ENGINEERED POWER SOLUTIONS
MATTHEW B. GILLISS, PROFESSIONAL ENGINEER

1405 SPRING STREET, SUITE 204
PASO ROBLES, CA 93446
(805) 423-1326

# STRUCTURAL DOCUMENTATION PACKET

PROJECT:

Renusol MS Roof Mounting System
Generic Structural Packet and Design Charts

CLIENT:

Renusol America, Inc.
1292 Logan Circle NW
Atlanta, GA 30318

PREPARED BY:

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3/11/15

PACKET EXPIRES 12/31/16
MUST BE RENEWED ANNUALLY

DATE: 3/11/15
EPS PROJECT NUMBER: 13-RNS001

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## T.2 – Table of Contents

# 1.0 – RESULTS & SCOPE OF WORK

## 1.1 – Overview of Analysis & Results

- Governing Building Code:
  International Building Code (IBC)
  Referencing the Minimum Design Loads for Buildings and Other Structures by the American Society of Civil Engineers (ASCE 7). [Because this packet is used in multiple states, results are provided for both ASCE 7-05 and ASCE 7-10]

- Project Description:
  The project consists of the design of the structural roof anchorage for the proposed roof mounting system (Renusol MS Solar Mounting System) for Photovoltaic (PV) modules on trapezoidal metal sheet roofs. The solar designer, Renusol America Inc. (Renusol) has contracted Engineered Power Solutions (EPS) to address the structural aspects of the anchorage, mainly the specification of the number of screws used at each clamp base. Renusol has specified a number of common design scenarios that EPS has used to determine the design loads at the clamp bases. These scenarios include roof tilt, design wind speed, wind exposure category, design ground snow load, thickness (gage) of the metal roofing, size and weight of the modules, occupancy category of the existing structure, and location of the modules on the roof. Renusol has also specified a number of design assumptions that remain constant for all scenarios which are discussed in further detail on the following pages.

  Because this product is to be used in multiple states which may be governed by different building codes, Renusol has requested that EPS provide design charts using both ASCE 7-05 and ASCE 7-10.

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## 1.2 – Scope of Work, Results, and Limitations

- **Scope of Work:**

  EPS has been hired by Renusol to address the following items:

  - Determination of the specified design loads on the clamp bases including dead loads, wind loads, snow loads, seismic loads, etc.

  - Determination of the number of EJOT EJOFAST screws to be specified at each clamp base as required by the specific design scenario.

  - Roof snow load limitations to the existing roof based on the various design scenarios specified by Renusol.

- **Results:**

  The results of this analysis are presented on the following pages in the form of design summary tables based on the design scenarios provided by Renusol. The final results are specified as the number of EJOT EJOFAST screws required at each clamp base under each specific scenario. Design tables that specify the allowable ground snow load that the MS system can be installed under for each scenario without further analysis on the existing roof/structure are also provided.

- **Limitations and Assumptions:**

  This Structural Documentation Packet is not in reference of any specific project and only addresses the anchorage requirements of the MS Roof Mounting System for the generic design assumptions shown in this packet. Sites with design scenarios which differ and/or are outside the scenarios specified in this packet must be addressed by a licensed design professional on a site specific basis. Any changes to the required design results given in the following result design tables such as screw quantities, type, installation requirements, etc. must be approved in writing by EPS prior to implementation. EPS has not checked and is not responsible for the structural adequacy of the existing structure nor is EPS responsible for the existing structure's ability to support the design loads imposed by the proposed PV system. Renusol has informed EPS that the structural aspects of the existing structure(s) affected by this new rooftop PV installation will be addressed by a licensed professional engineer on a site specific basis as required by the local governing jurisdiction. All non-structural issues including but not limited to waterproofing, corrosion protection, electrical, and mechanical issues are not the responsibility of EPS and must be addressed by the solar designer, installer, and/or owner before PV installation begins.

# 2.0 – DESIGN RESULTS AND SUMMARY TABLES

## 2.1 – Design Scenarios (Parameters)

- **Varying Design Parameters:**
  - Size and Weight of Module[1]:
    - 60-cell modules:
      - 65.55" x 39.02" / 40 lbs.
    - 72-cell modules:
      - 77.56" x 38.98" / 59 lbs.
  - Wind Exposure Category[2,6]:
    - Exposure "B"
    - Exposure "C"
  - Building Occupancy Category[2]:
    - II
    - III
  - Roof Pitch[3]:
    - 1:12 to 5:12
    - 6:12 to 12:12
  - Design Wind Speed[2] (3 Second Gust Speed in MPH):
    - 90, 100, 110, 120, 135, 150 (ASCE 7-05)
    - 115, 120, 140, 150, 160, 170 (ASCE 7-10)
  - Thickness (gage) of metal roof:
    - 26 gage
    - 24 gage (or thicker)
  - Roof Zone[4] (location of modules on roof):
    - Edge Zone
    - Mid Zone
  - Ground Snow Load[2] ($p_g$)

- **Constant Design Parameters:**
  - Wind Design Parameters:
    - Topographic Factor[2,5] ($K_{zt}$): 1.00
    - Wind Directionality Factor[2] ($K_d$): 0.85
    - Building Height[7]: 30 ft. or less
  - Snow Design Parameters:
    - Exposure Factor[8] ($C_e$): 1.0
    - Thermal Factor ($C_t$): 1.2

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Design Parameter Notes:

1) Modules of different sizes and/or weights than those specified shall be checked individually.

2) It is the solar designer/installer or owner's responsibility to determine the site specific design parameters of each site based on the current governing building code and/or local jurisdiction's requirements.

3) Roof Pitch determines various other design parameters such as wind external pressure coefficients ($GC_{pf}$), Snow Slope Factor ($C_s$), and the portion of gravity loads that are applied vertically and horizontally.

4) Please see section 3.1 of this packet for further information on Roof Zones.

5) The site is assumed to have no topographic effects, i.e. it is not on a bluff, cliff, mesa, escarpment, upper half of a hill, or any other condition as described in the governing building code that would require a Topographic Factor other than 1.00.

6) Wind Exposure Categories considered are "B" and "C" as defined in ASCE 7. Wind Exposure Category "D" (sites overlooking bodies of water, mudflats, saltflats, and/or ice) has not been considered in this analysis. A site specific analysis is required for Wind Exposure "D" sites.

7) The building height listed is defined as the distance between the highest point of the PV system and grade. If the building has varying grade elevations, the lowest grade elevation shall be used. Projects where the height is greater than 30 ft. require a site specific analysis.

8) It is assumed the roof is "Partially Exposed" as described in ASCE 7. This assumption is conservative for buildings with "Fully Exposed" roofs. For buildings with "Sheltered" roofs, a site specific analysis is required.

es

## ASCE 7-05 – Renusol MS Screw Quantities – 60 Cell Modules

| | Quantity of Screws Per Bracket | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| | 2 | 2 | 2 |
| | 2 | 2 | 2 |
| | 2 | 2 | 2 |
| | 2 | 2 | 2 |
| | 3 | 3 | 2 |
| | 3 | 4 | 2 |

| | Quantity of Screws Per Bracket | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| | 2 | 2 | 2 |
| | 2 | 2 | 2 |
| | 2 | 2 | 2 |
| | 2 | 2 | 2 |
| | 2 | 2 | 2 |
| | 3 | 2 | 2 |

**Exposure C, Occupancy II**

**Roof Pitch 1:12 to 5:12**

| | Quantity of Screws Per Bracket | | | |
|---|---|---|---|---|
| ASCE 7-05 | 26-Gage | | 24-Gage | |
| Wind Speed (MPH) | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 90 | 3 | 2 | 2 | 2 |
| 100 | 3 | 2 | 2 | 2 |
| 110 | 4 | 3 | 3 | 2 |
| 120 | N.G. | 3 | 3 | 2 |
| 135 | N.G. | 4 | 4 | 3 |
| 150 | N.G. | N.G. | N.G. | 3 |

**Roof Pitch 6:12 to 12:12**

| | Quantity of Screws Per Bracket | | | |
|---|---|---|---|---|
| ASCE 7-05 | 26-Gage | | 24-Gage | |
| Wind Speed (MPH) | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 90 | 2 | 2 | 2 | 2 |
| 100 | 2 | 2 | 2 | 2 |
| 110 | 3 | 2 | 2 | 2 |
| 120 | 3 | 2 | 2 | 2 |
| 135 | 4 | 3 | 3 | 2 |
| 150 | N.G. | 3 | 3 | 2 |

**Exposure B, Occupancy III**

**Roof Pitch 1:12 to 5:12**

| | Quan |
|---|---|
| ASCE 7-05 | 26-Ga |
| Wind Speed (MPH) | Edge Zone |
| 90 | 2 |
| 100 | 3 |
| 110 | 3 |
| 120 | 4 |
| 135 | N.G. |
| 150 | N.G. |

**Roof Pitch 6:12 to 12:12**

| | Quan |
|---|---|
| ASCE 7-05 | 26-Ga |
| Wind Speed (MPH) | Edge Zone |
| 90 | 2 |
| 100 | 2 |
| 110 | 2 |
| 120 | 3 |
| 135 | 3 |
| 150 | 4 |

FAST bi-metal self-drilling screws (JF3). Screws shall be installed per corresponding ICC-ES evaluation report (report number 0276). See Appendix for further informatio

enarios with "N.G." specified may have design loads in excess of the allowable capacity of 4 screws and require a site specific analysis.

# ASCE 7-05 – Renusol MS Screw Quantities – 72 Cell Modules

| Quantity of Screws Per Bracket | | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| | 2 | 2 | 2 |
| | 2 | 2 | 2 |
| | 2 | 2 | 2 |
| | 3 | 3 | 2 |
| | 3 | 3 | 2 |
| | 4 | 4 | 3 |

| Quantity of Screws Per Bracket | | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| | 2 | 2 | 2 |
| | 2 | 2 | 2 |
| | 2 | 2 | 2 |
| | 2 | 2 | 2 |
| | 2 | 2 | 2 |
| | 3 | 3 | 2 |

**Exposure C, Occupancy II**

**Roof Pitch 1:12 to 5:12**

| | Quantity of Screws Per Bracket | | | |
|---|---|---|---|---|
| ASCE 7-05 | 26-Gage | | 24-Gage | |
| Wind Speed (MPH) | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 90 | 3 | 2 | 2 | 2 |
| 100 | 4 | 2 | 3 | 2 |
| 110 | N.G. | 3 | 3 | 2 |
| 120 | N.G. | 4 | 4 | 2 |
| 135 | N.G. | 4 | N.G. | 3 |
| 150 | N.G. | N.G. | N.G. | 4 |

**Roof Pitch 6:12 to 12:12**

| | Quantity of Screws Per Bracket | | | |
|---|---|---|---|---|
| ASCE 7-05 | 26-Gage | | 24-Gage | |
| Wind Speed (MPH) | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 90 | 2 | 2 | 2 | 2 |
| 100 | 3 | 2 | 2 | 2 |
| 110 | 3 | 2 | 2 | 2 |
| 120 | 4 | 3 | 2 | 2 |
| 135 | N.G. | 3 | 3 | 2 |
| 150 | N.G. | 4 | 4 | 3 |

**Exposure B, Occupancy III**

**Roof Pitch 1:12 to 5:12**

| | Quan |
|---|---|
| ASCE 7-05 | 26-Ga |
| Wind Speed (MPH) | Edge Zone |
| 90 | 3 |
| 100 | 3 |
| 110 | 4 |
| 120 | 4 |
| 135 | N.G. |
| 150 | N.G. |

**Roof Pitch 6:12 to 12:12**

| | Quan |
|---|---|
| ASCE 7-05 | 26-Ga |
| Wind Speed (MPH) | Edge Zone |
| 90 | 2 |
| 100 | 2 |
| 110 | 3 |
| 120 | 3 |
| 135 | 4 |
| 150 | N.G. |

FAST bi-metal self-drilling screws (JF3). Screws shall be installed per corresponding ICC-ES evaluation report (report number 0276). See Appendix for further informatio

enarios with "N.G." specified may have design loads in excess of the allowable capacity of 4 screws and require a site specific analysis.

to the thickness of the metal roofing. Roofs with a thicker gage than 24 may conservatively use the results shown for a 24 gage roof. Roofs with a thinner gage than 26 are

or further information on Roof Zones.

