

February 16, 2021

Power Home Solar and Roofing 919 North Main Street Mooresville, NC 28115 **Design Criteria:** 

Design Wind Speed (ASD)- 120 mph Ground Snow Load- 10 psf Risk Category- II Exposure category- C

## RE: Structural Roof Evaluation for the *Oppermann Residence*: 235 Crawford Road, Coats, North Carolina

As per your request, we have evaluated the roof structure under the proposed solar panel array. The information used to evaluate this structure was gathered during a field visit by Power Home Solar and Roofing on behalf of Right Angle Engineering. The roof structure consists of 2x6 rafters spaced at 16" on center. The roof material consists of corrugated metal. The design criteria used to analyze this structure are listed above and included with this letter. The adopted building codes in this jurisdiction are: *the* 2018 North Carolina Building Code, the 2018 North Carolina Existing Building Code, and ASCE 7-16.

North Carolina Existing Building Code (NCEBC) 2018 section 807.4 indicates that alterations to an existing building that results in less than a 10% increase in the total stress may be performed without a structural evaluation of the existing building. As demonstrated in the attached calculations, the additional weight of the solar panels will be less than 10% increase in the gravity loading and the stress on the existing roof framing.

Based on our assessment we have determined that the existing roof framing will safely and adequately support the additional loads imposed by the solar panels without reinforcement. In order for the loads to be evenly distributed, the roof attachments should be staggered and spread evenly throughout the panel array. Attachment points should be spaced at a maximum of 48" on center. The racking system should be installed per the manufacture's specifications. There should be a minimum of 30 S5 Protea Bracket attachment points to the roof. Waterproofing around the roof penetrations is the responsibility of others. Right Angle Engineering assumes no responsibility for improper installation of the solar panels. Regards,

Robert D Smythe, P.E. Right Angle Engineering 2/16/21



| Design Criteria:                   |                      |            |                       |
|------------------------------------|----------------------|------------|-----------------------|
| Design Wind Speed (3 second gust)  | 120                  | mph        | -                     |
| Exposure Category                  | С                    |            |                       |
| Risk Category                      | 2                    |            |                       |
| Mean Roof Height                   | 30                   | ft         |                       |
| Roof Type                          | Gable Roof           |            |                       |
| Building Type                      | enclosed             |            |                       |
| Roof Dead Load- ASCE Table         | C3-1                 |            | l                     |
| Corrugated Metal                   | 1.5                  | psf        | -                     |
| 5/8" Plywood Sheathing             | 2                    | psf        |                       |
| Roof Framing                       | 4                    | psf        |                       |
| Insulation                         | 0                    | psf        |                       |
| Gypsum sheathing                   | 0                    | psf        |                       |
| Solar Panel Array                  | 3                    | psf        |                       |
|                                    |                      |            |                       |
| Dead Load Without Panels           | 7.5                  | psf        |                       |
| Dead Load With Solar panels        | 10.5                 | psf        |                       |
|                                    |                      |            | _                     |
| Roof Live Load                     |                      |            |                       |
| Existing Roof Live Load            | 20                   | psf        | ASCE 7-16 Table 4.3-1 |
| Roof Live Load with Solar Panels   | 0                    | psf        | 2018 NCBC 1607.12.5   |
|                                    |                      |            |                       |
| Roof Snow Load-ASCE 7-16           |                      |            |                       |
