will also help determine the design loading imposed by the Unirac PV Mounting Assembly that the building structure must be capable of supporting.

Step 1: Determine the *Total Design Load*

The *Total Design Load, P (psf)* is determined using ASCE 7-05 2.4.1 (ASD Method equations 3,5,6 and 7) by adding the *Snow Load*[1], S (psf), *Design Wind Load*, p_{net} *(psf)* from **Part I, Step 9, Page 9** and the *Dead Load (psf)*. Both Uplift and Downforce Wind Loads calculated in **Step 9 of Part 1, Page 9** must be investigated. Use **Table 12,** below, to calculate the Total Design Load for the load cases. Use the maximum absolute value of the three downforce cases and the uplift case for sizing the rail. Use the uplift case only for sizing lag bolts pull out capacities **(Part II, Step 6)**. Use the following equations ***or*** **Table 12,** below.

$P\ (psf) = 1.0D + 1.0S^{1}$ (downforce case 1)

$P\ (psf) = 1.0D + 1.0p_{net}$ (downforce case 2)

$P\ (psf) = 1.0D + 0.75S^{1} + 0.75p_{net}$ (downforce case 3)

$P\ (psf) = 0.6D + 1.0p_{net}$ (uplift)

D = Dead Load (psf)

S = Snow Load (psf)

p_{net} *= Design Wind Load (psf) (Positive for downforce, negative for uplift)*

The maximum Dead Load, D (psf), is 5 psf based on market research and internal data.

[1] *Snow Load Reduction - The snow load can be reduced according to Chapter 7 of ASCE 7-05. The reduction is a function of the roof slope, Exposure Factor, Importance Factor and Thermal Factor. Please refer to Chapter 7 of ASCE 7-05 for more information.*

Table 12. ASCE 7-05 Load Combinations

Description	Variable	Downforce Case 1	Downforce Case 2	Downforce Case 3	Uplift	units
Dead Load	D	1.0 x	1.0 x	1.0 x	0.6 x	psf
Snow Load	S	1.0 x + ______		0.75 x + ______		psf
Design Wind Load	Pnet		1.0 x + ______	0.75 x + ______	1.0 x -	psf
Total Design Load	P					psf

Note: Table to be filled out or attached for evaluation.

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ASCE 7-10

[2.1.2.] Using Standard Beam Calculations, Structural Engineering Methodology ASCE 7-10

Step 1. Determine the Total Design Load

The Total Design Load, P (psf) is determined using ASCE 7-10 2.4.1 (ASD Method equations 3, 5, 6a and 7) by adding the Snow Load, S (psf), Design Wind Load, p_{net} (psf) from Step 8, Page 23 of section 1.2.2 and the Dead Load (psf). Both Uplift and Downforce Wind Loads calculated in Step 8, Page 23 of section 1.2.2 must be investigated. Use Table 13 to calculate the Total Design Load for the load cases. Use the maximum absolute value of the three downforce cases and the uplift case for sizing the rail. Use the uplift case only for sizing lag bolts pull out capacities. Use the following equations or Table 13, below.

$P\,(psf) = 1.0D + 1.0S^1$ (downforce case 1)

$P\,(psf) = 1.0D + 0.6p_{net}$ (downforce case 2)

$P\,(psf) = 1.0D + 0.75S^1 + 0.75(0.6p_{net})$ (downforce case 3)

$P\,(psf) = 0.6D + 0.6p_{net}$ (uplift)

D = Dead Load (psf)

S = Snow Load (psf)

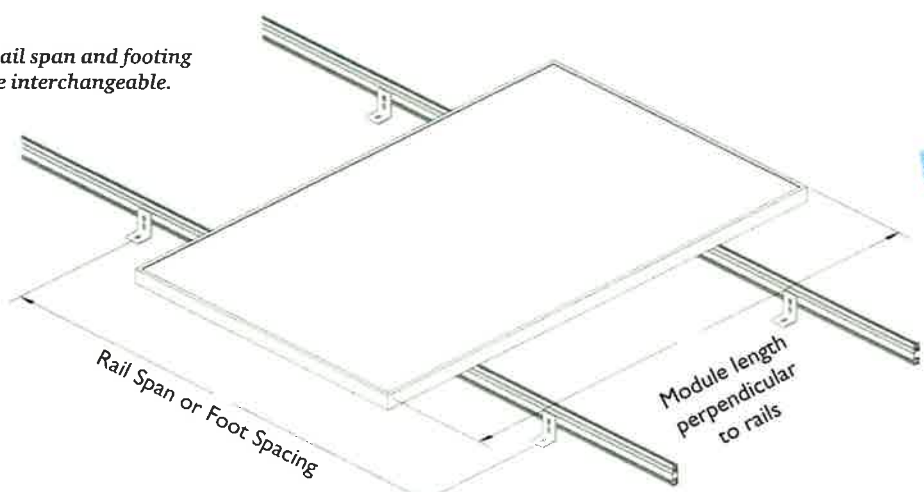
p_{net} *= Design Wind Load (psf) (Positive for downforce, negative for uplift)*

Table 13. ASCE 7-10 Load Combinations

Description	Variable	Downforce Case 1	Downforce Case 2	Downforce Case 3	Uplift	units
Dead Load	D	1.0 x	1.0 x	1.0 x	0.6 x	psf
Snow Load	S	1.0 x + ______		0.75 x + ______		psf
Design Wind Load	Pnet		0.6 x + ______	0.75 x + ______	0.6 x -	psf
Total Design Load	P					psf

Note: Table to be filled out or attached for evaluation.

Figure 4. Rail span and footing spacing are interchangeable.



***Note:** Modules must be centered symmetrically on the rails (+/- 2*), as shown.*

ASCE 7-05 AND ASCE 7-10

Step 2: Determine the *Distributed Load on the rail, w (plf)*

Determine the *Distributed Load, w (plf)*, by multiplying the module length, B (ft), by the *Total Design Load, P (psf)* and dividing by two. Use the maximum absolute value of the three downforce cases and the Uplift Case. We assume each module is supported by two rails.

$$w = PB/2$$

w = Distributed Load (pounds per linear foot, plf)

B = Module Length Perpendicular to Rails (ft)

P = Total Design Pressure (pounds per square foot, psf)

Step 3: Determine *Rail Span/ L-Foot Spacing*

Using the *distributed load, w*, from Part II, **Step 2**, look up the *allowable spans, L*, for each Unirac rail type, SOLARMOUNT (SM) and SOLARMOUNT Heavy Duty (HD) in table 14.

The L-Foot SOLARMOUNT Series Rail Span Table uses a single L-foot connection to the roof, wall or stand-off. Please refer to the **Part III** for more installation information.

Table 14. L-Foot SOLARMOUNT Series Rail Span

SM - SOLARMOUNT **HD - SOLARMOUNT Heavy Duty**

Span (ft)	Distributed Load (pounds/linear foot)															
	20	25	30	40	50	60	80	100	120	140	160	180	200	220	240	260
2	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM
2.5	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD
3	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD	HD	HD
3.5	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD	HD		
4	SM	SM	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD	HD			
4.5	SM	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD					
5	SM	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD					
5.5	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD						
6	SM	SM	SM	SM	SM	SM	SM	HD	HD							
6.5	SM	SM	SM	SM	SM	SM	SM	HD	HD							
7	SM	SM	SM	SM	SM	SM	HD	HD								
7.5	SM	SM	SM	SM	SM	SM	HD	HD								
8	SM	SM	SM	SM	SM	SM	HD	HD								
8.5	SM	SM	SM	SM	SM	HD	HD									
9	SM	SM	SM	SM	HD	HD	HD									
9.5	SM	SM	SM	SM	HD	HD	HD									
10	SM	SM	SM	HD	HD	HD	HD									
10.5	SM	SM	SM	HD	HD	HD										
11	SM	SM	HD	HD	HD	HD										
11.5	SM	HD	HD	HD	HD	HD										
12	SM	HD	HD	HD	HD	HD										

Step 4: Select Rail Type

Selecting a span and rail type affects the price of your installation. Longer spans produce fewer wall or roof penetrations. However, longer spans create higher point load forces on the building structure. A point load force is the amount of force transferred to the building structure at each connection.

It is the installer's responsibility to verify that the building structure is strong enough to support the point load forces.

Step 5: Determine the Downforce *Point Load, R (lbs)*, at each connection based on rail span

When designing the Unirac Flush Mount Installation, you must consider the downforce Point Load, R (lbs) on the roof structure.

The *Downforce, Point Load, R (lbs)*, is determined by multiplying the *Total Design Load, P (psf)* **(Step 1)** by the *Rail Span, L (ft)* **(Step 3)** and the *Module Length Perpendicular to the Rails, B (ft)* divided by two.

$$R\ (lbs) = PLB/2$$

R = Point Load (lbs)

P = Total Design Load (psf)

L = Rail Span (ft)

B = Module Length Perpendicular to Rails (ft)

It is the installer's responsibility to verify that the building structure is strong enough to support the maximum point loads calculated according to **Step 5**.

Table 15. Downforce Point Load Calculation

Total Design Load (downforce) (max of case 1, 2 or 3):	P		psf	Step 1
Module length perpendicular to rails:	B	x	ft	
Rail Span:	L	x	ft	Step 4
		/2		
Downforce Point Load:	R		lbs	

Step 6: Determine the Uplift Point Load, R (lbs), at each connection based on rail span

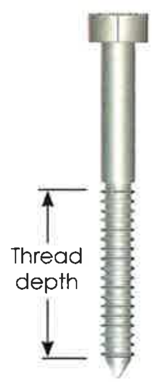
You must also consider the Uplift Point Load, R (lbs), to determine the required lag bolt attachment to the roof (building) structure.

Table 16. Uplift Point Load Calculation

Total Design Load (uplift):	P			psf	Step 1
Module length perpendicular to rails:	B	x		ft	
Rail Span:	L	x		ft	Step 4
			/2		
Uplift Point Load:	R			lbs	

Table 17. Lag pull-out (withdrawal) capacities (lbs) in typical roof lumber (ASD)

	Specific gravity	*Lag screw specifications* 5/16" shaft,* per inch thread depth
Douglas Fir, Larch	**0.50**	**266**
Douglas Fir, South	**0.46**	**235**
Engelmann Spruce, Lodgepole Pine (MSR 1650 f & higher)	**0.46**	**235**
Hem, Fir, Redwood (close grain)	**0.43**	**212**
Hem, Fir (North)	**0.46**	**235**
Southern Pine	**0.55**	**307**
Spruce, Pine, Fir	**0.42**	**205**
Spruce, Pine, Fir (E of 2 million psi and higher grades of MSR and MEL)	**0.50**	**266**



Sources: American Wood Council, NDS 2005, Table 11.2A, 11.3.2A.