## ASCE 7-10 – Renusol MS Screw Quantities – 60 Cell Modules

| | Quantity of Screws Per Bracket | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| | 2 | 2 | 2 |
| | 2 | 2 | 2 |
| | 2 | 3 | 2 |
| | 2 | 3 | 2 |
| | 2 | 4 | 2 |
| | 3 | 4 | 3 |

| | Quantity of Screws Per Bracket | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| | 2 | 2 | 2 |
| | 2 | 2 | 2 |
| | 2 | 2 | 2 |
| | 2 | 2 | 2 |
| | 2 | 3 | 2 |
| | 2 | 3 | 2 |

**Exposure C**

**Roof Pitch 1:12 to 5:12**

| ASCE 7-10 Wind Speed (MPH) | Quantity of Screws Per Bracket | | | |
|---|---|---|---|---|
| | 26-Gage | | 24-Gage | |
| | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 115 | 3 | 2 | 3 | 2 |
| 120 | 3 | 2 | 3 | 2 |
| 140 | 4 | 3 | 4 | 3 |
| 150 | 4 | 3 | 4 | 3 |
| 160 | N.G. | 3 | N.G. | 3 |
| 170 | N.G. | 4 | N.G. | 4 |

**Roof Pitch 6:12 to 12:12**

| ASCE 7-10 Wind Speed (MPH) | Quantity of Screws Per Bracket | | | |
|---|---|---|---|---|
| | 26-Gage | | 24-Gage | |
| | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 115 | 2 | 2 | 2 | 2 |
| 120 | 2 | 2 | 2 | 2 |
| 140 | 3 | 2 | 3 | 2 |
| 150 | 3 | 2 | 3 | 2 |
| 160 | 3 | 2 | 3 | 2 |
| 170 | 4 | 3 | 4 | 3 |

FAST bi-metal self-drilling screws (JF3). Screws shall be installed per corresponding ICC-ES evaluation report (report number 0276). See Appendix for further informatio

enarios with "N.G." specified may have design loads in excess of the allowable capacity of 4 screws and require a site specific analysis.

to the thickness of the metal roofing. Roofs with a thicker gage than 24 may conservatively use the results shown for a 24 gage roof. Roofs with a thinner gage than 26 are

or further information on Roof Zones.

# ASCE 7-10 – Renusol MS Screw Quantities – 72 Cell Modules

| Quantity of Screws Per Bracket | | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| | 2 | 2 | 2 |
| | 2 | 2 | 2 |
| | 2 | 3 | 2 |
| | 2 | 4 | 2 |
| | 3 | 4 | 3 |
| | 3 | N.G. | 3 |

| Quantity of Screws Per Bracket | | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| | 2 | 2 | 2 |
| | 2 | 2 | 2 |
| | 2 | 2 | 2 |
| | 2 | 2 | 2 |
| | 2 | 3 | 2 |
| | 2 | 3 | 2 |

**Exposure C**

**Roof Pitch 1:12 to 5:12**

| | Quantity of Screws Per Bracket | | | |
|---|---|---|---|---|
| ASCE 7-10 | 26-Gage | | 24-Gage | |
| Wind Speed (MPH) | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 115 | 3 | 2 | 3 | 2 |
| 120 | 3 | 2 | 3 | 2 |
| 140 | 4 | 3 | 4 | 3 |
| 150 | N.G. | 3 | N.G. | 3 |
| 160 | N.G. | 4 | N.G. | 4 |
| 170 | N.G. | 4 | N.G. | 4 |

**Roof Pitch 6:12 to 12:12**

| | Quantity of Screws Per Bracket | | | |
|---|---|---|---|---|
| ASCE 7-10 | 26-Gage | | 24-Gage | |
| Wind Speed (MPH) | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 115 | 2 | 2 | 2 | 2 |
| 120 | 2 | 2 | 2 | 2 |
| 140 | 3 | 2 | 3 | 2 |
| 150 | 3 | 2 | 3 | 2 |
| 160 | 4 | 3 | 4 | 3 |
| 170 | 4 | 3 | 4 | 3 |

FAST bi-metal self-drilling screws (JF3). Screws shall be installed per corresponding ICC-ES evaluation report (report number 0276). See Appendix for further informatio

enarios with "N.G." specified may have design loads in excess of the allowable capacity of 4 screws and require a site specific analysis.

to the thickness of the metal roofing. Roofs with a thicker gage than 24 may conservatively use the results shown for a 24 gage roof. Roofs with a thinner gage than 26 are

or further information on Roof Zones.

# ASCE 7-05 – Allowable Ground Snow Load ($P_g$) – 60 Cell Modules

| ...wable Ground Snow ($p_g$)Load (psf) | | | |
|---|---|---|---|
| ...6-Gage | | 24-Gage | |
| ...ne | Mid Zone | Edge Zone | Mid Zone |
| | 35 | 35 | 35 |
| | 35 | 35 | 35 |
| | 35 | 35 | 35 |
| | 35 | 35 | 35 |
| | 35 | 35 | 35 |
| | 35 | 35 | 35 |

| ...wable Ground Snow ($p_g$)Load (psf) | | | |
|---|---|---|---|
| ...6-Gage | | 24-Gage | |
| ...ne | Mid Zone | Edge Zone | Mid Zone |
| | 50 | 50 | 50 |
| | 50 | 50 | 50 |
| | 50 | 50 | 50 |
| | 50 | 50 | 50 |
| | 50 | 50 | 50 |
| | 50 | 50 | 50 |

**Exposure C, Occupancy II**

**Roof Pitch 1:12 to 5:12**

| | Allowable Ground Snow ($p_g$)Load (psf) | | | |
|---|---|---|---|---|
| ASCE 7-05 | 26-Gage | | 24-Gage | |
| Wind Speed (MPH) | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 90 | 35 | 35 | 35 | 35 |
| 100 | 35 | 35 | 35 | 35 |
| 110 | 35 | 35 | 35 | 35 |
| 120 | 35 | 35 | 35 | 35 |
| 135 | 35 | 35 | 35 | 35 |
| 150 | 35 | 35 | 35 | 35 |

**Roof Pitch 6:12 to 12:12**

| | Allowable Ground Snow ($p_g$)Load (psf) | | | |
|---|---|---|---|---|
| ASCE 7-05 | 26-Gage | | 24-Gage | |
| Wind Speed (MPH) | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 90 | 50 | 50 | 50 | 50 |
| 100 | 50 | 50 | 50 | 50 |
| 110 | 50 | 50 | 50 | 50 |
| 120 | 50 | 50 | 50 | 50 |
| 135 | 50 | 50 | 50 | 50 |
| 150 | 45 | 50 | 45 | 50 |

**Exposure B, Occupancy III**

**Roof Pitch 1:12 to 5:12**

| | Allowable... |
|---|---|
| ASCE 7-05 | 26-Ga... |
| Wind Speed (MPH) | Edge Zone |
| 90 | 30 |
| 100 | 30 |
| 110 | 30 |
| 120 | 30 |
| 135 | 30 |
| 150 | 30 |

**Roof Pitch 6:12 to 12:12**

| | Allowable... |
|---|---|
| ASCE 7-05 | 26-Ga... |
| Wind Speed (MPH) | Edge Zone |
| 90 | 45 |
| 100 | 45 |
| 110 | 45 |
| 120 | 45 |
| 135 | 45 |
| 150 | 45 |

...allowed per loading scenario based on the worst-case compression forces transferred to the roof. See section 3.5 for further information.

...e for certain roof tilts. Higher ground snow loads may be allowed based on the exact roof tilt but a site specific analysis is required to determine this.

# ASCE 7-05 – Allowable Ground Snow Load ($P_g$) – 72 Cell Modules

| wable Ground Snow ($p_g$)Load (psf) | | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| | 30 | 30 | 30 |
| | 30 | 30 | 30 |
| | 30 | 30 | 30 |
| | 30 | 30 | 30 |
| | 30 | 30 | 30 |
| | 30 | 30 | 30 |

| wable Ground Snow ($p_g$)Load (psf) | | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| | 40 | 40 | 40 |
| | 40 | 40 | 40 |
| | 40 | 40 | 40 |
| | 40 | 40 | 40 |
| | 40 | 40 | 40 |
| | 40 | 40 | 40 |

**Exposure C, Occupancy II**

**Roof Pitch 1:12 to 5:12**

| ASCE 7-05 Wind Speed (MPH) | Allowable Ground Snow ($p_g$)Load (psf) | | | |
|---|---|---|---|---|
| | 26-Gage | | 24-Gage | |
| | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 90 | 30 | 30 | 30 | 30 |
| 100 | 30 | 30 | 30 | 30 |
| 110 | 30 | 30 | 30 | 30 |
| 120 | 30 | 30 | 30 | 30 |
| 135 | 30 | 30 | 30 | 30 |
| 150 | 30 | 30 | 30 | 30 |

**Roof Pitch 6:12 to 12:12**

| ASCE 7-05 Wind Speed (MPH) | Allowable Ground Snow ($p_g$)Load (psf) | | | |
|---|---|---|---|---|
| | 26-Gage | | 24-Gage | |
| | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 90 | 40 | 40 | 40 | 40 |
| 100 | 40 | 40 | 40 | 40 |
| 110 | 40 | 40 | 40 | 40 |
| 120 | 40 | 40 | 40 | 40 |
| 135 | 40 | 40 | 40 | 40 |
| 150 | 35 | 40 | 35 | 40 |

**Exposure B, Occupancy III**

**Roof Pitch 1:12 to 5:12**

| ASCE 7-05 Wind Speed (MPH) | Allowable |
|---|---|
| | 26-Ga |
| | Edge Zone |
| 90 | 25 |
| 100 | 25 |
| 110 | 25 |
| 120 | 25 |
| 135 | 25 |
| 150 | 25 |

**Roof Pitch 6:12 to 12:12**

| ASCE 7-05 Wind Speed (MPH) | Allowable |
|---|---|
| | 26-Ga |
| | Edge Zone |
| 90 | 35 |
| 100 | 35 |
| 110 | 35 |
| 120 | 35 |
| 135 | 35 |
| 150 | 35 |

allowed per loading scenario based on the worst-case compression forces transferred to the roof. See section 3.5 for further information.

e for certain roof tilts. Higher ground snow loads may be allowed based on the exact roof tilt but a site specific analysis is required to determine this.