| Ground Snow Load (pg)              | 10                   | psf        | Section 7.2           |
| Exposure Factor (Ce)               | 0.9                  |            | Table 7.3-1           |
| Thermal Factor (Ct)                | 1.1                  |            | Table 7.3-2           |
| Importance Factor (Is)             | 1                    |            | Table 1.5-2           |
| Flat Roof Snow Load (Pf)           | 7                    |            | Equation 7.3-1        |
| Slippery surface Slope Factor (Cs) | 1                    |            | Figure 7-2            |
| Nonslippery Surface Slope Factor   | 4                    |            | F: 7.0                |
| (Cs)                               | 1                    |            | Figure 7-2            |
| Roof Snow Load                     | 7                    | psf        | Equation 7.4-1        |
| Reduced Roof Snow Load (Slippery   | ,                    | μsi        | Equation 7.4-1        |
| Surface)                           | 7                    | psf        | Equation 7.4-1        |
| Load Combinations - ASCE 7-        | 16 Section 2.4.1     |            |                       |
|                                    |                      | With Solar |                       |
|                                    | Without Solar Panels | panels     |                       |
| D + Lr                             | 27.5 psf             | 10.5 psf   |                       |

|       |                      | With Solar |
|-------|----------------------|------------|
|       | Without Solar Panels | panels     |
| D+Lr  | 27.5 psf             | 10.5 psf   |
| D + S | 14.4 psf             | 17.4 psf   |



| Solar Array 1- Roof 1         |  |                         |                |                                  |
|-------------------------------|--|-------------------------|----------------|----------------------------------|
| Roof Slope                    | 34   | degrees                 |                |                                  |
| Number of panels              | 6  | Ü                       |                |                                  |
| Panel Area                    | 105  | ft^2                    |                |                                  |
| Wind Calculations- ASCE 7-16  |  |                         |                |                                  |
| GCp Zone 1                    | -1   |                         | Figure         | 30.3-(2A-5B)                     |
| GC <sub>P</sub> Zone 2        | -1.2                                       |                         | Figure         | 30.3-(2A-5B)                     |
| GCp Zone 3                    | -1.2                                       |                         | Figure         | 30.3-(2A-5B)                     |
| Gcpi                          | 0.18                                       |                         | _              | 26.13-1                          |
| Velocity Pressure (qh)        | 30.7                                       | psf                     |                |                                  |
| qh= .00256KhKhtKdV^2          |  | ·                       | Equat          | ion 26.10-1                      |
| Kh                            | 0.98                                       |                         | •              | 26.10-1                          |
| Kht                           | 1  |                         | Eguati         | ion 26.8-1                       |
| Kd                            | 0.85                                       |                         | •              | 26.6-1                           |
| Designed wind pressure (P)    |  | psf                     |                | ion 30.8-1                       |
| P= qh(GCh) - (GChi))          |  | Į                       | -4             |                                  |
| Zone 1 Pressure (P)           | -36.2                                      | psf                     |                |                                  |
| Zone 2 Pressure (P)           | -42.4                                      | psf                     |                |                                  |
| Zone 3 Pressure (P)           | -42.4                                      | psf                     |                |                                  |