Notes: (1) Thread must be embedded in the side grain of a rafter or other structural member integral with the building structure.
(2) Lag bolts must be located in the middle third of the structural member.
(3) These values are not valid for wet service.
(4) This table does not include shear capacities. If necessary, contact a local engineer to specifiy lag bolt size with regard to shear forces.
(5) Install lag bolts with head and washer flush to surface (no gap). Do not over-torque.
(6) Withdrawal design values for lag screw connections shall be multiplied by applicable adjustment factors if necessary. See Table 10.3.1 in the American Wood Council NDS for Wood Construction.

**Use flat washers with lag screws.*

Use **Table 12** to select a lag bolt size and embedment depth to satisfy your Uplift Point Load Force, R (lbs), requirements. Divide the uplift pointload (from **Table 11**) by the withdrawal capacity in the 2nd column of **Table 12.** This results in inches of 5/16 lagbolt embedded thread depth needed to counteract the uplift force. If other than lag bolt is used (as with a concrete or steel), consult fastener mfr documentation.

It is the installer's responsibility to verify that the substructure and attachment method is strong enough to support the maximum point loads calculated according to Step 5 and Step 6.

Part III. Installing SOLARMOUNT

The Unirac Code-Compliant Installation Instructions support applications for building permits for photovoltaic arrays using Unirac PV module mounting systems.

This manual, SOLARMOUNT Planning and Assembly, governs installations using the SOLARMOUNT and SOLARMOUNT HD (Heavy Duty) systems.

[3.1.] SOLARMOUNT rail components

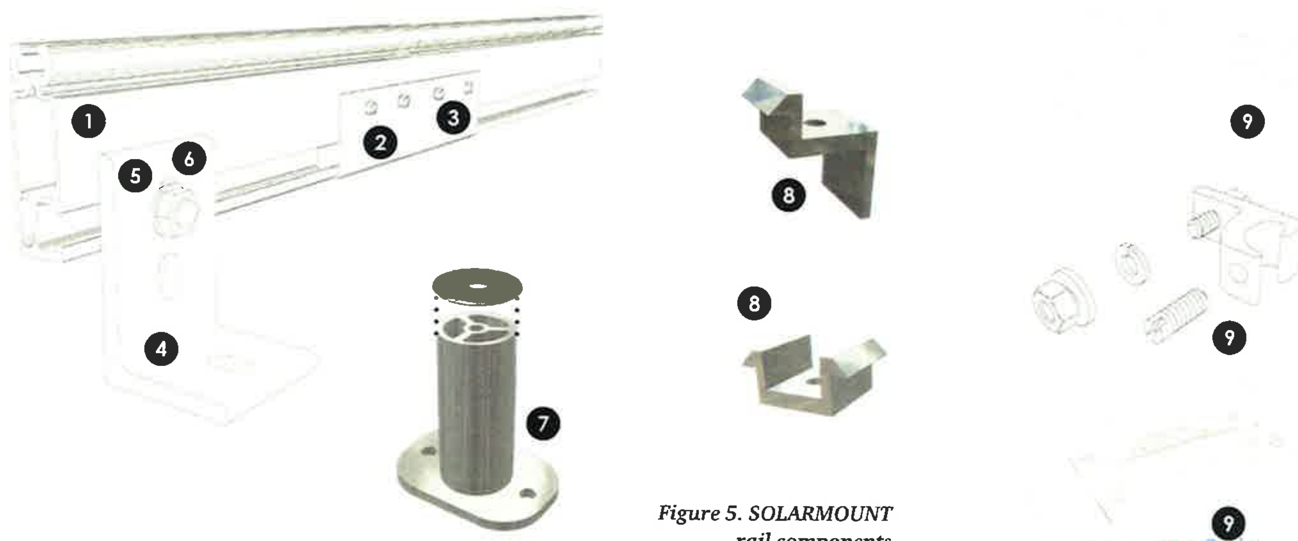


Figure 5. SOLARMOUNT rail components

❶ **Rail** – Supports PV modules. Use two per row of modules. Aluminum extrusion, available in mill finish, clear anodized, or dark anodized.

❷ **Rail splice** – Joins and aligns rail sections into single length of rail. It can form either a rigid or thermal expansion joint, 8 inches long, predrilled. Aluminum extrusion, anodized, clear or dark.

❸ **Self-drilling screw** – (No. 10 x ¾") – Use 4 per rigid splice or 2 per expansion joint. Galvanized steel. Supplied with splice.

❹ **L-foot** – Use to secure rails either through roofing material to building structure or standoffs. Refer to loading tables or U-Builder for spacing.

❺ **L-foot bolt** (3/8" x ¾") – Use one per L-foot to secure rail to L-foot. Stainless steel. Supplied with L-foot.

❻ **Flange nut** (3/8") – Use one per L-foot to secure rail to L-foot. Stainless steel. Supplied with L-foot

❼ **Aluminum two-piece standoff** (optional) (3", 4", 6" or 7" total height) – Use one per L-foot. Includes 3/8" x 3/4" serrated flange bolt with EPDM washer for attaching L-foot. Unirac offers flashings for use with standoffs.

❽ **Top Mounting Clamps** - Includes T-bolts.

❾ **Top Mounting Grounding Clips and Lugs**

Installer supplied materials:

- **Lag screw for L-foot** – Attaches L-foot or standoff to rafter. Determine the length and diameter based on pull-out values. If lag screw head is exposed to elements, use stainless steel. Under flashings, zinc plated hardware is adequate.
- **Waterproof roofing sealant** – Use a sealant appropriate to your roofing material. Consult with the company currently providing warranty of roofing.

[3.2.] Installing SOLARMOUNT & SMHD with top mounting clamps

This section covers SOLARMOUNT standard and SMHD rack assembly where the installer has elected to use top mounting clamps to secure modules to the rails. It details the procedure for flush mounting SOLARMOUNT systems to a pitched roof.

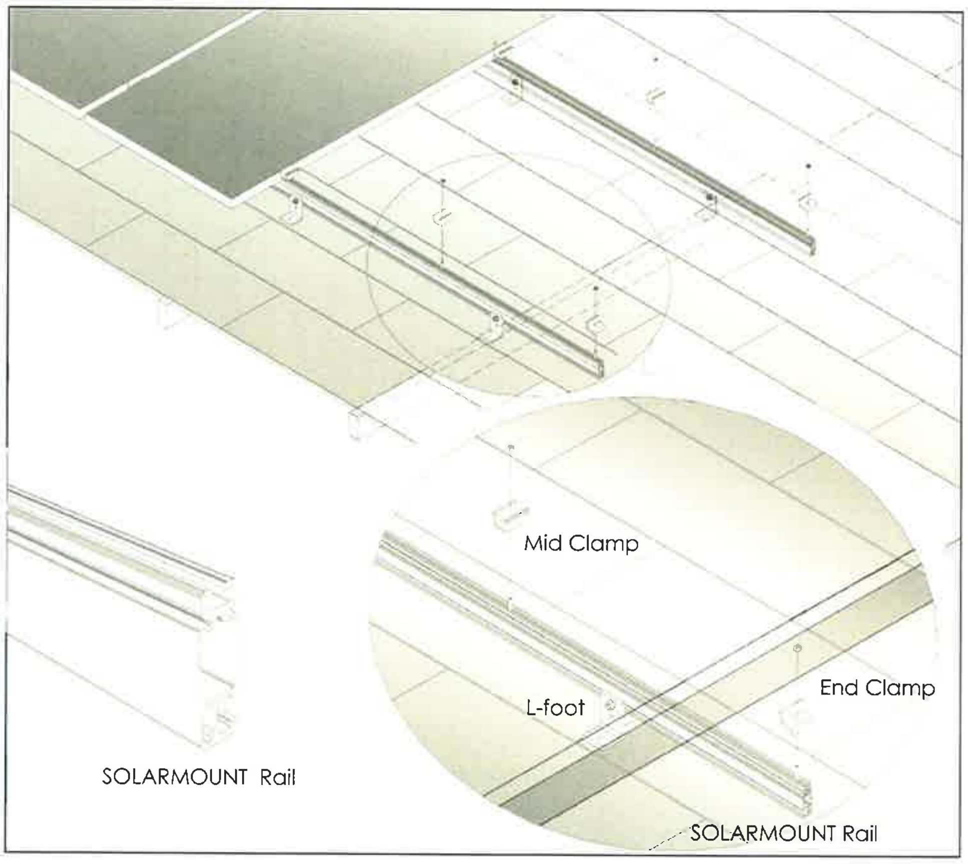


Figure 6. Exploded view of a flushmount installation mounted with L-feet.

Table 18. Wrenches and Torque

	Wrench size	* Recommended torque (ft-lbs)
¼″ hardware	7/16″	10 ⚠
3/8″ hardware	9/16″	30

Torques are not designated for use with wood connectors
*With anti-seize

⚠ *All top down clamps must be installed with anti-seize lubricant to prevent galling and provide uniformity in clamp load. 1/4" - 20 hardware used in conjunction with top down clamps must be installed to 10 ft-lbs of torque. When using UGC-1, UGC-2, WEEB 9.5 and WEEB 6.7, 1/4" - 20 hardware must be installed to 10 ft-lbs of torque. Additionally, when used with a top down clamp, the module frame cross section must be boxed shaped as opposed to a single, l-shaped member. Please refer to installation supplement **910: Galling and Its Prevention** for more information on galling and anti-seize and installation manual **225.6: Top Mounting Unirac Grounding Clips and WEEBLugs** for more information on Grounding Clips.*

[3.2.1] Planning your SOLARMOUNT installations

The installation can be laid out with rails parallel to the rafters or perpendicular to the rafters. Note that SOLARMOUNT rails make excellent straight edges for doing layouts.

Center the installation area over the structural members as much as possible.

Leave enough room to safely move around the array during installation. Some building codes and fire codes require minimum clearances around such installations, and the user should be directed to also check 'The Code'.

The length of the installation area is equal to:

- the total width of the modules,
- plus 1 inch for each space between modules (for mid-clamp),
- plus 3 inches (1½ inches for each pair of end clamps).