# ASCE 7-10 – Allowable Ground Snow Load ($P_g$) – 60 Cell Modules

| wable Ground Snow ($p_g$)Load (psf) | | |
|---|---|---|
| 6-Gage | 24-Gage | |
| Mid Zone | Edge Zone | Mid Zone |
| 35 | 35 | 35 |
| 35 | 35 | 35 |
| 35 | 35 | 35 |
| 35 | 35 | 35 |
| 35 | 35 | 35 |
| 35 | 35 | 35 |

| wable Ground Snow ($p_g$)Load (psf) | | |
|---|---|---|
| 6-Gage | 24-Gage | |
| Mid Zone | Edge Zone | Mid Zone |
| 50 | 50 | 50 |
| 50 | 50 | 50 |
| 50 | 50 | 50 |
| 50 | 50 | 50 |
| 50 | 50 | 50 |
| 50 | 50 | 50 |

**Exposure C, Occupancy II**

**Roof Pitch 1:12 to 5:12**

| ASCE 7-10 Wind Speed (MPH) | Allowable Ground Snow ($p_g$)Load (psf) | | | |
|---|---|---|---|---|
| | 26-Gage | | 24-Gage | |
| | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 115 | 35 | 35 | 35 | 35 |
| 120 | 35 | 35 | 35 | 35 |
| 140 | 35 | 35 | 35 | 35 |
| 150 | 35 | 35 | 35 | 35 |
| 160 | 35 | 35 | 35 | 35 |
| 170 | 35 | 35 | 35 | 35 |

**Roof Pitch 6:12 to 12:12**

| ASCE 7-10 Wind Speed (MPH) | Allowable Ground Snow ($p_g$)Load (psf) | | | |
|---|---|---|---|---|
| | 26-Gage | | 24-Gage | |
| | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 115 | 50 | 50 | 50 | 50 |
| 120 | 50 | 50 | 50 | 50 |
| 140 | 50 | 50 | 50 | 50 |
| 150 | 50 | 50 | 50 | 50 |
| 160 | 50 | 50 | 50 | 50 |
| 170 | 50 | 50 | 50 | 50 |

**Exposure B, Occupancy III**

**Roof Pitch 1:12 to 5:12**

| ASCE 7-10 Wind Speed (MPH) | Allowable |
|---|---|
| | 26-Ga |
| | Edge Zone |
| 115 | 30 |
| 120 | 30 |
| 140 | 30 |
| 150 | 30 |
| 160 | 30 |
| 170 | 30 |

**Roof Pitch 6:12 to 12:12**

| ASCE 7-10 Wind Speed (MPH) | Allowable |
|---|---|
| | 26-Ga |
| | Edge Zone |
| 115 | 45 |
| 120 | 45 |
| 140 | 45 |
| 150 | 45 |
| 160 | 45 |
| 170 | 45 |

allowed per loading scenario based on the worst-case compression forces transferred to the roof. See section 3.5 for further information.

e for certain roof tilts. Higher ground snow loads may be allowed based on the exact roof tilt but a site specific analysis is required to determine this.

# ASCE 7-10 – Allowable Ground Snow Load ($P_g$) – 72 Cell Modules

| wable Ground Snow ($p_g$)Load (psf) | | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| | 30 | 30 | 30 |
| | 30 | 30 | 30 |
| | 30 | 30 | 30 |
| | 30 | 30 | 30 |
| | 30 | 30 | 30 |
| | 30 | 30 | 30 |

| wable Ground Snow ($p_g$)Load (psf) | | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| | 40 | 40 | 40 |
| | 40 | 40 | 40 |
| | 40 | 40 | 40 |
| | 40 | 40 | 40 |
| | 40 | 40 | 40 |
| | 40 | 40 | 40 |

**Exposure C, Occupancy II**

**Roof Pitch 1:12 to 5:12**

| ASCE 7-10 Wind Speed (MPH) | Allowable Ground Snow ($p_g$)Load (psf) | | | |
|---|---|---|---|---|
| | 26-Gage | | 24-Gage | |
| | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 115 | 30 | 30 | 30 | 30 |
| 120 | 30 | 30 | 30 | 30 |
| 140 | 30 | 30 | 30 | 30 |
| 150 | 30 | 30 | 30 | 30 |
| 160 | 30 | 30 | 30 | 30 |
| 170 | 30 | 30 | 30 | 30 |

**Roof Pitch 6:12 to 12:12**

| ASCE 7-10 Wind Speed (MPH) | Allowable Ground Snow ($p_g$)Load (psf) | | | |
|---|---|---|---|---|
| | 26-Gage | | 24-Gage | |
| | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 115 | 40 | 40 | 40 | 40 |
| 120 | 40 | 40 | 40 | 40 |
| 140 | 40 | 40 | 40 | 40 |
| 150 | 40 | 40 | 40 | 40 |
| 160 | 40 | 40 | 40 | 40 |
| 170 | 40 | 40 | 40 | 40 |

**Exposure B, Occupancy III**

**Roof Pitch 1:12 to 5:12**

| ASCE 7-10 Wind Speed (MPH) | Allowable |
|---|---|
| | 26-Ga |
| | Edge Zone |
| 115 | 25 |
| 120 | 25 |
| 140 | 25 |
| 150 | 25 |
| 160 | 25 |
| 170 | 25 |

**Roof Pitch 6:12 to 12:12**

| ASCE 7-10 Wind Speed (MPH) | Allowable |
|---|---|
| | 26-Ga |
| | Edge Zone |
| 115 | 35 |
| 120 | 35 |
| 140 | 35 |
| 150 | 35 |
| 160 | 35 |
| 170 | 35 |

allowed per loading scenario based on the worst-case compression forces transferred to the roof. See section 3.5 for further information.

e for certain roof tilts. Higher ground snow loads may be allowed based on the exact roof tilt but a site specific analysis is required to determine this.

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## 3.0 – Renusol MS Roof Mounting System Calculations

The Renusol MS Roof Mounting System anchors the PV modules to the roofs of structures with trapezoidal steel sheet roofing using a series of clamps that attach to a clamp base which is screwed directly into the rib of the sheet roofing. Clamp bases occur at each of the four (4) corners of the modules giving end clamps a tributary area of ¼ of a modules and middle clamps a tributary area of ¼ of a module on each side for a total tributary are of ½ of a module. The following sections address the various design loads and parameters provided by Renusol to be addressed in this packet. The results for all scenarios are provided in the previous tables. The following pages provide descriptions of the design methodology used as well as an example calculation using a specific set of parameters.

For the example calculations, a set of parameters have been chosen which may or may not represent an actual in-field scenario but will illustrate the design processed used for all provided parameters/scenarios.

- *Example Scenario Design Parameters:*
  - *Local Code:* *IBC referencing ASCE 7-05*
  - *Module Type:* *60-Cell Modules*
  - *Wind Exposure Category:* *C*
  - *Building Occupancy:* *II*
  - *Roof Pitch:* *3:12 (≈14°)*
  - *Building Footprint:* *100 ft. x 50 ft.*
  - *Steel Sheet Roof Thickness:* *26 Gage*
  - *Building Ht.:* *25 ft. (grade to highest point of PV installation)*
  - *Design Wind Speed:* *90 MPH*
  - *Design Ground Snow Load:* *20 psf*

Note: It is the solar designer/installer or owner's responsibility to determine the site specific design parameters of each site based on the current governing building code and/or local jurisdiction's requirements. EPS is not responsible for incorrect use of the summary tables or using incorrect design parameters.

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## 3.1 – Roof Zones

Wind forces are determined in accordance with ASCE 7-05 (or ASCE 7-10) Section 6.5.12.2 (7-10: Section 28.4.1) which is the recommended method by the Solar America Board for Codes and Standards for flush roof-mounted PV systems. In accordance with Figure 6-10 (Figure 28.4-1), the roof has been broken up into zones, most notably a roof "Edge Zone" and a "Mid-Roof Zone". See Figure 1 below.

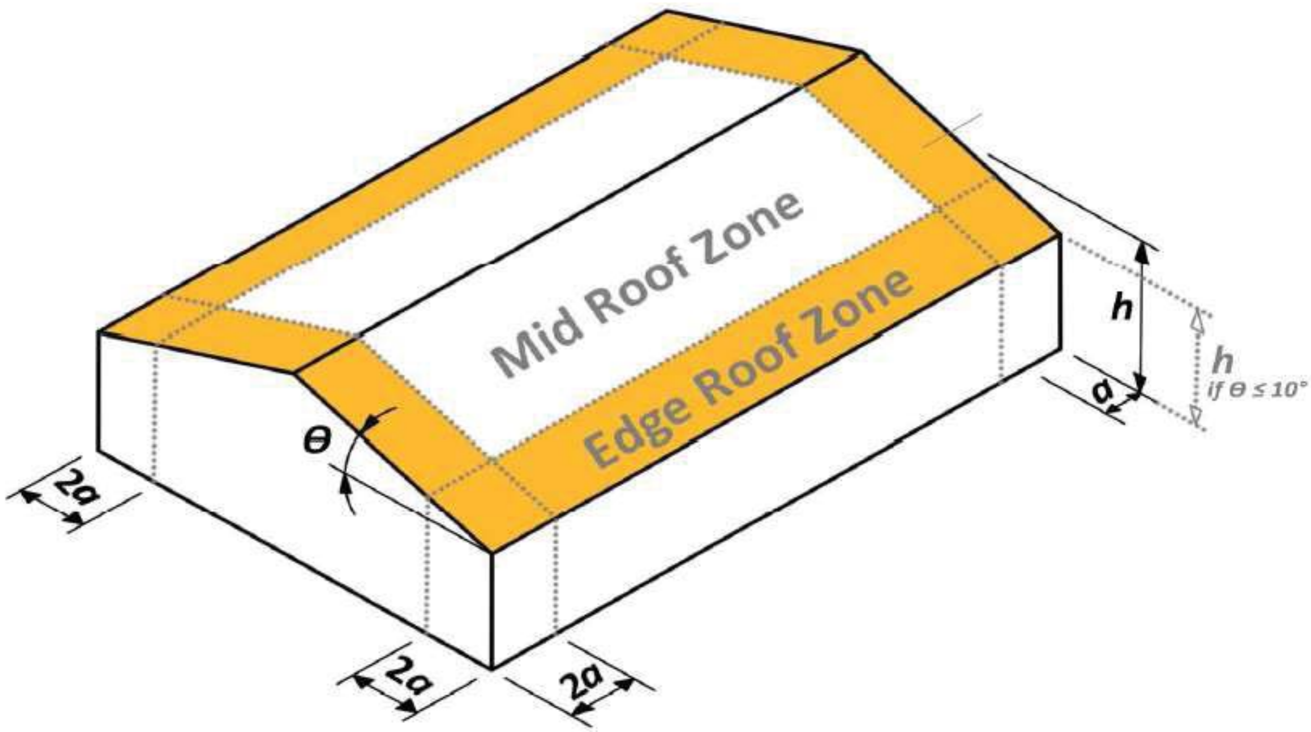


Figure 1: Roof Zones

The term "a" is determined in accordance with note 9 of Figure 6-10 (Figure 28.4-1):

- a: 10 percent of least horizontal dimension or 0.4h, whichever is smaller, but not less than either 4% of least horizontal dimension or 3 ft.
- h: Mean roof height (ft.) except eave height shall be used for roof tilts ≤ 10°.