|                               |  |                         |                |                                  |
| Roof Connection               | _  | <u>-</u>                |                |                                  |
| Shear Capacity                | 49   | lbs                     | S-5 Lo         | ad Testing                       |
| Shear tributary area          | 8.8  | ft^2                    |                |                                  |
| Total pullout capacity        | 364  | lbs                     | S-5 Lo         | ad Testing                       |
| Pullout max tributary area    | 8.6  | ft^2                    |                |                                  |
| Factor of Safety              | 1.11                                       |                         |                |                                  |
| Minimum number of connections | 10   |                         |                |                                  |
| Beam Stress NCEBC 2018 Secti  | on 806.2                                   |                         |                |                                  |
| Beam Span                     | 12   | ft                      |                | -                                |
| Spacing                       | 1.33                                       | ft                      |                |                                  |
| Roof Framing type             | 2x6 rafters                                |                         |                |                                  |
| Panel Orientation             | portrait                                   |                         |                |                                  |
| Number of Panels per rafter   | 3  |                         |                |                                  |
| Panel distance from eave      | 1  | NAME OF T               |                |                                  |
|                               | Without Solar                              |                         | Percent        |                                  |
| Don din a                     | Panels Mamont 659.4 ft lbs                 | Panels                  | Increase       | Loss than 10En/                  |
| Vertical Reac                 | Moment 658.4 ft-lbs<br>tion (V1) 219.4 lbs | 568.3 ft-lbs<br>196 lbs | 86.3%<br>89.3% | Less than 105%<br>Less than 105% |
| Vertical Reac                 |  | 190.14 lbs              | 89.3%<br>86.6% | Less than 105%                   |
| vertical neac                 | 213.4 103                                  | 170.14 103              | 30.070         | LC33 triair 103/0                |



| Number of panels   | Solar Array 2- Roof 2                 |              |            |          |                                       |
|--|---------------------------------------|--------------|------------|----------|---------------------------------------|
| Number of panels Panel Area         7           Wind Calculations- ASCE 7-16           GC₂ Zone 1         -0.9         Figure 30.3-(2A-5B)           GC₂ Zone 2         -1.7         Figure 30.3-(2A-5B)           GC₂ Zone 3         -2.6         Figure 30.3-(2A-5B)           GCρ         0.18         Table 26.13-1           Velocity Pressure (qh)         30.7         psf           qh= .00256KhKhkkdv^2         Equation 26.10-1           Kh         0.98         Table 26.10-1           Kd         1         Equation 26.6-1           Kd         0.85         Table 26.6-1           Designed wind pressure (P)         -33.2         psf         Equation 30.8-1           Zone 1 Pressure (P)         -57.7         psf         Equation 30.8-1           Zone 2 Pressure (P)         -57.7         psf         Equation 30.8-1           Pactor of Sarety (P)         -57.7         psf         Experimental Packet (P)           Shear Capacity         49         lbs         5-5 Load Testing           Shear tributary area         28.4         ft^2           Total pullout capacity         364         lbs         5-5 Load Testing           Pullout max tributary area         6.3         ft^2 <td>•</td> <td>10</td> <td>degrees</td> <td></td> <td></td>  | •                                     | 10           | degrees    |          |                                       |