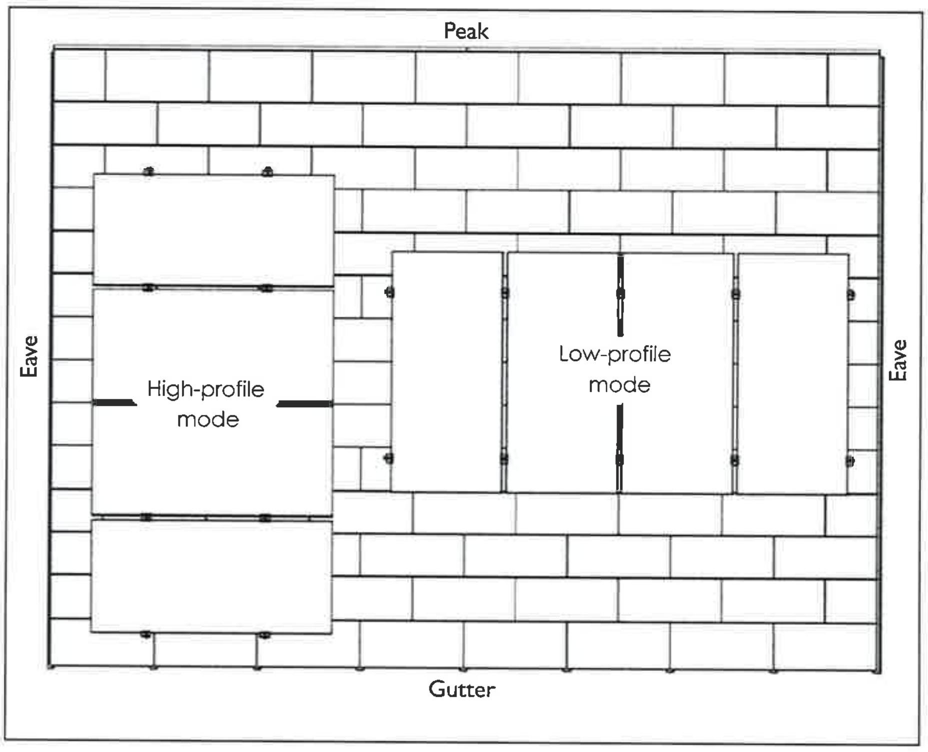


Figure 7. Rails may be placed parallel or perpendicular to rafters.

[3.2.2] Laying out L-feet for top clamps

L-feet (**Fig. 8**), in conjunction with proper flashing equipment and techniques, can be used for attachment through existing roofing material, such as asphalt shingles, sheathing or sheet metal to the building structure.

Use **Figure 9** below to locate and mark the position of the L-feet lag screw holes within the installation area.

If multiple rows are to be installed adjacent to one another, it is not likely that each row will be centered above the rafters. Adjust as needed, following the guidelines in **Figure 9** as closely as possible.

Figure 8

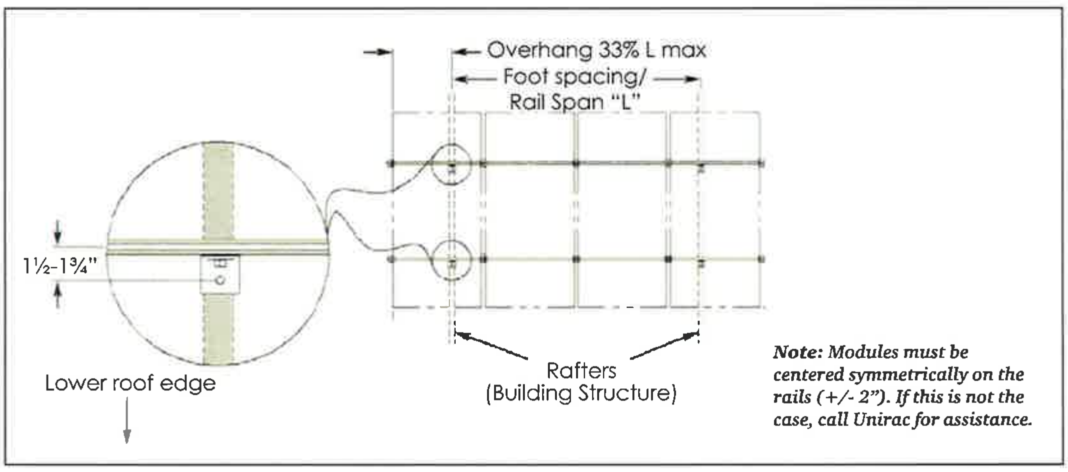


Figure 9. Layout with rails perpendicular to rafters.

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[3.2.3] Laying out standoffs

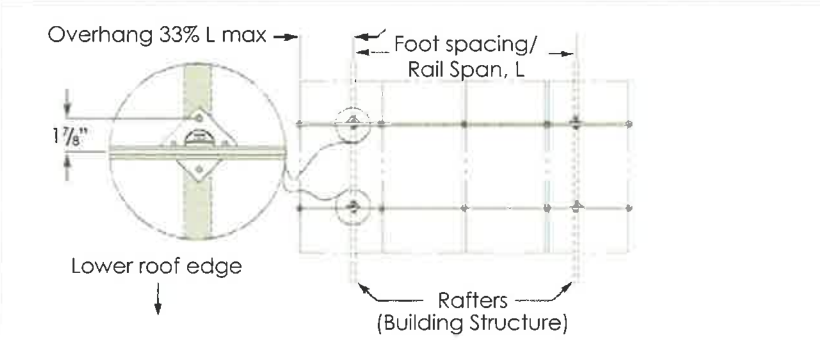
Standoffs (**Figure 10**) are used to increase the height of the array above the surface of the roof. Pair each standoff with a flashing to seal the lag bolt penetrations to the roof.

Use **Figure 11 or 12** to locate and mark the location of the standoff lag screw holes within the installation area.

Remove the tile or shake, if necessary, underneath each standoff location, exposing the roofing underlayment. Ensure that the standoff base lies flat on the underlayment, but remove no more material than required for the flashings to be installed properly.

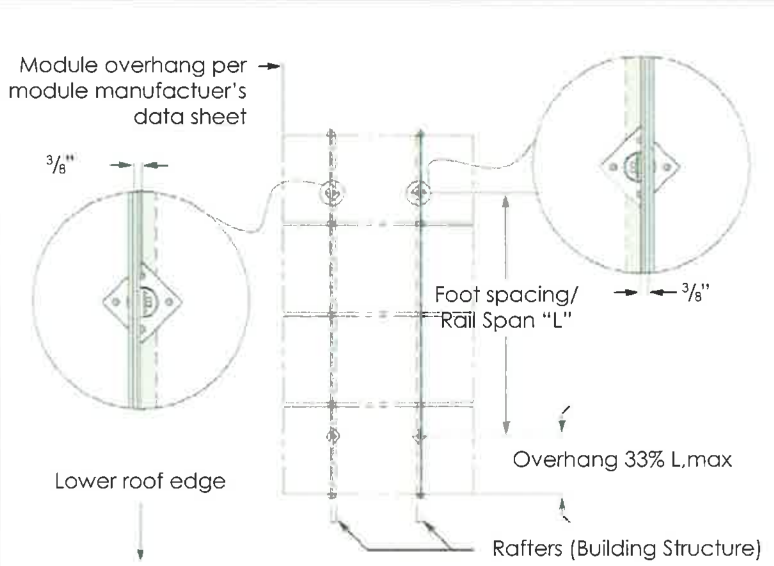
The standoffs must be firmly attached to the building structure.

Figure 10. Standoff used in conjunction with an L-foot.



***Note:** Modules must be centered symmetrically on the rails (+/- 2"). If this is not the case, call Unirac for assistance.*

Figure 11. Layout with rails perpendicular to rafters.perpendicular to rafters.



***Note:** Modules must be centered symmetrically on the rails (+/- 2*). If this is not the case, call Unirac for assistance.*

Figure 12. Layout with rails parallel to rafters.

If multiple high-profile rows are to be installed adjacent to each other, it may not be possible for each row to be centered above the rafters. Adjust as needed, following the guidelines of **Fig. 12** as closely as possible.

Installing standoffs:

Drill 3/16 inch pilot holes through the underlayment into the center of the rafters at each standoff location. Securely fasten each standoff to the rafters with the two 5/16" lag screws.

Ensure that the standoffs face as shown in **Figure 11 or 12**.

Unirac standoffs (1-5/8" O.D.) are designed for collared flashings available from Unirac.

Install and seal flashings and standoffs using standard building practices or as the company providing roofing warranty directs.

[3.2.4] Installing SOLARMOUNT rails

Keep rail slots free of roofing grit or other debris. Foreign matter will cause bolts to bind as they slide in the slots.

Installing Splices: If your installation uses SOLARMOUNT splice bars, attach the rails together (**Fig. 13**) before mounting the rails to the footings. Use splice bars only with flush installations or those that use low-profile tilt legs.

Although structural, the joint is not as strong as the rail itself. A rail should always be supported by ***more than one*** footing on ***both*** sides of the splice. (Reference installation manual 908, Splices/Expansion Joints.)

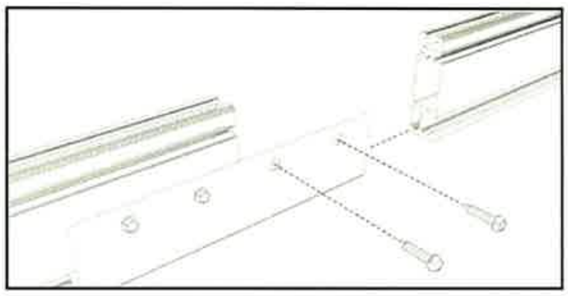


Figure 13. Splice bars slide into the footing bolt slots of SOLARMOUNT rail sections.

Mounting Rails on Footings: Rails may be attached to either of two mounting holes in the L-feet (**Fig. 14**). Mount in the lower hole for a low profile, more aesthetically pleasing installation. Mount in the upper hole for a higher profile, which will maximize airflow under the modules. This will cool them more and may enhance performance in hotter climates.

Slide the ⅜-inch mounting bolts into the footing bolt slots. Loosely attach the rails to the footings with the flange nuts.

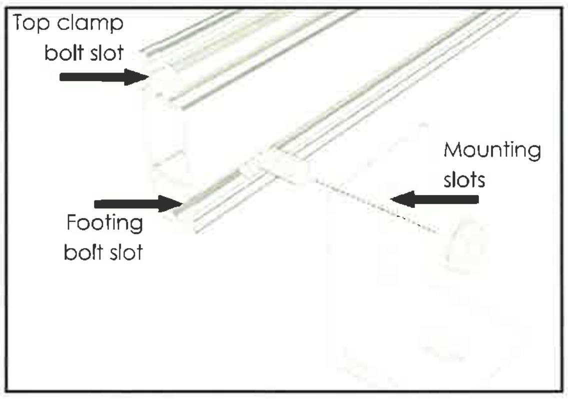


Figure 14. Foot-to-rail attachment

Aligning the Rail End: Align one pair of rail ends to the edge of the installation area (**Fig. 15 or Fig. 16**).