*Example Scenario Calculation:*

*a: Smaller of 0.1*50 ft. = 5.0 ft. or 0.4*25 ft. = 10 ft. but not less than 0.04*50 ft. = 2 ft. or 3 ft.*

➔ *Therefore a = 5.0 ft. and the roof edge zone would be 2a = 10.0 ft.*

### 3.2 – Dead Loads

The dead load supported by each clamp base consists of the weight of the modules used over the tributary area of the base clamp. Using a typical middle (mid) clamp tributary area of ½ a module, this would equate to ½ of the module weight. The 60 cell modules are assumed to weigh 40 lbs. and the 72 cell modules are assumed to weigh 59 lbs. The pitch of the roof affects how much of this load is applied to the clamp base vertically and how much is applied horizontally. For the design table uplift calculations, the lowest tilt in each roof pitch range has been used.

*Example Scenario Calculation:*

*60 cell module (40 lbs.) on a 3:12 pitch.*
*Mid clamps support 0.5* 40 lbs. = 20 lbs.*
*Tilt of 1:12 is the lowest in category but 0° conservatively used*
*20 lbs. * cos(0°) = 20 lbs.*

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## 3.3 – Wind Uplift Forces

Per Section 6.5.12.2, (Section 28.4.1), the wind velocity pressure is determined by Equation 6-18 (Eq. 28.4-1):

- $p = q_h[(GC_{pf}) - (GC_{pi})]$ (psf)

Where $q_h$, the velocity pressure evaluated at height h, is given by Section 6.5.10 (27.3.2) and Equation 6-15 (Eq. 27.3-1):

- $q_h = 0.00256K_zK_{zt}K_dV^2I$ (ASCE 7-05)
- $q_h = 0.00256K_zK_{zt}K_dV^2$ (ASCE 7-10)
  - $K_z$ = Velocity Pressure Exposure Coefficient per Table 6-3 (28.3-1)
    - 0.70 used for Exposure B
    - 0.98 used for Exposure C
  - $K_{zt}$ = Topographic Factor per Eq. 6-3 & Fig. 6-4 (Eq. 26.8-1 & Fig. 26.8-1)
    - These packets assume no topographic factor ($K_{zt}$ = 1.00)
  - $K_d$ = Wind Directionality Factor per Table 6-4 (26.6-1)
    - 0.85 used in all cases
  - V = 3 Second Gust Wind Speed per Fig. 6-1 (26.5-1) or local jurisdiction
  - I = Wind Importance Factor per Table 6-1 (ASCE 7-05 only)
    - 1.00 used for Occupancy Category II Buildings
    - 1.15 used for Occupancy Category III Buildings

$GC_{pf}$ is the external pressure coefficient given in Figure 6-10 (28.4-1).
$GC_{pi}$ is the internal pressure coefficient which in the case of this racking system is zero since air is able to flow freely above and below the modules.

The $GC_{pf}$ Coefficients are broken up by roof tilt and building surface location (mid or edge zones). Each zone has an associated worst-case uplift coefficient as well as a worst-case downward coefficient (discussed in more detail later in this packet).

- External Pressure Coefficients ($GC_{pf}$):
  - Building Surface 2 and 3 (Mid Zone)
    - Roof Tilt 0:12 to 5:12 (0° to 22.6°): -0.69
    - Roof Tilt 6:12 to 12:12 (26.6° to 45°): -0.48
      - Downward (compression) case: 0.21
  - Building Surface 2E and 3E (Edge Zone)
    - Roof Tilt 0:12 to 5:12 (0° to 22.6°): -1.07
    - Roof Tilt 6:12 to 12:12 (26.6° to 45°): -0.69
      - Downward (compression) case: 0.27

*Example Scenario Calculation:*

*$q_h$ = 0.00256(0.98)(1.0)(0.85)(90)$^2$(1.0) =* ***17.27 psf***

*With a 3:12 tilt, this produces wind uplift forces of:*

- *Mid-Roof Zone:*
  - *Uplift Force: 17.27 psf * -0.69 =* ***-11.92 psf***
- *Edge Zone:*
  - *Uplift Force: 17.27 psf * -1.07 =* ***-18.48 psf***

*Based on the area of a 60 cell module (17.76 ft$^2$) the maximum uplift forces imposed on the modules have been calculated on a per module basis:*

- *Mid-Roof Zone:*
  - *Uplift Force: -11.92 psf * 17.76 ft$^2$ =* ***-212 lbs./module***
- *Edge Zone:*
  - *Uplift Force: -18.48 psf * 17.76 ft$^2$ =* ***-328 lbs./module***

*Note: Wind loads act normal to the surface (away for uplift; towards for compression)*

*Per clamp base, the following loads are calculated:*

- *Mid-Roof Zone:*
  - *Uplift Force: -212 lbs. * 0.5 =* ***-106 lbs./base***
- *Edge Zone:*
  - *Uplift Force: -328 lbs. * 0.5 =* ***-164 lbs./base***

Using the worst-case wind uplift basic load combination (allowable stress design) of 0.6D+W (0.6D+0.6W) as dictated in Section 2.4.1 (Section 2.4.1) provides the governing wind uplift design load per base. Because the wind loads are calculated normal to the module, the dead loads must be broken into components to determine the dead load normal to the module.

*Example Scenario Calculation:*

- *Mid-Roof Zone:*
  - *Uplift Force: -106 lbs. + 0.6*(40 lbs.)*cos(22.62) =* ***-83.7 lbs.***
- *Edge Zone:*
  - *Uplift Force: -164 lbs. + 0.6*(40 lbs.)*cos(22.62) =* ***-142.0 lbs.***

*Note: Even though the example scenario tilt is 3:12 (14.04°) a tilt of 5:12 (22.62°) has been used as this would be the most conservative for the 1:12 to 5:12 pitch category.*

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## 3.4 – Allowable Screw Capacity

The screws to be used with this product are the EJOT EJOFAST bi-metal self-drilling screws (JF3). They are to be installed in accordance with their current Evaluation Report (Report Number 0276) which is provided in the appendix of this packet for reference.

As listed in the Evaluation Report, the product is rated for the following allowable design values:

- JF3 Screw Tensile Strength (Allowable Strength (ASD Level)):
  - 24 Gage Roofing: 99 lbs.
  - 26 Gage Roofing: 63 lbs.
- JF3 Screw Shear Strength (Allowable Strength (ASD Level)):
  - 24 Gage Roofing: 236 lbs.
  - 26 Gage Roofing: 119 lbs.

Dividing the worst-case uplift forces at each clamp base by the allowable capacity of the screws determines the number of screws needed at each clamp base (each clamp base can accommodate between 2 and 4 screws).

*Example Scenario Calculation:*

*With a 26 gage roof:*

- *Mid-Roof Zone:*
  - *-83.7 lbs. / 63 lbs. = 1.33 screws →* ***Use a min. of (2) screws per base***
- *Edge Zone:*
  - *-142.0 lbs. / 63 lbs. = 2.25 screws →* ***Use a min. of (3) screws per base***

Note: The addition of this flush mounted PV system does not affect the internal pressure coefficients of the existing roof and the external pressure coefficients will remain the same since the system is flush mounted to the roof. Therefore this racking system does not increase the loads on the roofing-to-substructure attachments.

It is assumed the original roof sheet anchorage to the existing roof joists/members was designed and installed correctly for the worst-case wind uplift pressures (internal and external) as dictated by the governing building code.

## 3.5 – Ground Snow Load Capacity

It is always assumed that the existing building was designed correctly for the site specific design snow loads per the governing building code. The addition of a new rooftop PV system (mounted flush with the roof) does not change the amount of snow that falls on the roof but it can change how the snow load is distributed to the roof as the modules transfer the snow loads as numerous point loads through the clamp bases rather than an area load over the roof.

The design Roof Live Load is interchangeable with the design Roof Snow Load as noted in the load combinations. Table 4-1 of ASCE 7 requires that roofs are designed for a concentrated Roof Live Load of 300 lbs. at any location suject to maintenance workers. Because Roof Live Loads and Snow Loads are interchangeable it can be assumed that the roof should have been orginally designed for a 300 lb. point load due to Roof Live Load or Snow Loads. Therefore, in order to keep the roof stresses within the original design intent, the maximum compression point load allowed on the existing roof at any clamp base is 300 lbs. Based on this limit, the allowable ground snow load can be calculated for each scenario (while also taking into account compression loads due to dead load and downward wind forces).

The sloped roof snow load ($p_s$) is determined as follows:

- $p_s = C_s*p_f$ — Eq. 7-2 (Eq. 7.4-1)
    - Slope Factor $C_s$: — Figure 7-2
        - Slopes up to 15° (≈3:12): 1.00
        - 26.6° (≈6:12): 0.79
        - 45° (12:12): 0.48
    - Flat Roof Snow Load $p_f = 0.7*C_e*C_t*I*p_g$ — Eq. 7-1 (Eq.7.3-1)
        - Exposure Factor Ce: 1.0 — Table 7-2
        - Thermal Factor Ct: 1.2 — Table 7-3
        - Snow Importance Factor (I): — Table 7-4 (Table 1.5-2)
            - Occ. Cat. II 1.0
            - Occ. Cat. III 1.1

      But not less than (I)*$p_g$ when $p_g$ is 20 psf or less
      Or 20*(I) when $p_g$ exceeds 20 psf

*Example Scenario Calculation:*

*Sloped Roof Snow = 1.00*$p_f$*

*Where $p_f$ = 0.7*1.0*1.2*1.0*20 psf = 16.8 psf*

*But not less than 1.0*20 psf = 20 psf → Use 20 psf*

*Sloped Roof Snow = 1.00*20 psf = 20 psf*

*Snow Load per Clamp Base = 20 psf * 17.76 ft² / 2 = **177.6 lbs./base***

## 3.6 – Combined Compression Loads

The governing compression (downward) loads at the clamp bases are from one of multiple load combinations. The governing load combination is dependant on the specific design parameters but the govering copression load combination will be from one of the following load combinations per Section 2.4.1:

- ASCE 7-05:
  - D
  - D+S
  - D+W
  - D+0.75S+0.75W
- ASCE 7-10:
  - D
  - D+S
  - D+0.6W
  - D+0.75S+0.75(0.6W)

*Example Scenario Calculation:*

*Compressive loads at Clamp Base:*

*D: 20 lbs.*

*S: 177.6 lbs.*

*W: 0 lbs. (no downward pressure possible per Figure 6-10 (28.4-1))*

*Worst-Case Load Combination: D+S = 20 lbs. + 177.6 lbs. =* ***197.6 lbs.***

*197.6 lbs. is less than 300 lbs.; therefore the addition of the propsoed MS system will not produce loads on the existing roof greater than what the existing roof should have been originally designed for.*

The following pages provide the resultant loads for all of the design parameters/scenarios under the various load cases.