| Wind Calculations- ASCE 7-16           GCp, Zone 1         -0.9         Figure 30.3-(2A-5B)           GCp, Zone 2         -1.7         Figure 30.3-(2A-5B)           GCp Zone 3         -2.6         Figure 30.3-(2A-5B)           Gcpi         0.18         Table 26.13-1           Velocity Pressure (qh)         30.7         psf           qh= .00256KnKntkdv^2         Equation 26.10-1           Kn         0.98         Table 26.10-1           Knt         1         Equation 26.8-1           Kd         0.85         Table 26.6-1           Designed wind pressure (P)         psf         Equation 30.8-1           P= qn(GCn) - (GCni))         Psf         Equation 30.8-1           Zone 1 Pressure (P)         -33.2         psf         Psf           Zone 2 Pressure (P)         -57.7         psf         Psf           Zone 3 Pressure (P)         -85.4         psf         Psf           Zone 3 Pressure (P)         -85.4         psf         Psf           Lag Screw Connection         Sear Capacity         49         lbs         S-5 Load Testing           Shear Capacity         364         lbs         S-5 Load Testing           Pale Unit max tributary area         6.3  | ·                                     | 7            | · ·        |          |                                       |
| GCp Zone 1   | Panel Area                            | 122.5        | ft^2       |          |                                       |
| GCp Zone 1   | Wind Coloulations ASCE 7.16           |              |            |          |                                       |
| CCp Zone 2   |                                       | 0.0          |            | Figuro   | 20.2 /24 ED)                          |
| GCp Zone 3   -2.6   Figure 30.3-(2A-5B)  |                                       |              |            | _        |                                       |
| Script   Quincity Pressure (qh)   30.7   psf   Equation 26.10-1  | ·                                     |              |            | _        |                                       |
| Velocity Pressure (qh)         30.7         psf           qh=.00256KhKhtKdV^2         Equation 26.10-1           Kh         0.98         Table 26.10-1           Kht         1         Equation 26.8-1           Kd         0.85         Table 26.6-1           Designed wind pressure (P)         psf         Equation 30.8-1           P= qh(GCh) - (GChi))         -57.7         psf           Zone 1 Pressure (P)         -57.7         psf           Zone 3 Pressure (P)         -57.7         psf           Zone 3 Pressure (P)         -85.4         psf           Lag Screw Connection           Shear Capacity         49         lbs         S-5 Load Testing           Shear tributary area         28.4         ft^2         Testing           Total pullout capacity         364         lbs         S-5 Load Testing           Pullout max tributary area         6.3         ft^2         Factor of Safety           Minimum number of connections         19         Testing         Testing           Beam Stress NCEBC 2018 Section 806.2           Beam Stress NCEBC 2018 Section 806.2         Testing         Testing           Beam Stress Parel Orientation         Indexagree         Indexagree   | •                                     |              |            | _        | · · · · · · · · · · · · · · · · · · · |
| Comparison of    | ·                                     |              | •          | Table 2  | 26.13-1                               |
| Kh       0.98       Table 26.10-1         Kht       1       Equation 26.8-1         Kd       0.85       Table 26.6-1         Designed wind pressure (P)       -       psf       Equation 30.8-1         P= qh(GCh) - (GChi))         Zone 1 Pressure (P)       -33.2       psf         Zone 2 Pressure (P)       -57.7       psf         Zone 3 Pressure (P)       -85.4       psf         Eag Screw Connection         Shear Capacity       49       lbs       S-5 Load Testing         Shear tributary area       28.4       ft^2         Total pullout capacity       364       lbs       S-5 Load Testing         Pullout max tributary area       6.3       ft^2         Factor of Safety       1.11         Minimum number of connections       19         Beam Stress NCEBC 2018 Section 806.2         Beam Span       12       ft         Spacing       1.33       ft         Roof Framing type       2x6 rafters       1andscape         Number of Panels per rafter       2         Panel Orientation       1ml         Number of Panels per rafter       2  |                                       | 30.7         | psf        |          | 00.40.4                               |