The opposite pair of rail ends will overhang the side of the installation area. Do not trim them off until the installation is complete.

If the rails are perpendicular to the rafters (**Fig. 15**), either end of the rails can be aligned, but the first module must be installed at the aligned end.

If the rails are parallel to the rafters (**Fig. 16**), the aligned end of the rails must face the lower edge of the roof. Securely tighten all hardware after alignment is complete (20 ft lbs).

Mount modules to the rails as soon as possible. Large temperature changes may bow the rails within a few hours if module placement is delayed.

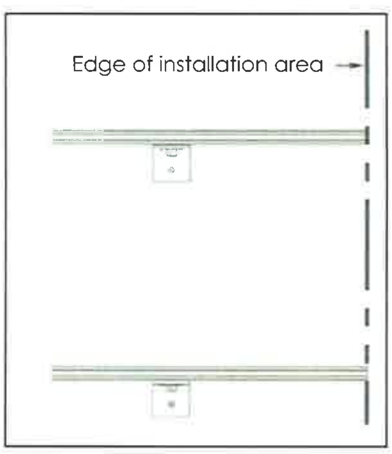


Figure 15. Rails perpendicular to the rafters.

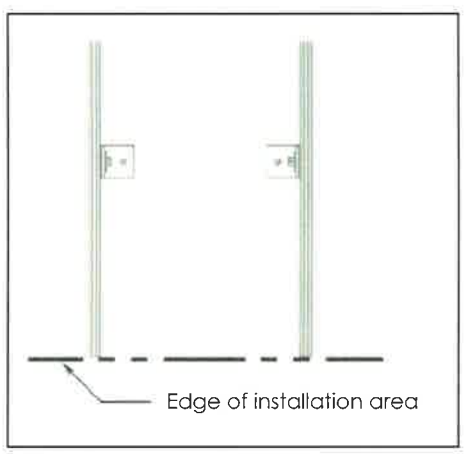


Figure 16. Rails parallel to the rafters.

[3.2.5] Installing the modules

Installing the First Module: In high-profile installations, the best practice would be to install a safety bolt (¼"-20 x ½")and flange nut (both installer provided) fastened to the module bolt slot at the aligned (lower) end of each rail. It will prevent the lower end clamps and clamping bolts from sliding out of the rail slot during installation.

If there is a return cable to the inverter, connect it to the first module. Secure the first module with T-bolts and end clamps at the aligned end of each rail. Allow half an inch between the rail ends and the end clamps (**Fig.18**). Finger tighten flange nuts, center and align the module as needed, and securely tighten the flange nuts (10 ft lbs).

Installing the Other Modules: Lay the second module face down (glass to glass) on the first module. Connect intermodule cable to the second module. Turn the second module face up (**Fig. 17**). With T-bolts, mid-clamps and flange nuts, secure the adjacent sides of the first and second modules. Align the second module and securely tighten the flange nuts (**Fig. 19**).

For a neat installation, fasten wire management devices to rails with self-drilling screws.

Repeat the procedure until all modules are installed. Attach the outside edge of the last module to the rail with end clamps.

Trim off any excess rail, being careful not to cut into the roof. Allow half an inch between the end clamp and the end of the rail (**Fig. 18**).

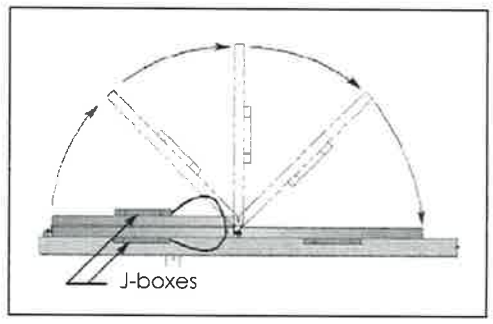


Figure 17

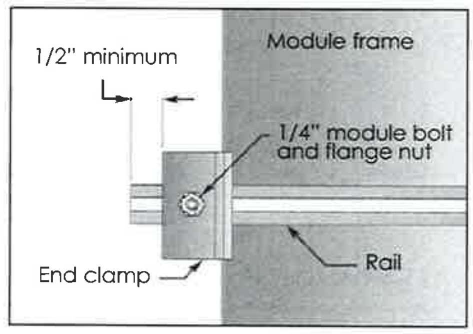


Figure 18

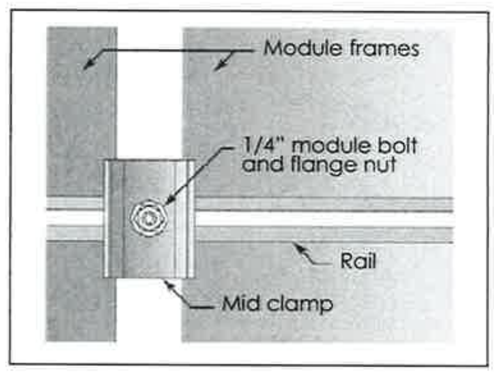


Figure 19

[3.3] Installing SOLARMOUNT with bottom mounting clips, HD rail only

This section covers SOLARMOUNT rack assembly where the installer has elected to use bottom mounting clamps to secure modules to the rails. It details the procedure for flush mounting SOLARMOUNT HD systems to a pitched roof.

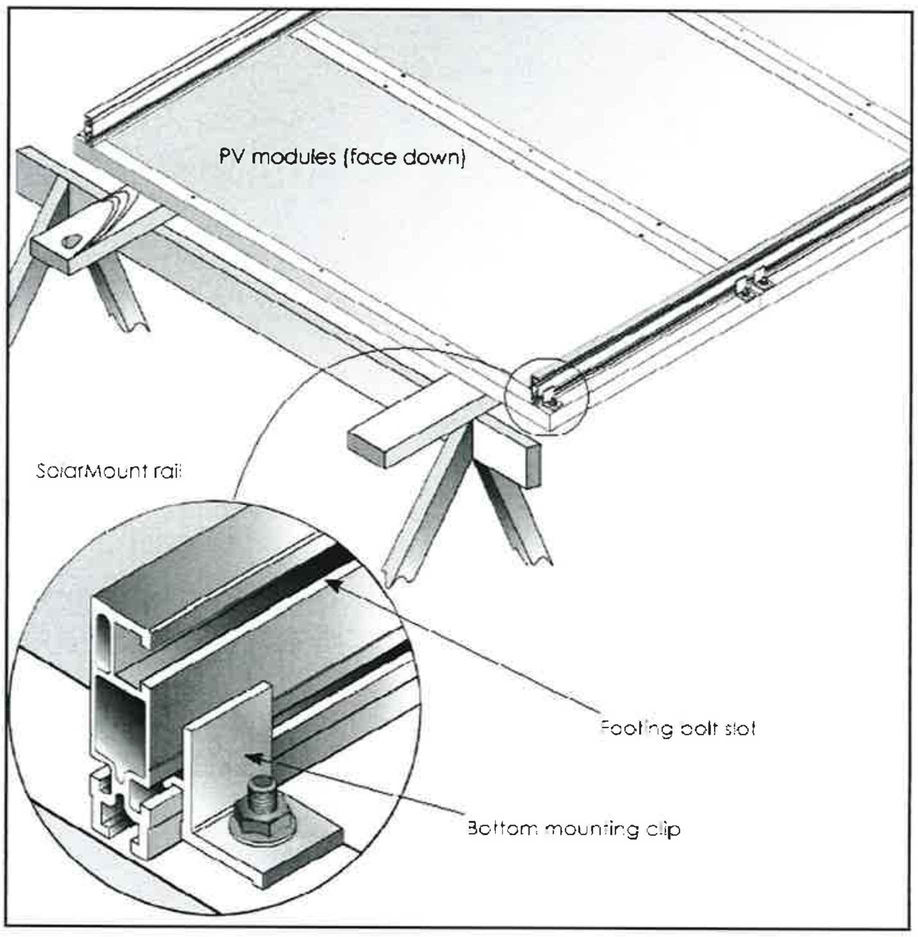


Figure 20. Installing bottom clips

Table 19. Wrenches and torque

	Wrench size	* Recommended torque (ft-lbs)
1/4" hardware	7/16"	10
3/8" hardware	9/16"	30

Note: Torque specifications do not apply to lag bolt connections.

**With anti-seize*

> ⚠ ***Stainless steel hardware can seize up, a process called galling. To significantly reduce its likelihood, (1) apply lubricant to bolts, preferably an anti-seize lubricant, available at auto parts stores, (2) shade hardware prior to installation, and (3) avoid spinning on nuts at high speed. See Installation Supplement 910, Galling and Its Prevention, at www.unirac.com.***

[3.3.1] Planning the installation area

Decide on an arrangement for clips, rails, and L-feet (**Fig. 21**).

Use Arrangement A if the full width of the rails contacts the module. Otherwise use Arrangement B.

Caution: If you choose Arrangement B, either
(1) use the upper mounting holes of the L-feet or
(2) be certain that the L-feet and clip positions don't conflict.

If rails must be parallel to the rafters, it is unlikely that they can be spaced to match rafters. In that case, add structural supports – either sleepers over the roof or mounting blocks beneath it. These additional members must meet code; if in doubt, consult a professional engineer.

Never secure the footings to the roof decking alone. Such an arrangement will not meet code and leaves the installation and the roof itself vulnerable to severe damage from wind.

Leave enough room to safely move around the array during installation. The width of a rail-module assembly equals the length of one module. Note that L-feet may extend beyond the width of the assembly by as much as 2 inches on each side. The length of the assembly equals the total width of the modules.