# ASCE 7-05 – Uplift Tables – 60 Cell Modules

| Uplift Force on Brackets (lbs.) | | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| . | -53.5 | -95.1 | -53.5 |
| 5 | -71.2 | -122.6 | -71.2 |
| 0 | -90.8 | -153.0 | -90.8 |
| 3 | -112.3 | -186.3 | -112.3 |
| 5 | -148.0 | -241.6 | -148.0 |
| 5 | -187.9 | -303.5 | -187.9 |

| Uplift Force on Brackets (lbs.) | | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| 5 | -35.6 | -58.6 | -35.6 |
| . | -48.0 | -76.4 | -48.0 |
| 0 | -61.6 | -96.0 | -61.6 |
| 4 | -76.5 | -117.4 | -76.5 |
| 1 | -101.4 | -153.1 | -101.4 |
| 0 | -129.1 | -193.0 | -129.1 |

**Exposure C, Occupancy II**

**Roof Pitch 1:12 to 5:12**

| ASCE 7-05 Wind Speed (MPH) | Uplift Force on Brackets (lbs.) | | | |
|---|---|---|---|---|
| | 26-Gage | | 24-Gage | |
| | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 90 | -142.0 | -83.7 | -142.0 | -83.7 |
| 100 | -180.5 | -108.5 | -180.5 | -108.5 |
| 110 | -223.0 | -136.0 | -223.0 | -136.0 |
| 120 | -269.7 | -166.0 | -269.7 | -166.0 |
| 135 | -347.2 | -216.0 | -347.2 | -216.0 |
| 150 | -433.8 | -271.9 | -433.8 | -271.9 |

**Roof Pitch 6:12 to 12:12**

| ASCE 7-05 Wind Speed (MPH) | Uplift Force on Brackets (lbs.) | | | |
|---|---|---|---|---|
| | 26-Gage | | 24-Gage | |
| | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 90 | -88.9 | -56.7 | -88.9 | -56.7 |
| 100 | -113.7 | -73.9 | -113.7 | -73.9 |
| 110 | -141.1 | -93.0 | -141.1 | -93.0 |
| 120 | -171.2 | -113.9 | -171.2 | -113.9 |
| 135 | -221.2 | -148.7 | -221.2 | -148.7 |
| 150 | -277.1 | -187.6 | -277.1 | -187.6 |

**Exposure B, Occupancy III**

**Roof Pitch 1:12 to 5:12**

| ASCE 7-05 Wind Speed (MPH) | Uplif |
|---|---|
| | 26-Ga |
| | Edge Zone |
| 90 | -112.7 |
| 100 | -144.3 |
| 110 | -179.3 |
| 120 | -217.5 |
| 135 | -281.2 |
| 150 | -352.4 |

**Roof Pitch 6:12 to 12:12**

| ASCE 7-05 Wind Speed (MPH) | Uplif |
|---|---|
| | 26-Ga |
| | Edge Zone |
| 90 | -70.0 |
| 100 | -90.4 |
| 110 | -112.9 |
| 120 | -137.6 |
| 135 | -178.7 |
| 150 | -224.5 |

the module face and are based on the 0.6D+W load combination.

or further information on Roof Zones.

# ASCE 7-05 – Uplift Tables – 72 Cell Modules

| Uplift Force on Brackets (lbs.) | | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| 9 | -56.7 | -105.9 | -56.7 |
| 4 | -77.7 | -138.4 | -77.7 |
| 3 | -100.8 | -174.3 | -100.8 |
| 7 | -126.2 | -213.7 | -126.2 |
| 1 | -168.4 | -279.1 | -168.4 |
| 3 | -215.6 | -352.3 | -215.6 |

| Uplift Force on Brackets (lbs.) | | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| | -37.1 | -64.3 | -37.1 |
| | -51.7 | -85.3 | -51.7 |
| 5 | -67.8 | -108.5 | -67.8 |
| 3 | -85.5 | -133.8 | -85.5 |
| 0 | -114.8 | -176.0 | -114.8 |
| 2 | -147.7 | -223.2 | -147.7 |

**Exposure C, Occupancy II**

**Roof Pitch 1:12 to 5:12**

| | Uplift Force on Brackets (lbs.) | | | |
|---|---|---|---|---|
| ASCE 7-05 | 26-Gage | | 24-Gage | |
| Wind Speed (MPH) | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 90 | -161.3 | -92.4 | -161.3 | -92.4 |
| 100 | -206.9 | -121.8 | -206.9 | -121.8 |
| 110 | -257.2 | -154.2 | -257.2 | -154.2 |
| 120 | -312.2 | -189.7 | -312.2 | -189.7 |
| 135 | -403.9 | -248.8 | -403.9 | -248.8 |
| 150 | -506.3 | -314.9 | -506.3 | -314.9 |

**Roof Pitch 6:12 to 12:12**

| | Uplift Force on Brackets (lbs.) | | | |
|---|---|---|---|---|
| ASCE 7-05 | 26-Gage | | 24-Gage | |
| Wind Speed (MPH) | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 90 | -100.1 | -62.0 | -100.1 | -62.0 |
| 100 | -129.4 | -82.4 | -129.4 | -82.4 |
| 110 | -161.9 | -105.0 | -161.9 | -105.0 |
| 120 | -197.4 | -129.7 | -197.4 | -129.7 |
| 135 | -256.5 | -170.8 | -256.5 | -170.8 |
| 150 | -322.5 | -216.7 | -322.5 | -216.7 |

**Exposure B, Occupancy III**

**Roof Pitch 1:12 to 5:12**

| | Uplif |
|---|---|
| ASCE 7-05 | 26-Ga |
| Wind Speed (MPH) | Edge Zone |
| 90 | -126.7 |
| 100 | -164.1 |
| 110 | -205.4 |
| 120 | -250.7 |
| 135 | -325.9 |
| 150 | -410.0 |

**Roof Pitch 6:12 to 12:12**

| | Uplif |
|---|---|
| ASCE 7-05 | 26-Ga |
| Wind Speed (MPH) | Edge Zone |
| 90 | -77.7 |
| 100 | -101.8 |
| 110 | -128.5 |
| 120 | -157.7 |
| 135 | -206.2 |
| 150 | -260.4 |

the module face and are based on the 0.6D+W load combination.

or further information on Roof Zones.

## ASCE 7-10 – Uplift Tables – 60 Cell Modules

| Uplift Force on Brackets (lbs.) | | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| | -51.9 | -92.7 | -51.9 |
| 9 | -58.5 | -102.9 | -58.5 |
| 1 | -87.6 | -148.1 | -87.6 |
| 3 | -103.9 | -173.3 | -103.9 |
| 2 | -121.2 | -200.2 | -121.2 |
| 3 | -139.7 | -228.8 | -139.7 |

| Uplift Force on Brackets (lbs.) | | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| | -34.6 | -57.1 | -34.6 |
| | -39.1 | -63.7 | -39.1 |
| | -59.4 | -92.8 | -59.4 |
| 0 | -70.7 | -109.0 | -70.7 |
| 4 | -82.8 | -126.4 | -82.8 |
| 9 | -95.6 | -144.9 | -95.6 |

**Exposure C**

**Roof Pitch 1:12 to 5:12**

| ASCE 7-10 Wind Speed (MPH) | Uplift Force on Brackets (lbs.) 26-Gage Edge Zone | 26-Gage Mid Zone | 24-Gage Edge Zone | 24-Gage Mid Zone |
|---|---|---|---|---|
| 115 | -138.6 | -81.5 | -138.6 | -81.5 |
| 120 | -152.9 | -90.8 | -152.9 | -90.8 |
| 140 | -216.2 | -131.5 | -216.2 | -131.5 |
| 150 | -251.4 | -154.3 | -251.4 | -154.3 |
| 160 | -289.1 | -178.6 | -289.1 | -178.6 |
| 170 | -329.2 | -204.4 | -329.2 | -204.4 |

**Roof Pitch 6:12 to 12:12**

| ASCE 7-10 Wind Speed (MPH) | Uplift Force on Brackets (lbs.) 26-Gage Edge Zone | 26-Gage Mid Zone | 24-Gage Edge Zone | 24-Gage Mid Zone |
|---|---|---|---|---|
| 115 | -86.7 | -55.2 | -86.7 | -55.2 |
| 120 | -95.9 | -61.6 | -95.9 | -61.6 |
| 140 | -136.7 | -89.9 | -136.7 | -89.9 |
| 150 | -159.4 | -105.8 | -159.4 | -105.8 |
| 160 | -183.8 | -122.7 | -183.8 | -122.7 |
| 170 | -209.6 | -140.7 | -209.6 | -140.7 |

the module face and are based on the 0.6D+0.6W load combination.

or further information on Roof Zones.

# ASCE 7-10 – Uplift Tables – 72 Cell Modules

| Uplift Force on Brackets (lbs.) | | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| 1 | -54.9 | -103.1 | -54.9 |
| 1 | -62.6 | -115.1 | -62.6 |
| 5 | -97.1 | -168.5 | -97.1 |
| 3 | -116.3 | -198.3 | -116.3 |
| 1 | -136.8 | -230.1 | -136.8 |
| 0 | -158.6 | -264.0 | -158.6 |

| Uplift Force on Brackets (lbs.) | | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| | -35.9 | -62.5 | -35.9 |
| | -41.3 | -70.3 | -41.3 |
| 7 | -65.2 | -104.7 | -65.2 |
| 9 | -78.6 | -123.9 | -78.6 |
| 4 | -92.9 | -144.4 | -92.9 |
| 3 | -108.1 | -166.3 | -108.1 |

**Exposure C**

**Roof Pitch 1:12 to 5:12**

| ASCE 7-10 Wind Speed (MPH) | Uplift Force on Brackets (lbs.) | | | |
|---|---|---|---|---|
| | 26-Gage | | 24-Gage | |
| | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 115 | -157.4 | -89.9 | -157.4 | -89.9 |
| 120 | -174.3 | -100.8 | -174.3 | -100.8 |
| 140 | -249.0 | -149.0 | -249.0 | -149.0 |
| 150 | -290.7 | -175.8 | -290.7 | -175.8 |
| 160 | -335.2 | -204.6 | -335.2 | -204.6 |
| 170 | -382.7 | -235.2 | -382.7 | -235.2 |

**Roof Pitch 6:12 to 12:12**

| ASCE 7-10 Wind Speed (MPH) | Uplift Force on Brackets (lbs.) | | | |
|---|---|---|---|---|
| | 26-Gage | | 24-Gage | |
| | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 115 | -97.5 | -60.2 | -97.5 | -60.2 |
| 120 | -108.4 | -67.8 | -108.4 | -67.8 |
| 140 | -156.6 | -101.3 | -156.6 | -101.3 |
| 150 | -183.5 | -120.0 | -183.5 | -120.0 |
| 160 | -212.2 | -140.0 | -212.2 | -140.0 |
| 170 | -242.8 | -161.3 | -242.8 | -161.3 |

the module face and are based on the 0.6D+0.6W load combination.

or further information on Roof Zones.