| Kht         1         Equation 26.8-1           Kd         0.85         Table 26.6-1           Designed wind pressure (P)         psf         Equation 30.8-1           P= qh(GCh) - (GChi))         -33.2         psf           Zone 2 Pressure (P)         -57.7         psf           Zone 3 Pressure (P)         -85.4         psf           Lag Screw Connection           Shear Capacity         49         lbs         S-5 Load Testing           Shear tributary area         28.4         ft^2           Total pullout capacity         364         lbs         S-5 Load Testing           Pullout max tributary area         6.3         ft^2           Factor of Safety         1.11         Minimum number of connections         19           Beam Stress NCEBC 2018 Section 806.2           Beam Span         12         ft           Spacing         1.33         ft           Roof Framing type         2x6 rafters           Panel Orientation         landscape           Number of Panels per rafter         2           Panel distance from eave         3           Without Solar Panels Increase           Bending Moment Vertical Reaction (V1)         219.4 lbs <td>•</td> <td></td> <td></td> <td>•</td> <td></td>   | •                                     |              |            | •        |                                       |
| Kd0.85Table 26.6-1Designed wind pressure (P)psfEquation 30.8-1P= qh(GCh) - (GChi))Zone 1 Pressure (P)-33.2psfZone 2 Pressure (P)-57.7psfZone 3 Pressure (P)-85.4psf  Shear Capacity  Shear tributary area  28.4 ft^2 Total pullout capacity 364 lbs S-5 Load Testing Pullout max tributary area 6.3 ft^2 Factor of Safety 1.11 Minimum number of connections 19  Beam Stress NCEBC 2018 Section 806.2 Beam Span 12 Spacing 1.33 ft Spacing 1.33 ft Spacing 2x6 rafters Panel Orientation landscape Number of Panels per rafter Panel Orientation Number of Panels per rafter Panel Bending Moment Panels Less than 105% Less than 105% Less than 105%   |                                       |              |            |          |                                       |
| Designed wind pressure (P) P= qh(GCh) - (GChi))  Zone 1 Pressure (P) Jone 2 Pressure (P) Jone 3 Pressure (P) Jone 3 Pressure (P) Jone 3 Pressure (P) Jone 3 Pressure (P)  Shear Capacity Shear tributary area Jotal pullout capacity Joulin max tributary area Jotal pullout max tributary area Jotal pullout max tributary area Josephine Joulin max tributary area |                                       | <del>-</del> |            | •        |                                       |
| P= qh(GCh) - (GChi))  Zone 1 Pressure (P) -33.2 psf  Zone 2 Pressure (P) -57.7 psf  Zone 3 Pressure (P) -85.4 psf   Lag Screw Connection  Shear Capacity 49 lbs S-5 Load Testing Shear tributary area 28.4 ft^2  Total pullout capacity 364 lbs S-5 Load Testing Pullout max tributary area 6.3 ft^2  Factor of Safety 1.11  Minimum number of connections 19   Beam Stress NCEBC 2018 Section 806.2  Beam Span 12 ft Spacing 1.33 ft Roof Framing type 2x6 rafters Panel Orientation landscape Number of Panels per rafter 2 Panel distance from eave 3  Without Solar Panels Panels Increase  Bending Moment Vertical Reaction (V1) 219.4 lbs 153.3 lbs 69.9% Less than 105% Less than 105%  |                                       | 0.85         | _          |          |                                       |
| Zone 2 Pressure (P) Zone 3 Pressure (P) -57.7 psf Zone 3 Pressure (P) -85.4 psf  Lag Screw Connection  Shear Capacity Shear tributary area 28.4 ft^2 Total pullout capacity 364 lbs S-5 Load Testing Pullout max tributary area 6.3 ft^2 Factor of Safety 1.11 Minimum number of connections 19  Beam Stress NCEBC 2018 Section 806.2  Beam Span 12 ft Spacing 1.33 ft Roof Framing type 2x6 rafters Panel Orientation Number of Panels per rafter 2 Panel distance from eave  Bending Moment Vertical Reaction (V1)  Beam Stress NCEBC 2018 Section 806.2  Without Solar Panels Panels Panels Increase Less than 105% Less than 105% Less than 105%   |                                       |              | psf        | Equation | on 30.8-1                             |
| Lag Screw Connection   | Zone 1 Pressure (P)                   | -33.2        | psf        |          |                                       |