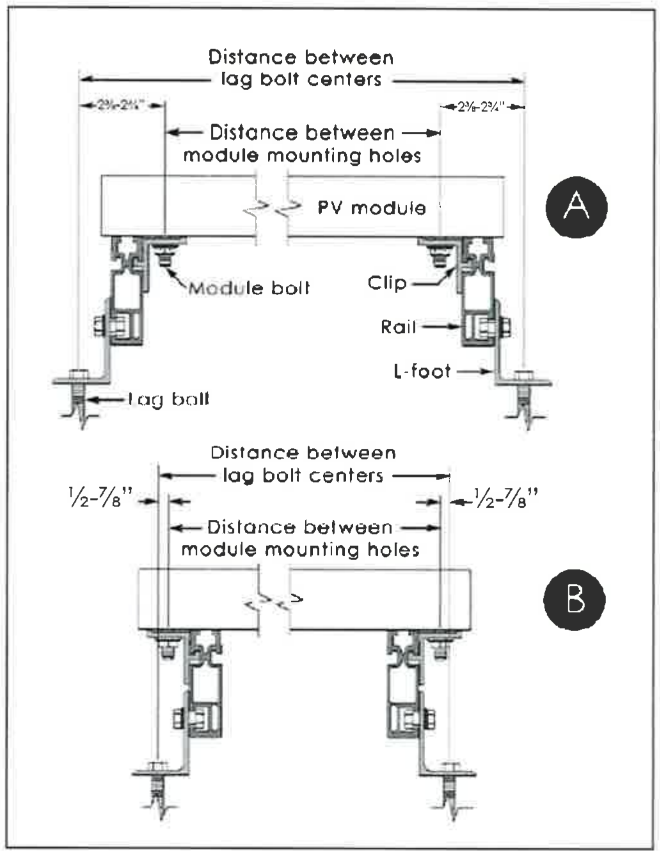


Figure 21. Clip Arrangements A and B

[3.3.2] Laying out the installing L-feet for bottom clips

L-feet, in conjunction with proper flashing equipment and techniques, are used for installation through existing low profile roofing material, such as asphalt shingles or sheet metal. They are also used for most ground mount installations. To ensure that the L-feet will be easily accessible during flush installation:

- Use the PV module mounting holes nearest the ends of the modules.
- Situate the rails so that footing bolt slots face outward.

The single slotted side of the L-foot must always lie against the roof with the double-slotted side perpendicular to the roof.

Foot spacing (along the same rail) and rail overhang depend on design wind loads.

Install half the L-feet:

- If rails are perpendicular to rafters **(Fig. 22)**, install the feet closest to the lower edge of the roof.
- If rails are parallel to rafters **(Fig. 23)**, install the feet for one of the rails, but not both.

Ensure that the L-feet face as shown in **Figure 22 or Figure 23**.

Hold the rest of the L-feet and fasteners aside until the panels are ready for the installation.

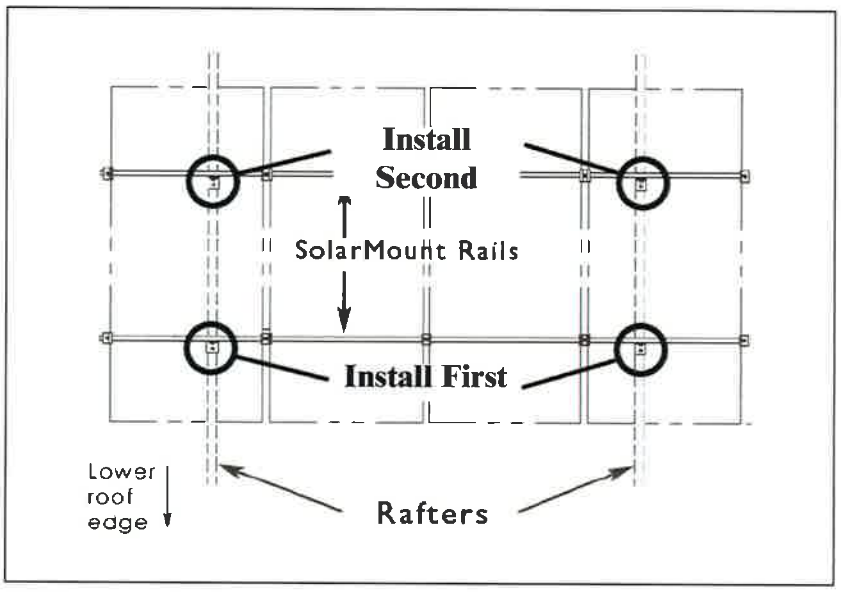


Figure 22. Layout with rails perpendicular to rafters.

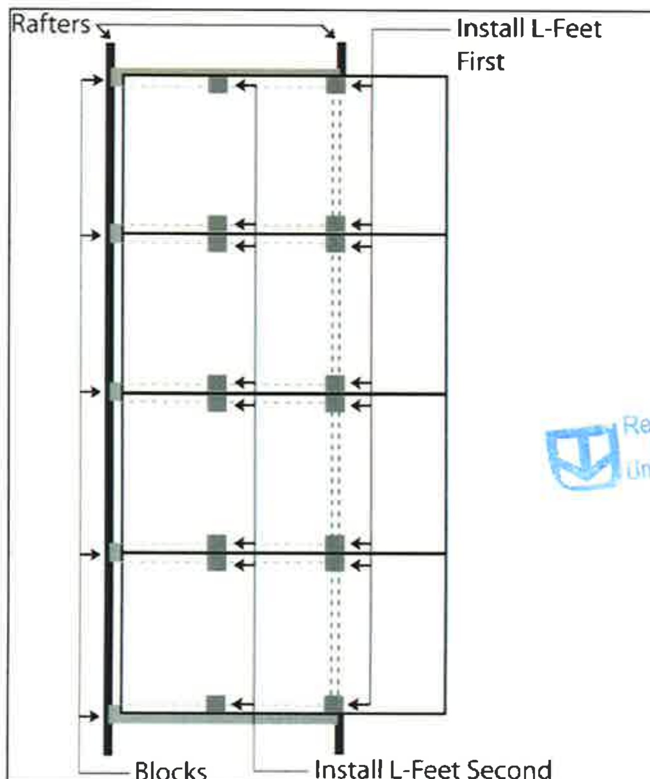


Figure 23. Layout with rails parallel to rafters.

[3.3.3] Attaching modules to the rails

Lay the modules for a given panel face down on a surface that will not damage the module glass. Align the edges of the modules and snug them together (**Fig. 21, page 22**).

Trim the rails to the total width of the modules to be mounted. Place a rail adjacent to the outer mounting holes. Orient the footing bolt slot outward. Place a clip slot adjacent to the mounting holes, following the arrangement you selected earlier.

Assemble the clips, mounting bolts, and flange nuts. Torque the flange nuts to 10 foot-pounds.

[3.3.4] Installing the module-rail assembly

Bring the module-rail assembly to the installation site. Keep rail slots free of debris that might cause bolts to bind in the slots.

Consider the weight of a fully assembled panel. Unirac recommends safety lines whenever lifting one to a roof.

Align the panel with the previously installed L-feet. Slide 3/8 inch L-foot mounting bolts onto the rail and align them with the L-feet mounting holes. Attach the panel to the L-feet and finger tighten the flange nuts.

Rails may be attached to either of two mounting holes in the footings (**Fig. 24**).

- Mount in the lower hole for a low, more aethetically pleasing installation.
- Or mount in the upper hole to maximize a cooling airflow under the modules. This may enhance performance in hotter climates.

Adjust the position of the panel as needed to fit the installation area. Slide the remaining L-feet bolts onto the other rail, attach L-feet, and finger tighten with flange nuts. Align L-feet with mounting holes previously drilled into the roof. Install lag bolts into remaining L-feet as described in "Laying out and installing L-feet" above.

Torque all footing flange nuts to 30 foot-pounds. Verify that all lag bolts are securely fastened.

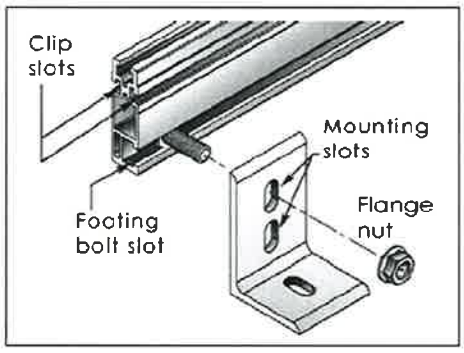
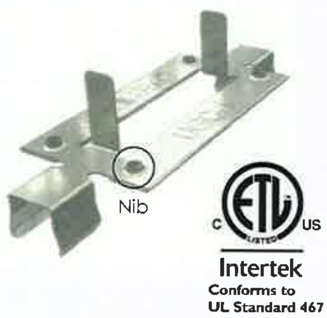


Figure 24. Leg-to-rail attachment

[3.4] Installing SOLARMOUNT with grounding clips and lugs

Clips and lugs are sold separately.

UGC-1



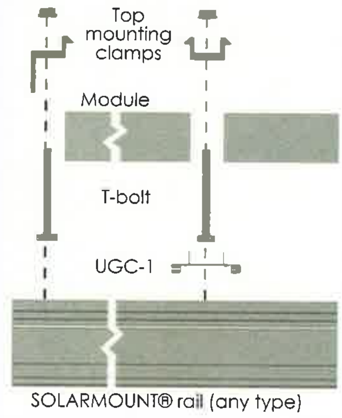


Figure 25. Slide UGC-1 grounding clip into top mounting slot of rail. Torque modules in place on top of clip. Nibs will penetrate rail anodization and create grounding path through rail.

WEEBLug

Figure 26. Insert a bolt in the aluminum rail or through the clearance hole in the stainless steel flat washer. Place the stainless steel flat washer on the bolt, oriented so the dimples will contact the aluminum rail. Place the lug portion on the bolt and stainless steel flat washer. Install stainless steel flat washer, lock washer and nut. Tighten the nut until the dimples are completely embedded into the rail and lug. The embedded dimples make a gas-tight mechanical connection and ensure good electrical connection between the aluminum rail and the lug through the WEEB.

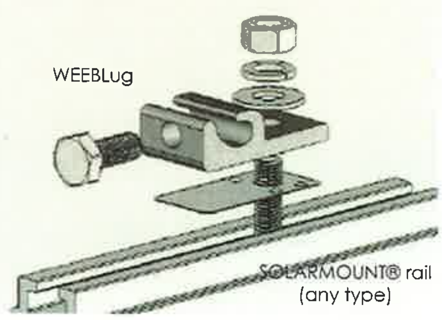
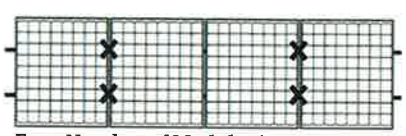
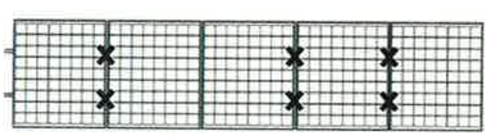


Figure 27. UGC-1 layout for even and odd number of modules in row. "X" denotes places to install UGC-1.