# ASCE 7-05 – Governing Compression Tables – 60 Cell Modules

| ...npression Force on Brackets (lbs.) | | | |
|---|---|---|---|
| ...6-Gage | | 24-Gage | |
| ...ne | Mid Zone | Edge Zone | Mid Zone |
| ...5 | 197.6 | 197.6 | 197.6 |
| ...5 | 197.6 | 197.6 | 197.6 |
| ...5 | 197.6 | 197.6 | 197.6 |
| ...5 | 197.6 | 197.6 | 197.6 |
| ...5 | 197.6 | 197.6 | 197.6 |
| ...5 | 197.6 | 197.6 | 197.6 |

| ...npression Force on Brackets (lbs.) | | | |
|---|---|---|---|
| ...6-Gage | | 24-Gage | |
| ...ne | Mid Zone | Edge Zone | Mid Zone |
| ...3 | 176.8 | 176.8 | 176.8 |
| ...3 | 176.8 | 176.8 | 176.8 |
| ...3 | 176.8 | 176.8 | 176.8 |
| ...3 | 176.8 | 176.8 | 176.8 |
| ...0 | 176.8 | 187.0 | 176.8 |
| ...7 | 185.0 | 198.7 | 185.0 |

**Exposure C, Occupancy II**

**Roof Pitch 1:12 to 5:12**

| | Compression Force on Brackets (lbs.) | | | |
|---|---|---|---|---|
| ASCE 7-05 | 26-Gage | | 24-Gage | |
| Wind Speed (MPH) | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 90 | 197.6 | 197.6 | 197.6 | 197.6 |
| 100 | 197.6 | 197.6 | 197.6 | 197.6 |
| 110 | 197.6 | 197.6 | 197.6 | 197.6 |
| 120 | 197.6 | 197.6 | 197.6 | 197.6 |
| 135 | 197.6 | 197.6 | 197.6 | 197.6 |
| 150 | 197.6 | 197.6 | 197.6 | 197.6 |

**Roof Pitch 6:12 to 12:12**

| | Compression Force on Brackets (lbs.) | | | |
|---|---|---|---|---|
| ASCE 7-05 | 26-Gage | | 24-Gage | |
| Wind Speed (MPH) | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 90 | 176.8 | 176.8 | 176.8 | 176.8 |
| 100 | 176.8 | 176.8 | 176.8 | 176.8 |
| 110 | 183.4 | 176.8 | 183.4 | 176.8 |
| 120 | 192.3 | 180.0 | 192.3 | 180.0 |
| 135 | 206.9 | 191.4 | 206.9 | 191.4 |
| 150 | 223.3 | 204.1 | 223.3 | 204.1 |

**Exposure B, Occupancy III**

**Roof Pitch 1:12 to 5:12**

| | Compres... |
|---|---|
| ASCE 7-05 | 26-G... |
| Wind Speed (MPH) | Edge Zone |
| 90 | 215.4 |
| 100 | 215.4 |
| 110 | 215.4 |
| 120 | 215.4 |
| 135 | 215.4 |
| 150 | 215.4 |

**Roof Pitch 6:12 to 12:12**

| | Compres... |
|---|---|
| ASCE 7-05 | 26-G... |
| Wind Speed (MPH) | Edge Zone |
| 90 | 192.6 |
| 100 | 192.6 |
| 110 | 192.6 |
| 120 | 194.3 |
| 135 | 206.4 |
| 150 | 219.8 |

...rmal to the module face and are based on the worst-case combination of D; D+W; D+S; or D+0.75W+0.75S

...or further information on Roof Zones.

# ASCE 7-05 – Governing Compression Tables – 72 Cell Modules

| npression Force on Brackets (lbs.) | | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| | 239.5 | 239.5 | 239.5 |
| | 239.5 | 239.5 | 239.5 |
| | 239.5 | 239.5 | 239.5 |
| | 239.5 | 239.5 | 239.5 |
| | 239.5 | 239.5 | 239.5 |
| | 239.5 | 239.5 | 239.5 |

| npression Force on Brackets (lbs.) | | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| | 214.2 | 214.2 | 214.2 |
| | 214.2 | 214.2 | 214.2 |
| | 214.2 | 214.2 | 214.2 |
| | 214.2 | 214.2 | 214.2 |
| | 214.2 | 226.2 | 214.2 |
| | 223.9 | 240.1 | 223.9 |

**Exposure C, Occupancy II**

**Roof Pitch 1:12 to 5:12**

| ASCE 7-05 Wind Speed (MPH) | Compression Force on Brackets (lbs.) | | | |
|---|---|---|---|---|
| | 26-Gage | | 24-Gage | |
| | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 90 | 239.5 | 239.5 | 239.5 | 239.5 |
| 100 | 239.5 | 239.5 | 239.5 | 239.5 |
| 110 | 239.5 | 239.5 | 239.5 | 239.5 |
| 120 | 239.5 | 239.5 | 239.5 | 239.5 |
| 135 | 239.5 | 239.5 | 239.5 | 239.5 |
| 150 | 239.5 | 239.5 | 239.5 | 239.5 |

**Roof Pitch 6:12 to 12:12**

| ASCE 7-05 Wind Speed (MPH) | Compression Force on Brackets (lbs.) | | | |
|---|---|---|---|---|
| | 26-Gage | | 24-Gage | |
| | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 90 | 214.2 | 214.2 | 214.2 | 214.2 |
| 100 | 214.2 | 214.2 | 214.2 | 214.2 |
| 110 | 222.1 | 214.2 | 222.1 | 214.2 |
| 120 | 232.5 | 218.0 | 232.5 | 218.0 |
| 135 | 249.8 | 231.5 | 249.8 | 231.5 |
| 150 | 269.2 | 246.5 | 269.2 | 246.5 |

**Exposure B, Occupancy III**

**Roof Pitch 1:12 to 5:12**

| ASCE 7-05 Wind Speed (MPH) | Compres |
|---|---|
| | 26-Ga |
| | Edge Zone |
| 90 | 260.4 |
| 100 | 260.4 |
| 110 | 260.4 |
| 120 | 260.4 |
| 135 | 260.4 |
| 150 | 260.4 |

**Roof Pitch 6:12 to 12:12**

| ASCE 7-05 Wind Speed (MPH) | Compres |
|---|---|
| | 26-Ga |
| | Edge Zone |
| 90 | 232.9 |
| 100 | 232.9 |
| 110 | 232.9 |
| 120 | 234.9 |
| 135 | 249.2 |
| 150 | 265.1 |

rmal to the module face and are based on the worst-case combination of D; D+W; D+S; or D+0.75W+0.75S

or further information on Roof Zones.

# ASCE 7-10 – Governing Compression Tables – 60 Cell Modules

| …pression Force on Brackets (lbs.) | | | |
|---|---|---|---|
| …6-Gage | | 24-Gage | |
| …ne | Mid Zone | Edge Zone | Mid Zone |
| | 197.6 | 197.6 | 197.6 |
| | 197.6 | 197.6 | 197.6 |
| | 197.6 | 197.6 | 197.6 |
| | 197.6 | 197.6 | 197.6 |
| | 197.6 | 197.6 | 197.6 |
| | 197.6 | 197.6 | 197.6 |

| …pression Force on Brackets (lbs.) | | | |
|---|---|---|---|
| …6-Gage | | 24-Gage | |
| …ne | Mid Zone | Edge Zone | Mid Zone |
| | 176.8 | 176.8 | 176.8 |
| | 176.8 | 176.8 | 176.8 |
| | 176.8 | 176.8 | 176.8 |
| | 176.8 | 176.8 | 176.8 |
| | 176.8 | 179.1 | 176.8 |
| | 176.8 | 184.5 | 176.8 |

**Exposure C, Occupancy II**

**Roof Pitch 1:12 to 5:12**

| | Compression Force on Brackets (lbs.) | | | |
|---|---|---|---|---|
| ASCE 7-10 | 26-Gage | | 24-Gage | |
| Wind Speed (MPH) | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 115 | 197.6 | 197.6 | 197.6 | 197.6 |
| 120 | 197.6 | 197.6 | 197.6 | 197.6 |
| 140 | 197.6 | 197.6 | 197.6 | 197.6 |
| 150 | 197.6 | 197.6 | 197.6 | 197.6 |
| 160 | 197.6 | 197.6 | 197.6 | 197.6 |
| 170 | 197.6 | 197.6 | 197.6 | 197.6 |

**Roof Pitch 6:12 to 12:12**

| | Compression Force on Brackets (lbs.) | | | |
|---|---|---|---|---|
| ASCE 7-10 | 26-Gage | | 24-Gage | |
| Wind Speed (MPH) | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 115 | 176.8 | 176.8 | 176.8 | 176.8 |
| 120 | 176.8 | 176.8 | 176.8 | 176.8 |
| 140 | 182.1 | 176.8 | 182.1 | 176.8 |
| 150 | 188.8 | 177.3 | 188.8 | 177.3 |
| 160 | 195.9 | 182.9 | 195.9 | 182.9 |
| 170 | 203.5 | 188.8 | 203.5 | 188.8 |

**Exposure B, Occupancy III**

**Roof Pitch 1:12 to 5:12**

| | Compres… |
|---|---|
| ASCE 7-10 | 26-G… |
| Wind Speed (MPH) | Edge Zone |
| 115 | 215.4 |
| 120 | 215.4 |
| 140 | 215.4 |
| 150 | 215.4 |
| 160 | 215.4 |
| 170 | 215.4 |

**Roof Pitch 6:12 to 12:12**

| | Compres… |
|---|---|
| ASCE 7-10 | 26-G… |
| Wind Speed (MPH) | Edge Zone |
| 115 | 192.6 |
| 120 | 192.6 |
| 140 | 192.6 |
| 150 | 192.6 |
| 160 | 192.6 |
| 170 | 196.5 |

…rmal to the module face and are based on the worst-case combination of D; D+0.6W; D+S; or D+0.75(0.6W)+0.75S

…or further information on Roof Zones.

# ASCE 7-10 – Governing Compression Tables – 72 Cell Modules

| npression Force on Brackets (lbs.) | | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| | 239.5 | 239.5 | 239.5 |
| | 239.5 | 239.5 | 239.5 |
| | 239.5 | 239.5 | 239.5 |
| | 239.5 | 239.5 | 239.5 |
| | 239.5 | 239.5 | 239.5 |
| | 239.5 | 239.5 | 239.5 |

| npression Force on Brackets (lbs.) | | | |
|---|---|---|---|
| 6-Gage | | 24-Gage | |
| ne | Mid Zone | Edge Zone | Mid Zone |
| | 214.2 | 214.2 | 214.2 |
| | 214.2 | 214.2 | 214.2 |
| | 214.2 | 214.2 | 214.2 |
| | 214.2 | 214.2 | 214.2 |
| | 214.2 | 217.0 | 214.2 |
| | 214.2 | 223.4 | 214.2 |

**Exposure C, Occupancy II**

**Roof Pitch 1:12 to 5:12**

| | Compression Force on Brackets (lbs.) | | | |
|---|---|---|---|---|
| ASCE 7-10 | 26-Gage | | 24-Gage | |
| Wind Speed (MPH) | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 115 | 239.5 | 239.5 | 239.5 | 239.5 |
| 120 | 239.5 | 239.5 | 239.5 | 239.5 |
| 140 | 239.5 | 239.5 | 239.5 | 239.5 |
| 150 | 239.5 | 239.5 | 239.5 | 239.5 |
| 160 | 239.5 | 239.5 | 239.5 | 239.5 |
| 170 | 239.5 | 239.5 | 239.5 | 239.5 |