| Lag Screw Connection  Shear Capacity 49 lbs S-5 Load Testing Shear tributary area 28.4 ft^2 Total pullout capacity 364 lbs S-5 Load Testing Pullout max tributary area 6.3 ft^2 Factor of Safety 1.11 Minimum number of connections 19  Beam Stress NCEBC 2018 Section 806.2  Beam Span 12 ft Spacing 1.33 ft Spacing 1.33 ft Roof Framing type 2x6 rafters Panel Orientation landscape Number of Panels per rafter 2 Panel distance from eave 3  Without Solar Panels Increase  Bending Moment Vertical Reaction (V1) 219.4 lbs 153.3 lbs 69.9% Less than 105% Less than 105% Less than 105% Less than 105%   | Zone 2 Pressure (P)                   | -57.7        | psf        |          |                                       |
| Shear Capacity  Shear tributary area  28.4 ft^2  Total pullout capacity  364 lbs  S-5 Load Testing  Pullout max tributary area  6.3 ft^2  Factor of Safety  1.11  Minimum number of connections  19   Beam Stress NCEBC 2018 Section 806.2  Beam Span  5pacing  1.33 ft  Spacing  Roof Framing type  2x6 rafters  Panel Orientation  Number of Panels per rafter  Panel distance from eave  3  Without Solar Panels  Panels  Panels  Panels  Bending Moment Vertical Reaction (V1)  Vertical Reaction (V1)  Panels  153.3 lbs  S-5 Load Testing  S-5 Load Testing  Fallos  S-5 Load Testing  S-5 Load Testing  S-6 Less than 105%  Less than 105%  Less than 105%  | Zone 3 Pressure (P)                   | -85.4        | psf        |          |                                       |
| Shear Capacity  Shear tributary area  28.4 ft^2  Total pullout capacity  364 lbs  S-5 Load Testing  Pullout max tributary area  6.3 ft^2  Factor of Safety  1.11  Minimum number of connections  19   Beam Stress NCEBC 2018 Section 806.2  Beam Span  5pacing  1.33 ft  Spacing  Roof Framing type  2x6 rafters  Panel Orientation  Number of Panels per rafter  Panel distance from eave  3  Without Solar Panels  Panels  Panels  Panels  Bending Moment Vertical Reaction (V1)  Vertical Reaction (V1)  Panels  153.3 lbs  S-5 Load Testing  S-5 Load Testing  Fallos  S-5 Load Testing  S-5 Load Testing  S-6 Less than 105%  Less than 105%  Less than 105%  | 16                                    |              |            |          |                                       |
| Shear tributary area  28.4 ft^2  Total pullout capacity 364 lbs S-5 Load Testing  Pullout max tributary area 6.3 ft^2  Factor of Safety 1.11  Minimum number of connections 19   Beam Stress NCEBC 2018 Section 806.2  Beam Span 12 ft Spacing 1.33 ft Roof Framing type 2x6 rafters Panel Orientation Number of Panels per rafter Panel distance from eave 3  Without Solar Panels Less than 105% Less than 105% Less than 105%  | <u> </u>                              |              |            |          |                                       |
| Total pullout capacity Pullout max tributary area 6.3 ft^2 Factor of Safety 1.11 Minimum number of connections 19  Beam Stress NCEBC 2018 Section 806.2  Beam Span 12 ft Spacing 1.33 ft Roof Framing type 2x6 rafters Panel Orientation Number of Panels per rafter Panel distance from eave  Bending Moment Vertical Reaction (V1) Vertical Reaction (V1)  S-5 Load Testing S-5 Load Testing  **S-5 Load Testing **S-5 Load Testing **S-5 Load Testing **S-5 Load Testing **S-5 Load Testing **S-5 Load Testing **S-5 Load Testing **S-5 Load Testing **S-5 Load Testing **S-5 Load Testing **S-5 Load Testing **S-5 Load Testing **S-5 Load Testing **S-5 Load Testing **S-5 Load Testing **S-5 Load Testing **S-5 Load Testing **S-5 Load Testing **Less Load Testing **In Capacitana Testing **In |                                       |              |            | S-5 Loa  | nd Testing                            |
| Pullout max tributary area Factor of Safety 1.11 Minimum number of connections 19  Beam Stress NCEBC 2018 Section 806.2  Beam Span 12 Ft Spacing 1.33 Ft Roof Framing type 2x6 rafters Panel Orientation Number of Panels per rafter Panel distance from eave  Bending Moment Vertical Reaction (V1) 219.4 lbs 153.3 lbs  Panel  Factor of Safety  Int'2  ft  Comparison  With 2  Ft  Ft  Ft  Ft  Ft  Ft  Ft  Ft  Ft  F  | •                                     |              |            |          |                                       |
| Factor of Safety  Minimum number of connections  19    Beam Stress NCEBC 2018 Section 806.2  |                                       |              |            | S-5 Loa  | nd Testing                            |
| Minimum number of connectionsBeam Stress NCEBC 2018 Section 806.2Beam Span12ftSpacing1.33ftRoof Framing type2x6 raftersPanel OrientationlandscapeNumber of Panels per rafter2Panel distance from eave3Without Solar<br>PanelsWith Solar<br>PanelsPercent<br>PanelsBending Moment<br>Vertical Reaction (V1)658.4 ft-lbs<br>219.4 lbs504.3 ft-lbs<br>153.3 lbs76.6%<br>69.9%Less than 105%<br>Less than 105%   | ·                                     |              | ft^2       |          |                                       |