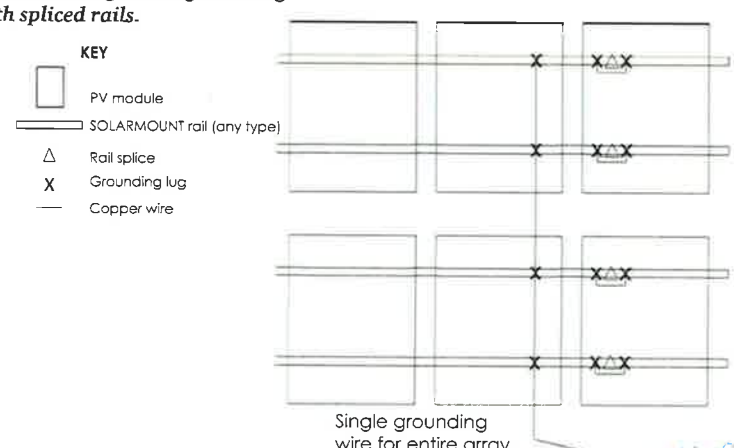


Even Number of Modules in row



Odd Number of Modules in row

Figure 28. Single wire grounding with spliced rails.



AMERISOLAR

Worldwide Energy and Manufacturing USA Co., Limited

AS-6P30

Designed for maximum power output, AS-6P30 modules, offer higher power output over a longer period of time, 30-year warranty.

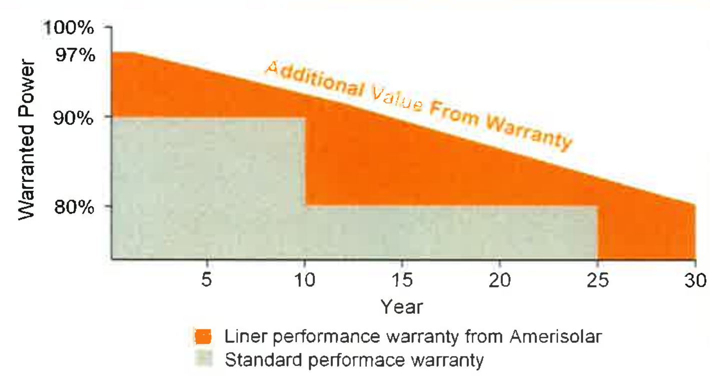
30 YEAR WARRANTY 30 YEAR GUARANTEED

Special Warranties

- 12 year limited product warranty.
- Limited power warranty: 12 years 91.2% of the nominal power output, 30 years 80.6% of the nominal power output.

Key Features

- High module conversion efficiency up to 16.29% through superior * manufacturing technology.
- Low degradation and excellent performance under high temperature and low * light conditions.
- Robust aluminum frame ensures the modules to withstand wind loads up to * 2400Pa and snow loads up to 5400Pa.
- Positive power tolerance of 0 ~ +3 %.
- High ammonia and salt mist resistance.



Quality Certificates

- IEC61215, IEC61730, IEC62716, IEC61701, UL1703, CE, MCS, CEC, Israel Electric, Kemco
- ISO9001:2008: Quality management system
- ISO14001:2004: Environmental management system
- OHSAS18001:2007: Occupational health and safety management system

TÜV Rheinland · c UL us LISTED · Clean Energy Council · חברת החשמל Israel Electric · PV CYCLE · CE · Reviewed for Code Compliance Universal Engineering

Passionately committed to delivering innovative energy solution
www.weamerisolar.com

Electrical Characteristics

Electrical parameters at STC							
Nominal Power (P_{max})	235W	240W	245W	250W	255W	260W	265W
Open Circuit Voltage (V_{OC})	37.5V	37.7V	37.9V	38.0V	38.1V	38.2V	38.3V
Short Circuit Current (I_{SC})	8.48A	8.57A	8.66A	8.75A	8.83A	8.90A	8.98A
Voltage at Nominal Power (V_{mp})	29.7V	29.9V	30.1V	30.3V	30.5V	30.7V	30.9V
Current at Nominal Power (I_{mp})	7.92A	8.03A	8.14A	8.26A	8.37A	8.47A	8.58A
Module Efficiency (%)	14.44	14.75	15.06	15.37	15.67	15.98	16.29

STC: Irradiance 1000W/m^2, Cell temperature 25°C, AM1.5

Electrical parameters at NOCT							
Nominal Power (P_{max})	172W	175W	179W	183W	186W	190W	194W
Open Circuit Voltage (V_{OC})	34.5V	34.7V	34.9V	35.0V	35.1V	35.2V	35.3V
Short Circuit Current (I_{SC})	6.87A	6.94A	7.01A	7.09A	7.15A	7.21A	7.27A
Voltage at Nominal Power (V_{mp})	27.0V	27.2V	27.4V	27.6V	27.8V	27.9V	28.1V
Current at Nominal Power (I_{mp})	6.38A	6.44A	6.54A	6.64A	6.70A	6.81A	6.91A

NOCT: Irradiance 800W/m^2, Ambient temperature 20°C, Wind speed 1 m/s

Mechanical Characteristics

Cell type	Polycrystalline 156x156mm
Number of cells	60 (6x10)
Module dimension	1640x992x40mm
Weight	18.5kg
Front cover	3.2mm low-iron tempered glass
Frame	Anodized aluminum alloy
Junction box	IP67, 6 diodes
Cable	4mm^2, 900mm
Connector	MC4 or MC4 compatible
Standard packaging	26pcs/pallet
Module quantity per container	728pcs/40'HQ

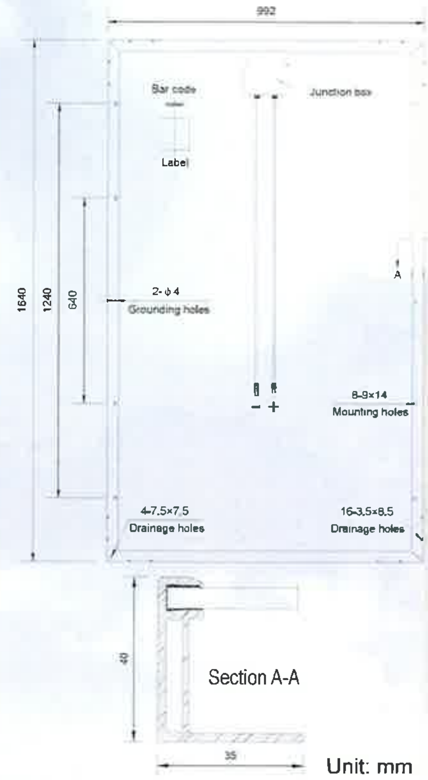
Temperature Characteristics

Nominal Operating Cell Temperature (NOCT)	45°C±2°C
Temperature Coefficients of P_{max}	-0.43%/°C
Temperature Coefficients of V_{OC}	-0.33%/°C
Temperature Coefficients of I_{SC}	0.056%/°C

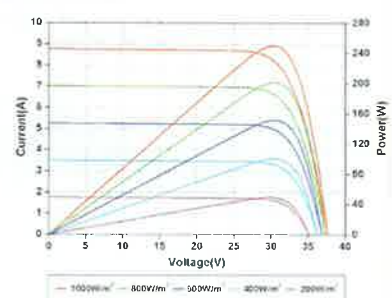
Maximum Ratings

Operating Temperature	-40°C to +85°C
Maximum System Voltage	1000V DC
Maximum Series Fuse Rating	15A

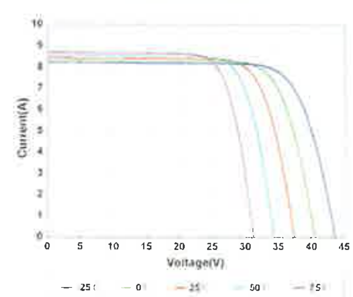
Drawings



I-V Curves



Current-Voltage and Power-Voltage Curves at Different Irradiances



Current-Voltage Curves at Different Temperatures

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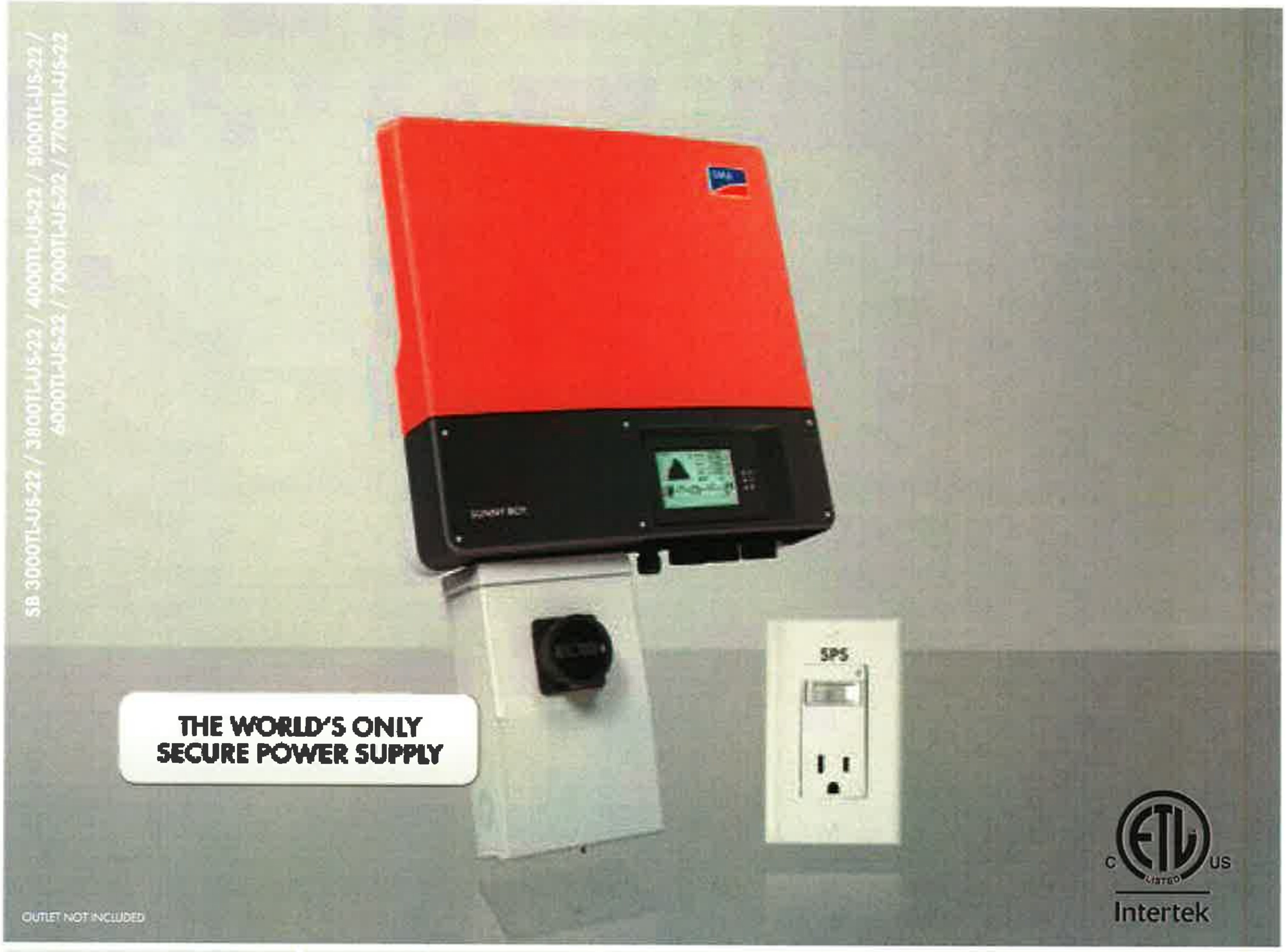
Tel: +1-650-777-7606 Email: sales@weamerisolar.com
www.weamerisolar.com