**Roof Pitch 6:12 to 12:12**

| | Compression Force on Brackets (lbs.) | | | |
|---|---|---|---|---|
| ASCE 7-10 | 26-Gage | | 24-Gage | |
| Wind Speed (MPH) | Edge Zone | Mid Zone | Edge Zone | Mid Zone |
| 115 | 214.2 | 214.2 | 214.2 | 214.2 |
| 120 | 214.2 | 214.2 | 214.2 | 214.2 |
| 140 | 220.5 | 214.2 | 220.5 | 214.2 |
| 150 | 228.4 | 214.8 | 228.4 | 214.8 |
| 160 | 236.8 | 221.4 | 236.8 | 221.4 |
| 170 | 245.8 | 228.4 | 245.8 | 228.4 |

**Exposure B, Occupancy III**

**Roof Pitch 1:12 to 5:12**

| | Compres |
|---|---|
| ASCE 7-10 | 26-Ga |
| Wind Speed (MPH) | Edge Zone |
| 115 | 260.4 |
| 120 | 260.4 |
| 140 | 260.4 |
| 150 | 260.4 |
| 160 | 260.4 |
| 170 | 260.4 |

**Roof Pitch 6:12 to 12:12**

| | Compres |
|---|---|
| ASCE 7-10 | 26-Ga |
| Wind Speed (MPH) | Edge Zone |
| 115 | 232.9 |
| 120 | 232.9 |
| 140 | 232.9 |
| 150 | 232.9 |
| 160 | 232.9 |
| 170 | 237.4 |

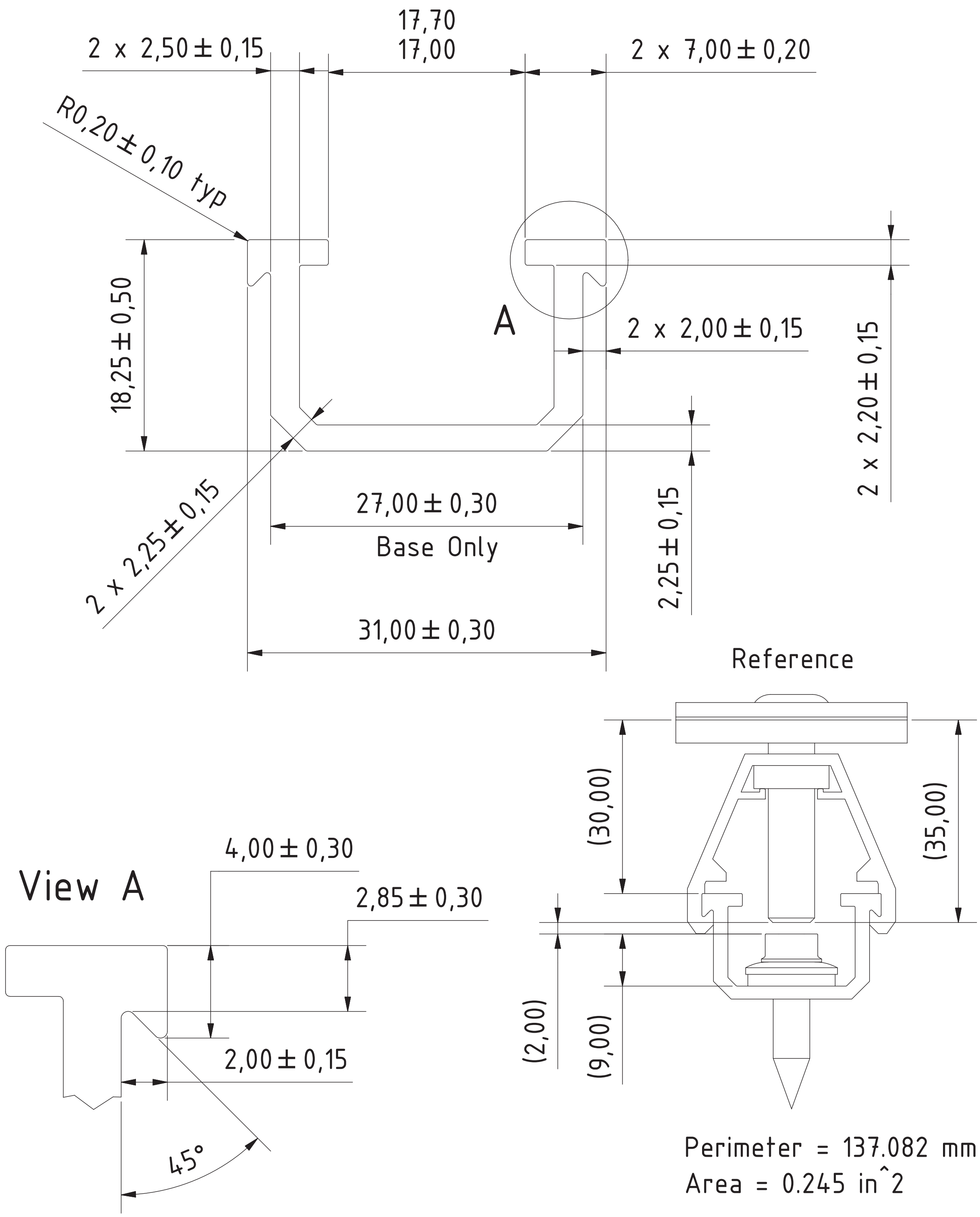
rmal to the module face and are based on the worst-case combination of D; D+0.6W; D+S; or D+0.75(0.6W)+0.75S

or further information on Roof Zones.

1405 SPRING STREET, SUITE 204
PASO ROBLES, CA 93446
(805) 423-1326

# APPENDIX

(FOR REFERENCE ONLY)




Perimeter = 137.082 mm
Area = 0.245 in^2

| Section Properties | | | |
|---|---|---|---|
| Ix (cm$^4$) | | ix (cm) | |
| Wx(cm$^3$) | | iy (cm) | |
| Iy (cm$^4$) | | A (cm$^2$) | |
| Wy(cm$^3$) | | | |

| Rev | Description | Date | Name |
|---|---|---|---|

Renusol Solar Mounting Systems

Tolerances according to EN 12020-2

| Date | Name |
|---|---|
| 6/12/2013 | dhughes |

Renusol America
1292 Logan Circle NW
Atlanta, GA 30318

Scale: 1 : 1

Weight: 0.288 lbs/ft

Material: EN AW6063 T6

Part Number: TBD

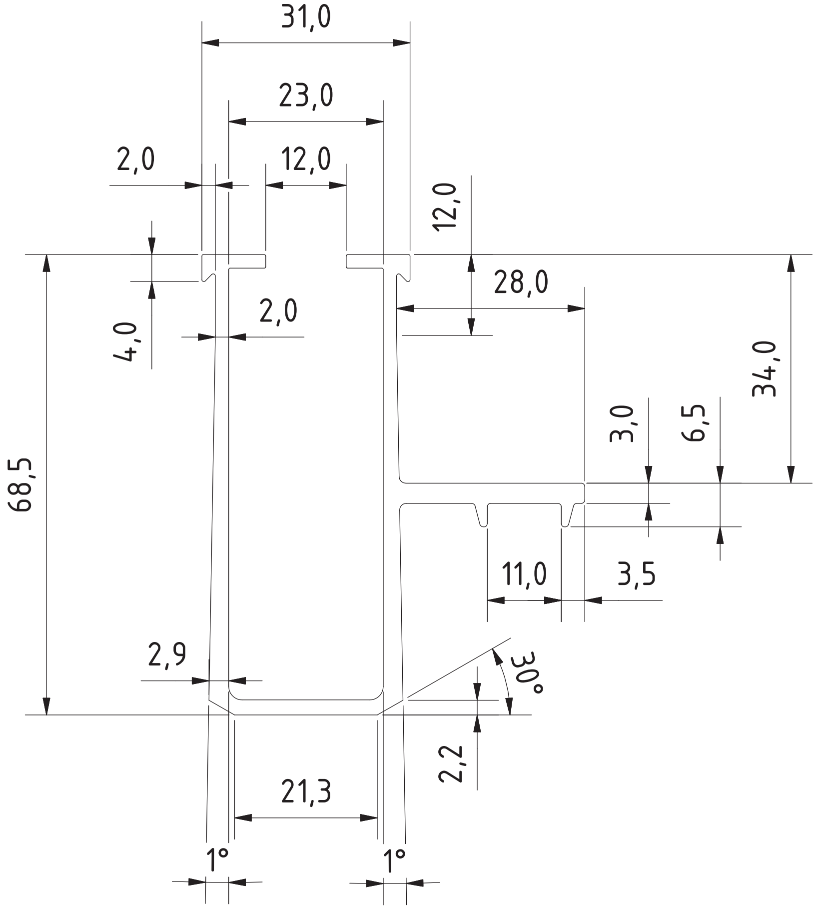
Title: Renusol MS Rail

Drawing Number: TBD

Sheet: 1 / 1

Sheet Size: A4

NO EXPOSED EDGES




Perimeter = 417.42 mm
Area = 0.781 in^2

| Section Properties | | | |
|---|---|---|---|
| Ix (cm⁴) | | ix (cm) | |
| Wx(cm³) | | iy (cm) | |
| Iy (cm⁴) | | A (cm²) | |
| Wy(cm³) | | | |

| Rev | Description | Date | Name |
|---|---|---|---|

Renusol Solar Mounting Systems

Tolerances according to EN 12020-2

| Date | Name |
|---|---|
| 1/5/2015 | dhughes |

Renusol America
1292 Logan Circle NW
Atlanta, GA 30318

Scale:

Weight: 0.937 lb/ft

Material: EN AW6063 T6

Part Number: TBD

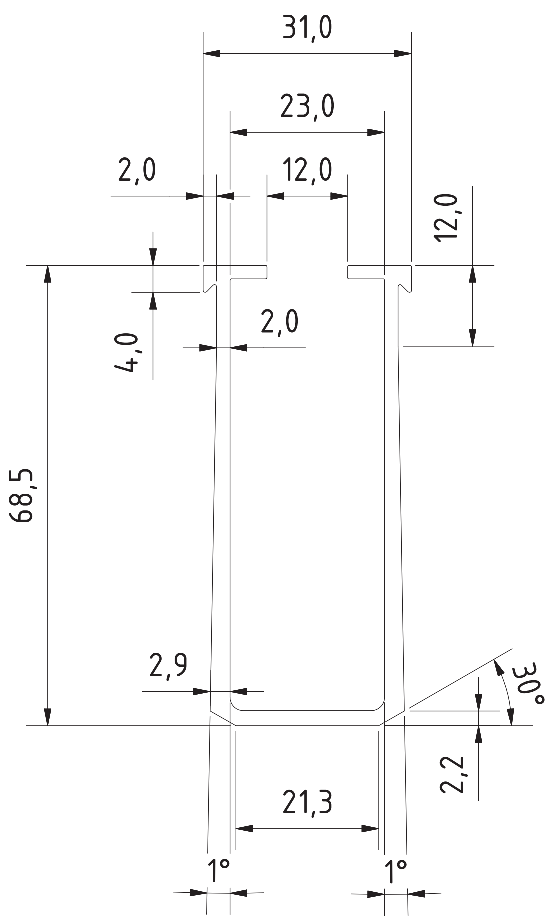
Title: MS 2.0 concept 1a, profile

Drawing Number: 01052015.1a

Sheet: 1 / 1

Sheet Size: A4

NO EXPOSED EDGES




Perimeter = 352.467 mm
Area = 0.636 in^2

| Section Properties | | | |
|---|---|---|---|
| Ix (cm⁴) | | ix (cm) | |
| Wx(cm³) | | iy (cm) | |
| Iy (cm⁴) | | A (cm²) | |
| Wy(cm³) | | | |

| Rev | Description | Date | Name |
|---|---|---|---|

Scale:

Weight: 0.763 lb/ft

Material: EN AW6063 T6

Part Number: TBD

Tolerances according to EN 12020-2

| Date | Name |
|---|---|
| 1/5/2015 | dhughes |

Title: MS 2.0 concept 2a, profile

Drawing Number: 01052015.2a

Sheet: 1 / 1

Sheet Size: A4

Renusol America
1292 Logan Circle NW
Atlanta, GA 30318

Report Number: 0276
Originally Issued: 01/2013
Valid Through: 01/2014

**DIVISON: 05 – METALS**
**Section 050523 – Metal Fastenings**

**REPORT HOLDER:**

**EJOT BAUBEFESTIGUNGEN GmbH**
**In der Stockwiese 35**
**57334 Bad Laasphe**
**Germany**
**www.ejot-usa.com**
**bau@ejot.de**

**EVALUATION SUBJECT:**

**EJOT EJOFAST® bi-metal SELF-DRILLING SCREWS JF3**

## 1.0 EVALUATION SCOPE

### 1.1 Compliance with the following codes

- *2012 International Building Code®* (2012 IBC)
- *2009 International Building Code®* (2009 IBC)

### 1.2 Evaluated in accordance with

- ICC-ES *Acceptance Criteria for Tapping Screw Fasteners* (AC118), approved June 2012

### 1.3 Property evaluated

- Structural

## 2.0 USES

The EJOT EJOFAST® bi-metal self-drilling screws are used to resist shear and tension loads in engineered connections for cold-formed steel to cold formed-steel construction with thicknesses ranging from 20ga to 26ga.

## 3.0 DESCRIPTION

**3.1 Product Information:** The EJOT EJOFAST® bi-metal self-drilling screws, illustrated in Figure 1 of this report are No. 12 self-drilling screws. The screws have a nominal major shank diameter of 0.217 inch (5.5 mm) and nominal minor shank diameter of 0.161 inch (4.1 mm) with 17 threads per inch. The screws include a hex washer head with a 0.413 inch (10.5 mm) nominal diameter, and a custom drill point. Screws are 1 inch (25 mm) in length. Table 1 provides a description of the screws recognized in this report.

### 3.2 Material

**3.2.1 Screws:** The screws described in this report are manufactured from stainless steel conforming to ASTM 304 and in the area of the drill point from carbon steel conforming to ASTM A 510, Grade 1022, and hardened through induction, and coated with zinc coating.

**3.2.2 Cold-Formed Steel Members:** Connected members (sheet metal) covered in this report must be manufactured from materials in compliance with the American Iron and Steel Institute *North American Specification for the Design of Cold-Formed Steel Structural Members* (AISI S100). Loads provided in this report are based on the following material properties:

| MEMBER THICKNESS DESIGNATION | DESIGN THICKNESS (in.) | MINIMUM YIELD STRESS (psi) | MINIMUM TENSILE STRESS (psi) |
|---|---|---|---|
| 26 gage | 0.017 | 33,000 | 45,000 |
| 24 gage | 0.023 | 33,000 | 45,000 |
| 22 gage | 0.028 | 33,000 | 45,000 |
| 20 gage | 0.034 | 33,000 | 45,000 |

## 4.0 DESIGN AND INSTALLATION

### 4.1 Design:

The nominal, design, and allowable shear and tensile strengths of the screws are provided in Table 2. The nominal shear strength, $P_{ss}$, and nominal tensile strength, $P_{ts}$, of the screws are the average ultimate values from testing. The tabulated LRFD design strength and ASD allowable strength values are based on a resistance factor, Φ, and a safety factor, Ω, as defined in AISI S100.

The nominal density, and allowable strengths for shear, pull-over, and pull-out of steel-to-steel connections are provided in Tables 3, 4, and 5, respectively. The resistance factors and safety factors used to determine the LRFD and ASD strengths are determined in accordance with AISI S100.

For connections subject to shear, the lesser of the fastener shear strength (Table 2) and the connection shear strength (Table 3) must be used for design. For connections subject to tension, the least of the tension strength of screws (Table 2), connection pull-over strength (Table 4) and connection pull-out strength (Table 5) must be used for design. Connections subject to combined tension and shear loading must be designed in accordance with Section E4.5 of AISI S100, using strength values found in this report.

The values in the tables are based on a minimum spacing between the centers of fasteners of three times the diameter of the screw, and a minimum distance of 1.5 times the diameter of the screw from the center of a fastener to the edge of any connected part.

**4.2 Installation**:

Installation of the EJOT EJOFAST® bi-metal self-drilling screws must be in accordance with AISI S100, the manufacturer's published installation instructions and this report. The manufacturer's published installation instructions must be available at the jobsite at all times during the installation.

The screws must be installed perpendicular to the work surface using a tool with maximum recommended speed of 2,500 rpm. The screw must penetrate through the supporting steel with a minimum of three threads protruding past the back side of the supporting steel.

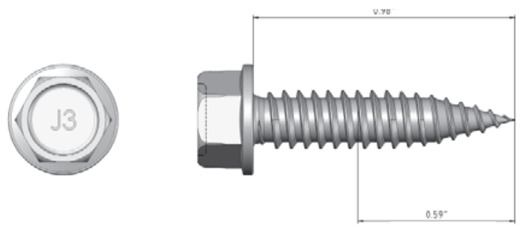



Figure 1 - EJOT EJOFAST® bi-metal SELF-DRILLING SCREW JF3

**5.0 CONDITIONS OF USE**

The EJOT EJOFAST® bi-metal self-drilling screws described in this report are in compliance with, or are acceptable alternatives to what is specified in, those codes listed in Section 1.0 of this report subject to the following conditions:

**5.1** Screws must be installed in accordance with AISI S100, the manufacturer's published installation instructions and this report. Where conflict exists between these three documents, this report shall govern. Otherwise, the most restrictive requirement shall cover.

**5.2** The allowable strengths (ASD) specified in Section 4.1 may not be increased when the screws are used to resist wind or seismic force.

**5.3** The bi-metal screws must be suitable for the intended use, as determined by a registered design professional.

**5.4** Calculations to verify conformance with this report must be submitted to the code official for review and approval. The calculations and applicable drawings are to be prepared by a registered design professional when required by the statues of the jurisdiction in which the project is proposed.

**5.5** The connected members must be checked for rupture in accordance with Section E5 of AISI S100.

**6.0 EVIDENCE SUBMITTED**

Data in accordance with ICC-ES *Acceptance Criteria for Tapping Screw Fasteners* (AC118), approved June 2012, including test results from laboratories in compliance with ISO/IEC 17025.

**7.0 IDENTIFICATION**

The EJOT EJOFAST® bi-metal self-drilling screws described in this report are identified with “J3” on the top surface of the screw head, as shown in Figure 1. Packages of screws are labeled with the report holder's name (EJOT), the brand name (EJOFAST®), the model number (JF3-2-5.5X25 or JF3-2-5.5X35), the screw quantity in the package, and the number of the evaluation report (ER-0276).

Richard Beck, PE, CBO, MCP
**Director of Uniform Evaluation Service**

GP Russ Chaney
**CEO, The IAPMO Group**

**Table 1 - Self-Drilling Screw Specifications**

| Model No. | Designation | Size | Nominal Diameter (mm) | Nominal Screw Length (mm) | Head Style | Nominal Point Length (mm) |
|---|---|---|---|---|---|---|
| EJOT EJOFAST® JF3 | 5.5 (#12 X 17) | 5.5 x 25 (#12 x 1") | 5.5 (0.217") | 25 (1") | Hex Washer | 15 (0.591") |
| EJOT EJOFAST® JF3 | 5.5 (#12 X 17) | 5.5 x 35 (#12 x 1 3/8") | 5.5 (0.217") | 35 (1 3/8") | Hex Washer | 15 (0.591") |

**Table 2 - Self-Drilling Screw Strengths (lbs)**

| Model No. | Nominal Strength | | Design Strength (LRFD) | | Allowable Strength (ASD) | |
|---|---|---|---|---|---|---|
| | Shear ($P_{ss}$) | Tension ($P_{ts}$) | Shear ($P_{ss}$) | Tension ($P_{ts}$) | Shear ($P_{ss}$) | Tension ($P_{ts}$) |
| EJOT EJOFAST® JF3 | 1912 | 2732 | 956 | 1366 | 637 | 911 |

Note - For LRFD, $\Phi = 0.5$. For ASD, $\Omega = 3.0$.

**Table 3 - Self-Drilling Screw Lap-Joint Connection Shear Strength limited by Tilting and Bearing (lbs)**

| Model No. | Strength | Minimum base steel thickness | | | |
|---|---|---|---|---|---|
| | | 26 gage | 24 gage | 22 gage | 20 gage |
| EJOT EJOFAST® JF3 | Nominal Strength, $P_{ns}$ | 490 | 745 | 1018 | 1056 |
| | Design Strength (LRFD), $\Phi P_{ns}$ | 190 | 377 | 459 | 442 |
| | Allowable Strength (ASD), $P_{ns}/\Omega$ | 119 | 236 | 287 | 282 |

Notes: For 26 gage, $\Phi = 0.6$ and $\Omega = 2.7$. For 24 gage, $\Phi = 0.6$ and $\Omega = 2.5$.
For 22 gage, $\Phi = 0.6$ and $\Omega = 2.5$. For 20 gage, $\Phi = 0.5$ and $\Omega = 3.0$.

**Table 4 - Self-Drilling Screw Lap-Joint Connection Tensile Strength limited by Pull-Over (lbs)**

| Model No. | Strength | Minimum base steel thickness of member not in Contact with screw head | | | |
|---|---|---|---|---|---|
| | | 26 gage | 24 gage | 22 gage | 20 gage |
| EJOT EJOFAST® JF3 | Nominal Strength, $P_{ns}$ | 473 | 775 | 888 | 1188 |
| | Design Strength (LRFD), $\Phi P_{ns}$ | 169 | 366 | 373 | 496 |
| | Allowable Strength (ASD), $P_{ns}/\Omega$ | 106 | 229 | 233 | 317 |

Notes: For 26 gage, $\Phi = 0.5$ and $\Omega = 3.0$. For 24 gage, $\Phi = 0.6$ and $\Omega = 2.7$.
For 22 gage, $\Phi = 0.6$ and $\Omega = 2.7$. For 20 gage, $\Phi = 0.5$ and $\Omega = 3.0$.

**Table 5 - Self-Drilling Screw Lap-Joint Connection Tensile Strength limited by Pull-Out (lbs)**

| Model No. | Strength | Minimum base steel thickness of member not in Contact with screw head | | | |
|---|---|---|---|---|---|
| | | 26 gage | 24 gage | 22 gage | 20 gage |
| EJOT EJOFAST® JF3 | Nominal Strength, $P_{ns}$ | 259 | 334 | 464 | 497 |
| | Design Strength (LRFD), $\Phi P_{ns}$ | 101 | 158 | 196 | 235 |
| | Allowable Strength (ASD), $P_{ns}/\Omega$ | 63 | 99 | 122 | 147 |

Note - For all thicknesses, $\Phi = 0.6$ and $\Omega = 2.7$.