| Beam Stress NCEBC 2018 Section 806.2  Beam Span 12 ft Spacing 1.33 ft Roof Framing type 2x6 rafters Panel Orientation landscape Number of Panels per rafter 2 Panel distance from eave 3  Without Solar Percent Panels Increase  Bending Moment 658.4 ft-lbs 504.3 ft-lbs 76.6% Less than 105% Less than 105% Less than 105% Less than 105%  | Factor of Safety                      |              |            |          |                                       |
| Beam Span 12 ft Spacing 1.33 ft Roof Framing type 2x6 rafters Panel Orientation landscape Number of Panels per rafter 2 Panel distance from eave 3  Without Solar With Solar Percent Panels Panels Increase  Bending Moment 658.4 ft-lbs 504.3 ft-lbs 76.6% Vertical Reaction (V1) 219.4 lbs 153.3 lbs 69.9%  Less than 105%   | Minimum number of connections         | 19           |            |          |                                       |
| Spacing 1.33 ft  Roof Framing type 2x6 rafters  Panel Orientation landscape  Number of Panels per rafter 2  Panel distance from eave 3  Without Solar With Solar Percent Panels Panels Increase  Bending Moment 658.4 ft-lbs 504.3 ft-lbs 76.6% Less than 105%  Vertical Reaction (V1) 219.4 lbs 153.3 lbs 69.9% Less than 105%  | Beam Stress NCEBC 2018 Section 800    | 6.2          |            |          |                                       |
| Roof Framing type  Panel Orientation  Number of Panels per rafter  Panel distance from eave  Without Solar With Solar Percent Panels Panels Increase  Bending Moment Vertical Reaction (V1)  Bending Moment Vertical Reaction (V1)  Panels Solar Framing type  With Solar Percent Increase  Less than 105% Less than 105%  | Beam Span                             | 12           | ft         |          | _                                     |
| Panel Orientation landscape Number of Panels per rafter 2 Panel distance from eave 3  Without Solar With Solar Percent Panels Panels Increase  Bending Moment Of Bending Moment Vertical Reaction (V1) 219.4 lbs 153.3 lbs 69.9%  Less than 105%   | •                                     |              | ft         |          |                                       |
| Number of Panels per rafter  Panel distance from eave  3  Without Solar With Solar Percent Panels Panels Increase  Bending Moment 658.4 ft-lbs 504.3 ft-lbs 76.6% Less than 105% Vertical Reaction (V1) 219.4 lbs 153.3 lbs 69.9% Less than 105%   |                                       |              |            |          |                                       |
| Panel distance from eave  3  Without Solar With Solar Percent Panels Panels Increase  Bending Moment Vertical Reaction (V1)  3  Without Solar With Solar Percent Increase Panels 105% Panels 153.3 lbs 69.9%  Less than 105% Less than 105%  |                                       |              |            |          |                                       |
| Without Solar With Solar Percent Panels Panels Increase  Bending Moment 658.4 ft-lbs 504.3 ft-lbs 76.6% Less than 105% Vertical Reaction (V1) 219.4 lbs 153.3 lbs 69.9% Less than 105%   | ·                                     |              |            |          |                                       |
| Panels         Panels         Increase           Bending Moment         658.4 ft-lbs         504.3 ft-lbs         76.6%         Less than 105%           Vertical Reaction (V1)         219.4 lbs         153.3 lbs         69.9%         Less than 105%   | ranei distance from eave              |              | With Solar | Dorcont  | 1                                     |
| Bending Moment         658.4 ft-lbs         504.3 ft-lbs         76.6%         Less than 105%           Vertical Reaction (V1)         219.4 lbs         153.3 lbs         69.9%         Less than 105%  |                                       |              |            |          |                                       |
| Vertical Reaction (V1)         219.4 lbs         153.3 lbs         69.9%         Less than 105%  | Rending Momen                         |              |            |          | Less than 105%                        |
|  |                                       |              |            |          |                                       |
|  | · · · · · · · · · · · · · · · · · · · |              |            |          |                                       |