SMA



Certified
- UL 1741 and 1699B compliant
- Integrated AFCI meets the requirements of NEC 2011 690.11

Innovative
- Secure Power Supply provides daytime power during grid outages

Powerful
- 97.6% maximum efficiency
- Wide input voltage range
- Shade management with OptiTrac Global Peak MPP tracking

Flexible
- Two MPP trackers provide numerous design options
- Extended operating temperature range

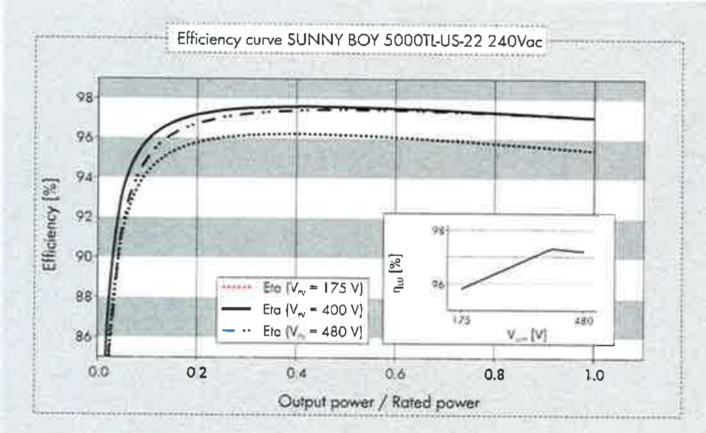
SUNNY BOY 3000TL-US / 3800TL-US /4000TL-US / 5000TL-US / 6000TL-US / 7000TL-US / 7700TL-US

Setting new heights in residential inverter performance

The Sunny Boy 3000TL-US/3800TL-US/4000TL-US/5000TL-US/6000TL-US/7000TL-US/7700TL-US represents the next step in performance for UL certified inverters. Its transformerless design means high efficiency and reduced weight. Maximum power production is derived from wide input voltage and operating temperature ranges. Multiple MPP trackers and OptiTrac™ Global Peak mitigate the effect of shade and allow for installation at challenging sites. The unique Secure Power Supply feature provides daytime power in the event of a grid outage. High performance, flexible design and innovative features make the Sunny Boy TL-US series the first choice among solar professionals.

MADE IN THE USA
SMA
OF U.S. AND IMPORTED PARTS

Technical data	Sunny Boy 3000TL-US		Sunny Boy 3800TL-US		Sunny Boy 4000TL-US	
	208 V AC	240 V AC	208 V AC	240 V AC	208 V AC	240 V AC
Input (DC)						
Max. usable DC power (@ cos φ = 1)	3200 W		4200 W		4200 W	
Max. DC voltage	600 V		600 V		600 V	
Rated MPPT voltage range	175 - 480 V		175 - 480 V		175 - 480 V	
MPPT operating voltage range	125 - 500 V		125 - 500 V		125 - 500 V	
Min. DC voltage / start voltage	125 V / 150 V		125 V / 150 V		125 V / 150 V	
Max. operating input current / per MPP tracker	18 A / 15 A		24 A / 15 A		24 A / 15 A	
Number of MPP trackers / strings per MPP tracker			2 / 2			
Output (AC)						
AC nominal power	3000 W		3330 W	3840 W	4000 W	
Max. AC apparent power	3000 VA		3330 VA	3840 VA	4000 VA	
Nominal AC voltage / adjustable	208 V / ●	240 V / ●	208 V / ●	240 V / ●	208 V / ●	240 V / ●
AC voltage range	183 - 229 V	211 - 264 V	183 - 229 V	211 - 264 V	183 - 229 V	211 - 264 V
AC grid frequency; range	60 Hz / 59.3 - 60.5 Hz		60 Hz / 59.3 - 60.5 Hz		60 Hz / 59.3 - 60.5 Hz	
Max. output current	15 A		16 A		20 A	
Power factor (cos φ)	1		1		1	
Output phases / line connections	1 / 2		1 / 2		1 / 2	
Harmonics	< 4%		< 4%		< 4%	
Efficiency						
Max. efficiency	97.2%	97.6%	97.2%	97.5%	97.2%	97.5%
CEC efficiency	96.5%	96.5%	96.5%	97.0%	96.5%	97.0%
Protection devices						
DC disconnection device			●			
DC reverse-polarity protection			●			
Ground fault monitoring / Grid monitoring			● / ●			
AC short circuit protection			●			
All-pole sensitive residual current monitoring unit			●			
Arc fault circuit interrupter (AFCI) compliant to UL 1699B			●			
Protection class / overvoltage category			I / IV			
General data						
Dimensions (W / H / D) in mm (in)			490 / 519 / 185 (19.3 / 20.5 / 7.3)			
DC Disconnect dimensions (W / H / D) in mm (in)			187 / 297 / 190 (7.4 / 11.7 / 7.5)			
Packing dimensions (W / H / D) in mm (in)			617 / 597 / 266 (24.3 / 23.5 / 10.5)			
DC Disconnect packing dimensions (W / H / D) in mm (in)			370 / 240 / 280 (14.6 / 9.4 / 11.0)			
Weight / DC Disconnect weight			24 kg (53 lb) / 3.5 kg (8 lb)			
Packing weight / DC Disconnect packing weight			27 kg (60 lb) / 3.5 kg (8 lb)			
Operating temperature range			−40 °C ... +60 °C (−40 °F ... +140 °F)			
Noise emission (typical)	≤ 25 dB(A)		≤ 25 dB(A)		≤ 25 dB(A)	
Internal consumption at night	< 1 W		< 1 W		< 1 W	
Topology	Transformerless		Transformerless		Transformerless	
Cooling	Convection		Convection		Convection	
Electronics protection rating	NEMA 3R		NEMA 3R		NEMA 3R	
Features						
Secure Power Supply	●		●		●	
Display: graphic	●		●		●	
Interfaces: RS485 / Speedwire/Webconnect	○/○		○/○		○/○	
Warranty: 10 / 15 / 20 years	●/○/○		●/○/○		●/○/○	
Certificates and permits (more available on request)			UL 1741, UL 1998, UL 1699B, IEEE1547, FCC Part 15 (Class A & B), CAN/CSA C22.2 107.1-1			
NOTE: US inverters ship with gray lids						
Type designation	SB 3000TL-US-22		SB 3800TL-US-22		SB 4000TL-US-22	



Accessories

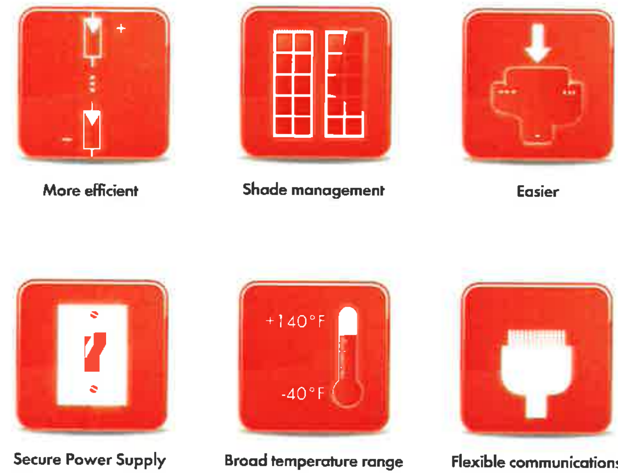
Speedwire/Webconnect interface
SWDM-US-10

RS485 interface
DM-485CB-US-10

Fan kit for SB 3000/3800/4000/5000TL-US-22
FANKIT02-10

● Standard feature   o Optional feature   — Not available
Data at nominal conditions

Sunny Boy 5000TL-US		Sunny Boy 6000TL-US		Sunny Boy 7000TL-US		Sunny Boy 7700TL-US	
208 V AC	**240 V AC**	**208 V AC**	**240 V AC**	**208 V AC**	**240 V AC**	**208 V AC**	**240 V AC**
5300 W		6300 W		7300 W		8000 W	
600 V		600 V		600 V		600 V	
175 - 480 V		210 - 480 V		245 - 480 V		270 - 480 V	
125 - 500 V		125 - 500 V		125 - 500 V		125 - 500 V	
125 V / 150 V		125 V / 150 V		125 V / 150 V		125 V / 150 V	
30 A / 15 A		30 A / 15 A		30 A / 18 A		30 A / 18 A	
2 / 2							
4550 W	5000 W	5200 W	6000 W	6000 W	7000 W	6650 W	7680 W
4550 VA	5000 VA	5200 VA	6000 VA	6000 VA	7000 VA	6650 VA	7680 VA
208 V / ●	240 V / ●	208 V / ●	240 V / ●	208 V / ●	240 V / ●	208 V / ●	240 V / ●
183 - 229 V	211 - 264 V	183 - 229 V	211 - 264 V	183 - 229 V	211 - 264 V	183 - 229 V	211 - 264 V
60 Hz / 59.3 - 60.5 Hz		60 Hz / 59.3 - 60.5 Hz		60 Hz / 59.3 - 60.5 Hz		60 Hz / 59.3 - 60.5 Hz	
22 A		25 A		29.2 A		32 A	
1		1		1		1	
1 / 2		1 / 2		1 / 2		1 / 2	
< 4%		< 4%		< 4%		< 4%	
97.2%	97.6%	97.0%	97.4%	96.8%	96.8%	96.8%	97.3%
96.5%	97.0%	96.5%	97.0%	96.5%	96.5%	96.5%	96.5%
●							
●							
● / ●							
●							
●							
●							
I / IV							
490 / 519 / 185 (19.3 / 20.5 / 7.3)							
187 / 297 / 190 (7.4 / 11.7 / 7.5)							
617 / 597 / 266 (24.3 / 23.5 / 10.5)							
370 / 240 / 280 (14.6 / 9.4 / 11.0)							
24 kg (53 lb) / 3.5 kg (8 lb)							
27 kg (60 lb) / 3.5 kg (8 lb)							
-40 °C ... +60 °C (-40 °F ... +140 °F)							
< 29 dB(A)		< 29 dB(A)		< 29 dB(A)		< 29 dB(A)	
< 1 W		< 1 W		< 1 W		< 1 W	
Transformerless		Transformerless		Transformerless		Transformerless	
Convection		Fan		Fan		Fan	
NEMA 3R		NEMA 3R		NEMA 3R		NEMA 3R	
●		●		●		●	
●		●		●		●	
o / o		o / o		o / o		o / o	
● / o / o		● / o / o		● / o / o		● / o / o	
UL 1741, UL 1998, UL 1699B, IEEE1547, FCC Part 15 (Class A & B), CAN/CSA C22.2 107.1-1							
SB 5000TL-US-22		SB 6000TL-US-22		SB 7000TL-US-22		SB 7700TL-US-22	



A NEW GENERATION OF INNOVATION

THE SUNNY BOY TL-US RESIDENTIAL SERIES HAS YET AGAIN REDEFINED THE CATEGORY.

Transformerless design

The Sunny Boy 3000TL-US / 3800TL-US / 4000TL-US / 5000TL-US / 6000TL-US / 7000TL-US / 7700TL-US are transformerless inverters, which means owners and installers benefit from high efficiency and lower weight. A wide input voltage range also means the inverters will produce high amounts of power under a number of conditions.

Additionally, transformerless inverters have been shown to be among the safest string inverters on the market. An industry first, the TL-US series has been tested to UL 1741 and UL 1699B and is in compliance with the arc fault requirements of NEC 2011.

Increased energy production

OptiTrac™ Global Peak, SMA's shade-tolerant MPP tracking algorithm, quickly adjusts to changes in solar irradiation, which mitigates the effects of shade and results in higher total power output. And, with two MPP trackers, the TL-US series can ably handle complex roofs with multiple orientations or string lengths.

An extended operating temperature range of -40 °F to +140 °F ensures power is produced in all types of climates and for longer periods of time than with most traditional string inverters.

Secure Power Supply

One of many unique features of the TL-US residential series is its innovative Secure Power Supply. With most grid-tied inverters, when the grid goes down, so does the solar-powered home. SMA's solution provides daytime energy to a dedicated power outlet during prolonged grid outages, providing homeowners with access to power as long as the sun shines.

Simple installation

As a transformerless inverter, the TL-US residential series is lighter in weight than its transformer-based counterparts, making it easier to lift and transport. A new wall mounting plate features anti-theft security and makes hanging the inverter quick and easy. A simplified DC wiring concept allows the DC disconnect to be used as a wire raceway, saving labor and materials.

The 3800TL-US and 7700TL-US models allow installers to maximize system size and energy production for customers with 100 A and 200 A service panels.

Leading monitoring and control solutions

The new TL-US residential line features more than high performance and a large graphic display. The monitoring and control options provide users with an outstanding degree of flexibility. Multiple communication options allow for a highly controllable inverter and one that can be monitored on Sunny Portal from anywhere on the planet via an Internet connection. Whether communicating through RS485, or SMA's new plug-and-play WebConnect, installers can find an optimal solution to their monitoring needs.

Wide Power Class Range

Whether you're looking for a model to maximize a 100 A service panel or trying to meet the needs of a larger residential PV system, the Sunny Boy TL-US with Secure Power Supply has you covered. Its wide range of power classes—from 3 to 7.7 kW—offers customers the right size for virtually any residential application. The TL-US series is not only the smartest inverter on the planet, it's also the most flexible.

Reviewed for Code Compliance Universal Engineering

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SMA America, LLC


Florida The Sunshine State
DRIVER LICENSE CLASS E
W620-132-48-188-0
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WEIRICH
541 TEACUP SPRINGS CT
WINTER GARDEN, FL 34787-2143
DOB: 05-28-1948 SEX: M
ISSUED: 04-12-2012 HGT: 5-11
EXPIRES: 05-28-2020
REST:
ENDORSE:
REPLACED: 08-22-201

RICK SCOTT, GOVERNOR KEN LAWSON, SECRETARY

STATE OF FLORIDA
DEPARTMENT OF BUSINESS AND PROFESSIONAL REGULATION
CONSTRUCTION INDUSTRY LICENSING BOARD

LICENSE NUMBER	
CVC56880	

The SOLAR CONTRACTOR
Named below IS CERTIFIED
Under the provisions of Chapter 489 FS.
Expiration date: AUG 31, 2016

WEIRICH, CARL L
SOLAR-RAY INC.
6007 ANNO AVE
ORLANDO FL 32809

ISSUED: 08/31/2014 DISPLAY AS REQUIRED BY LAW SEQ # L1408310006481

cott Randolph, Tax Collector Local Business Tax Receipt Orange County, Florida

s local business tax receipt is in addition to and not in lieu of any other tax required by law or municipal ordinance. Businesses are subject to regulation of zoning, health and oth ful authorities. This receipt is valid from October 1 through September 30 of receipt year. **Delinquent penalty is added October 1.**

2014 **EXPIRES 9/30/2015** 3501-0561833

3501 SOLAR ENERGY PRODUC $30.00 4 EMPLOYEE

TOTAL TAX	$30.00
PREVIOUSLY PAID	$30.00
TOTAL DUE	$0.00

SOLAR RAY INC

SOLAR RAY
SOLAR RAY INC
6007 ANNO AVE
ORLANDO FL 32809

6007 ANNO AVE (MOBILE)
U - ORLANDO, 32809

JEFF ATWATER
CHIEF FINANCIAL OFFICER

STATE OF FLORIDA
DEPARTMENT OF FINANCIAL SERVICES
DIVISION OF WORKERS' COMPENSATION

** CERTIFICATE OF ELECTION TO BE EXEMPT FROM FLORIDA WORKERS' COMPENSATION LAW **

CONSTRUCTION INDUSTRY EXEMPTION

This certifies that the individual listed below has elected to be exempt from Florida Workers' Compensation law.

EFFECTIVE DATE: 5/9/2014 **EXPIRATION DATE:** 5/8/2016

PERSON: WEIRICH CARL L

FEIN: 550844985

BUSINESS NAME AND ADDRESS:

SOLAR RAY INC

2014 PAGE AVE

ORLANDO FL 32806

SCOPES OF BUSINESS OR TRADE:

MACHINERY OR EQUIPMENT ERECTIO	PLUMBING NOC AND DRIVERS	ELECTRICAL WIRING WITHIN BUIL	ROOFING - ALL KINDS AND DRIVER

Pursuant to Chapter 440.05(14), F.S., an officer of a corporation who elects exemption from this chapter by filing a certificate of election under this section may not recover benefits or compensation under this chapter. Pursuant to Chapter 440.05(12), F.S., Certificates of election to be exempt... apply only within the scope of the business or trade listed on the notice of election to be exempt. Pursuant to Chapter 440.05(13), F.S., Notices of election to be exempt and certificates of election to be exempt shall be subject to revocation if, at any time after the filing of the notice or the issuance of the certificate, the person named on the notice or certificate no longer meets the requirements of this section for issuance of a certificate. The department shall revoke a certificate at any time for failure of the person named on the certificate to meet the requirements of this section.

SOLAR-1 OP ID: CS

ACORD

CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY) 04/07/2015

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER
Insurance and Risk Management
of Florida, LLC
220 Crown Oak Centre Drive
Longwood, FL 32750
David Russell Curry

CONTACT NAME: Marty Smith
PHONE (A/C, No, Ext): 321-214-1990 FAX (A/C, No): 321-710-2501
E-MAIL ADDRESS: martys@irmtoday.com

INSURER(S) AFFORDING COVERAGE	NAIC #
INSURER A : Maxum Indemnity Company	
INSURER B : Old Dominion Insurance Company	40231
INSURER C : Nautilus Insurance Co	
INSURER D :	
INSURER E :	
INSURER F :	

INSURED Solar-Ray, Inc.
PO Box 560481
Orlando, FL 32806

COVERAGES CERTIFICATE NUMBER: REVISION NUMBER:

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSD	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
A	X COMMERCIAL GENERAL LIABILITY; CLAIMS-MADE; X OCCUR; GEN'L AGGREGATE LIMIT APPLIES PER: POLICY / PRO-JECT / LOC; OTHER:			BDG3005778-01	04/24/2014	04/24/2015	EACH OCCURRENCE	$ 1,000,000
							DAMAGE TO RENTED PREMISES (Ea occurrence)	$ 100,000
							MED EXP (Any one person)	$ 1,000
							PERSONAL & ADV INJURY	$ 1,000,000
							GENERAL AGGREGATE	$ 2,000,000
							PRODUCTS - COMP/OP AGG	$ 2,000,000
								$
A	AUTOMOBILE LIABILITY; X ANY AUTO; ALL OWNED AUTOS; SCHEDULED AUTOS; HIRED AUTOS; NON-OWNED AUTOS			B1T6267N	05/08/2014	05/08/2015	COMBINED SINGLE LIMIT (Ea accident)	$ 1,000,000
							BODILY INJURY (Per person)	$
							BODILY INJURY (Per accident)	$
							PROPERTY DAMAGE (Per accident)	$
								$
C	UMBRELLA LIAB; X OCCUR; X EXCESS LIAB; CLAIMS-MADE; DED; RETENTION $			AN017781	11/11/2014	11/11/2015	EACH OCCURRENCE	$ 1,000,000
							AGGREGATE	$ 1,000,000
								$
	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY Y/N; ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? (Mandatory in NH); If yes, describe under DESCRIPTION OF OPERATIONS below	N / A					PER STATUTE / OTH-ER	
							E.L. EACH ACCIDENT	$
							E.L. DISEASE - EA EMPLOYEE	$
							E.L. DISEASE - POLICY LIMIT	$

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (ACORD 101, Additional Remarks Schedule, may be attached if more space is required)

CERTIFICATE HOLDER

BELLEIS

City of Belle Isle
1600 Nela Avenue
Belle Isle, FL 32809

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE