Technical Evaluation Report
TER 1906-01
Quadravent® as a component of Wind-Ballasted Securement Systems for Single Ply Membrane Roofs

Qorbo Enterprises, LLC

Product:
Quadravent®

Issue Date:
April 3, 2020
Revision Date:
October 10, 2020
Subject to Renewal:
July 1, 2021
COMPANY INFORMATION:

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SECTION: 07 05 00 - Membrane Roofing
SECTION: 07 07 00 - Roof Accessories

1 PRODUCT EVALUATED

1.1 Quadravent®

2 APPLICABLE CODES AND STANDARDS

2.1 Codes

2.1.1 IBC—12, 15: International Building Code®

2.2 Standards and Referenced Documents

2.2.1 ASCE/SEI 7: Minimum Design Loads and Associated Criteria for Buildings and Other Structures

2.2.2 FM 4474: American National Standard for Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures

2.2.3 UL 1897: Uplift Tests for Roof Covering Systems

1 Building codes require data from valid research reports be obtained from approved sources. Agencies who are accredited through ISO/IEC 17065 have met the code requirements for approval by the building official. DrJ is an ISO/IEC 17065 ANAB-Accredited Product Certification Body — Accreditation #1131.

Through ANAB accreditation and the IAF MLA, DrJ certification can be used to obtain product approval in any jurisdiction or country that has IAF MLA Members & Signatories to meet the Purpose of the MLA — “certified once, accepted everywhere.”

Building official approval of a licensed registered design professional (RDP) is performed by verifying the RDP and/or their business entity complies with all professional engineering laws of the relevant jurisdiction. Therefore, the work of licensed RDPs is accepted by building officials, except when plan (i.e. peer) review finds an error with respect to a specific section of the code. Where this TER is not approved, the building official responds in writing stating the reasons for disapproval.

For more information on any of these topics or our mission, product evaluation policies, product approval process, and engineering law, visit drjcertification.org or call us at 608-310-6748.

2 Unless otherwise noted, all references in this TER are from the 2018 version of the codes and the standards referenced therein (e.g., ASCE 7, NDS, ASTM). This material, design, or method of construction also complies with the 2000-2015 versions of the referenced codes and the standards referenced therein.

3 All terms defined in the applicable building codes are italicized.
3 PERFORMANCE EVALUATION

3.1 The Quadravent® was evaluated for use with modified bitumen and single-ply roof membranes installed on low-slope roofs to resist wind uplift forces:

3.1.1 Wind load resistance for roof coverings in accordance with IBC Section 1504.1.

3.1.2 Resistance to wind loads on nonballasted roofs in accordance with IBC Section 1504.3 and Section 1504.3.1.

3.2 The roof assembly design, materials and components, other than the Quadravent®, are outside the scope of this TER.

3.3 Any code compliance issues not specifically addressed in this section are outside the scope of this TER.

3.4 Any engineering evaluation conducted for this TER was performed on the dates provided in this TER and within DrJ’s professional scope of work.

4 PRODUCT DESCRIPTION AND MATERIALS

4.1 The product evaluated in this TER is shown in Figure 1.

4.2 Quadravent® Roof Vent System Description

4.2.1 The Quadravent® is a bi-modal roof vent for use on loose-laid, single ply roof membrane systems on low-slope (“flat”) roofs to keep the roof membrane in place during low-pressure weather events. The term bi-modal means the Quadravent® can be placed in both a low wind velocity, low air pressure zone as well as a high wind velocity, low air pressure zone.

4.2.2 The Quadravent® creates low air pressure at its ports when wind passes by them. This low air pressure is communicated from the ports, through the housing, to the base of the Quadravent® which is welded, and thus air-sealed, to the membrane. The stronger the wind, the lower the air pressure created.

4.2.3 Air distribution strips, called “scrim”, are placed on the roof layer just beneath the roof membrane to allow airflow under the membrane and between each Quadravent®. See Section 6 for installation details.

4.2.4 The underlying substrate layer and the roof membrane layer are air-sealed to each other to create an air-sealed space between the underlying substrate and the membrane. The low air pressure created by each Quadravent® will evacuate air from between the membrane and the underlying substrate, which lowers the pressure under the membrane across the roof and pulls the membrane down against the layers below it, thereby protecting the roof against wind.

4.2.5 The Quadravent® roof system replaces ballasted, adhered, or mechanically attached methods of securing the roof membrane to the roof deck.

4.3 Materials
4.3.1 Quadravent®: Made from UV-stable PVC

4.3.2 Air Distribution Strips (Scrim):
4.3.2.1 Air permeable filter fabric (loose laid) approved by Qorbo Enterprises, LLC.
4.3.2.2 Scrim is a thin polyethylene mesh material that has thin strands of plastic laid out in a grid with widthwise strands on top and lengthwise strands on bottom.

4.3.3 Roof Membrane:
4.3.3.1 Ketone Ethylene Ester (KEE) based sheet roofing membrane meeting ASTM D6754 or equivalent approved by Qorbo Enterprises, LLC.
4.3.3.2 Other modified bitumen roofing, thermostet single-ply roof membrane, or thermoplastic single-ply roof membrane products can be used if they meet the material standards and installation requirements of IBC Section 1507.11, Section 1507.12, or Section 1507.13 respectively.

4.3.4 Air Sealing:
4.3.4.1 Bitumen, modified bitumen, built up roof, commercial air and vapor barriers, vapor barrier adhesive sheets, or other materials approved by Qorbo Enterprises, LLC.
4.3.4.2 All termination points of both the underlying substrate layer and the membrane layer must be air sealed at the membrane layer and at the underlying substrate layer. See Section 6 for further details.

4.3.5 Edge Securement:
4.3.5.1 Edge metal meeting the requirements of ES 1, as required by the authority having jurisdiction, or equivalent.
4.3.5.2 Roof edge must be air sealed using techniques shown in the manufacturer’s installation instructions or Qorbo-accepted shop drawings.
4.3.5.3 The edge securement method used for securing the edges of the roof membrane shall meet the requirements of IBC Section 1504.5.

5 APPLICATIONS

5.1 The Quadravent® is used as a hold-down device to resist wind uplift forces on single-ply and modified bitumen membrane systems in accordance with IBC Section 1504.3.1.

5.2 Where the application exceeds the limitations set forth herein, design shall be permitted in accordance with accepted engineering procedures, experience, and technical judgment.

5.3 Design
5.3.1 The Quadravent® roof system shall be designed on a per roof basis in accordance with ASCE 7 to meet the wind pressure requirements and/or designed by the Building Designer (e.g., owner or registered design professional).
5.3.2 The ultimate uplift resistance for the Quadravent® is given in Table 1.

<table>
<thead>
<tr>
<th>Product</th>
<th>Ultimate Wind Uplift Resistance$^{1/2}$ (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quadravent®</td>
<td>345</td>
</tr>
</tbody>
</table>

1. SI: 1 psf = 0.0479 kN/m²
2. Tested in accordance with UL 1897
3. Building designer shall apply appropriate factors of safety.
4. Design wind loads shall be in accordance with ASCE 7. Note: the basic wind speeds (V) used in ASCE 7-10 are ultimate design wind speeds ($V_{ult}$). If required, conversion to nominal design wind speed ($V_{asd}$) is specified in IBC Section 1609.3.1.
5. Perimeter enhancements are additive to the ultimate wind uplift resistance in accordance with Section 5.3.3.

5.3.3 The uplift resistance provided by the fastening method in the edge securement around the roof perimeter and at penetrations can be added to the uplift resistance of the Quadravent® system given in Table 1.

5.3.4 Wind load pressures on the roof membrane that are to be resisted by the Quadravent® system shall be determined in accordance with ASCE 7 per IBC Section 1504.3 and Section 1609.5.

5.3.4.1 The roof membrane shall be designed to resist the design wind load pressures for components and cladding in accordance with ASCE 7 Chapter 30.

5.3.4.2 The design wind speeds shall be for the Risk Category determined from the applicable building code unless a higher Risk Category is specified on the construction documents.

5.3.4.2.1 For roofs designed in accordance with the recommendations of FM LPDS 1-28, the design wind speeds shall be for Risk Category III-IV, regardless of the actual Risk Category for the building.

5.3.4.3 The effective wind area of the roof membrane shall be determined in accordance with ASCE 7 unless a smaller effective wind area is specified on the construction documents.

5.3.4.3.1 For roofs designed in accordance with the recommendations of FM LPDS 1-28, the wind pressures shall be based on a maximum 10 ft² effective wind area, regardless of the actual effective area of the roof membrane.

5.3.5 The Quadravent® vents are positioned according to a layout plan provided for each project.

5.3.5.1 The vent edge distance (VED) (the distance between the vents closest to the roof edge and the outer edge of the roof) shall be no less than 5 ft. and no more than 20 ft.

5.3.5.2 For roofs with surface area greater than 500 ft², the number of vents per roof shall be greater than or equal to two.

5.3.5.3 The maximum grid spacing between the vents is 50 ft.

5.3.5.4 Quadravent® that service corner zones shall be oriented with arm facing the apex of the corner as detailed in Section 6. Exceptions are allowed for special circumstances per specific designs.

5.3.5.5 Quadravent® that do not service corner zones shall be oriented with arm facing the closest roof edge as detailed in Section 6. Exceptions are allowed for special circumstances per specific designs.

5.3.5.6 The design wind pressure of each roof zone as defined in ASCE 7 shall each be less than the nominal wind uplift resistance of the Quadravent®.

5.3.5.7 See Appendix A for a calculation example for a roof height ≤ 60 ft.
6 INSTALLATION

6.1 Installation shall comply with the manufacturer’s installation instructions and this TER. In the event of a conflict between the manufacturer’s installation instructions and this TER, the more restrictive shall govern.

6.2 A copy of the manufacturer’s published installation instructions shall be available at all times on the jobsite during installation.

6.3 Installation of the roofing membrane shall be in accordance with the roofing membrane manufacturer’s specifications and the approved construction documents.

6.4 The roof shall have flashing installed in accordance with IBC Section 1503.2 and the manufacturer’s installation instructions.

6.5 The roof covering used in the roof assembly shall meet the requirements of IBC Section 1507.

6.6 Installation Procedure

6.6.1 Documentation Review:

6.6.1.1 Review the design documents for the specific roof.

6.6.1.2 Confirm the existing underlying substrate can support the loads from the roof system including the weight of all Quadravent® vents and roof system materials during and after the construction process and the wind load requirements for the roof as determined by ASCE 7 per Section 5.3.

6.6.2 Air Seal the Underlying Substrate:

6.6.2.1 Assure the underlying substrate is adequately air-sealed prior to installing the new roof system. This includes the entire field and all termination points of the underlying substrate including roof edges, walls, penetrations, curbs, drains, scuppers, expansion joints, visible dividers, and any unique termination points.

6.6.2.2 A floating membrane from an existing roof cannot be the primary air-seal for the underlying substrate.

6.6.3 Roof Recovering:

6.6.3.1 The Quadravent® single ply membrane roof system can be installed over an existing roof, which serves as the underlying substrate, when the existing roof meets the following requirements:

6.6.3.1.1 The existing roof has an existing air barrier that provides an adequate air-seal across the entire roof and at every termination point, or can be made to have an adequate air-seal across the entire roof and at every termination point. Termination points include roof edges, walls, penetrations, curbs, drains, scuppers, expansion joints, visible dividers, and any unique termination points not mentioned above.

6.6.3.1.2 The primary air seal of the existing roof is not from a loose-laid membrane.

6.6.3.2 If the existing roof has a floating membrane and an air-sealed layer below the floating membrane, and the design calls for leaving the membrane in place, a hole at every Quadravent® location equal to the diameter of the Quadravent® base flange shall be cut to allow air under the existing membrane to escape.

6.6.4 Insulate:

6.6.4.1 If required, install the insulation and cover board layers. Place these layers on top of the air-sealed underlying substrate. These can be loose-laid, or, if required, adhered to the underlying substrate.

6.6.4.2 Mechanical fasteners cannot be used to install insulation on top of the air-sealed underlying substrate.

6.6.5 Install Air Distribution Strips (Scrim):

6.6.5.1 Scrim is laid out on the roof layer just below the membrane, allowing for air to travel along and across the scrim area while the membrane is resting on top of it.

6.6.5.2 Lay out the scrim to create the air distribution system per the design documentation. For each Quadravent® location, there is a star scrim pattern; for each roof edge there is edge scrim. Figure 2 shows a typical star scrim pattern. Figure 3 shows a typical 200’ x 400’ rooftop including both star scrim patterns and edge scrim.
6.6.5.3 For each Quadravent® location, lay out a pattern of scrim as shown on the design documentation. The scrim is laid out and oriented such that the widthwise strands are on top and the lengthwise strands are on the bottom as shown in Section A-A of Figure 2.

6.6.5.4 There is one scrim pattern per Quadravent®. There are four scrim segments per pattern. Each segment is laid such that it intersects the other three segments at the Quadravent® location. The length of each segment of the pattern is cut per the design documentation.

6.6.5.5 Tack scrim to the roofing surface over which it is being laid using 2" square tabs of Qorbo butyl tape. The roofing surface must be clear of debris and be a suitable surface as specified in the design documentation.

6.6.5.6 Lay out the roof edge scrim (Figure 3). Roof edge scrim is in addition to scrim patterns at each vent location. A length of scrim is placed parallel to and within 5' of each roof edge such that it intersects with one or more of the lengths of scrim from the scrim patterns of the line of Quadravent® closest to the edge. The roof edge scrim is tacked per Section 6.6.5.5.

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**Figure 2. Scrim Layout and Cross Section Showing Proper Orientation of Scrim**

*SECTION A-A (MAGNIFIED, NOT TO SCALE)*
6.6.5.7 Scrim may be moved or trimmed as required to avoid large obstructions not shown in the design documentation. In addition, it is acceptable to cut holes in scrim to go around small penetrations.

6.6.5.8 In the field of the roof, a scrim segment can be moved +/-3 ft from the specified layout in order to avoid obstructions that are not shown on the design documentation. In cases where many scrim segments need to be moved, contact Qorbo Enterprises, LLC.

6.6.6 Install and Air Seal the Membrane:

6.6.6.1 Sheets of membrane are welded together per manufacturer’s specifications to create a single, airtight sheet that fits over the air distribution layer. The membrane is loose laid and to be attached or adhered and air-sealed to the building structure at all membrane termination points.

6.6.6.2 Air sealing the membrane beyond weather sealing is required. The membrane must be air sealed at all terminations, including roof edges, walls, penetrations, curbs, drains, scuppers, expansion joints, visible dividers, and any unique termination points. The air seals must meet the guidelines in the manufacturer’s installation manual and/or in the membrane manufacturer’s installation guide, whichever is the more stringent.

6.6.7 Install the Quadravent® with Preinstalled Boot:

6.6.7.1 Carefully cut the pattern shown in Figure 4 into the membrane at the Quadravent® locations specified by the layout document. Do not cut the 12.0” cuts beyond the edge of the Quadravent® flange (which is 12.0” in diameter).
6.6.7.2 The location of each Quadravent® cut pattern should coincide with the center of the scrim star pattern below the membrane.

6.6.7.3 Place a Quadravent® at each cut pattern with the flange positioned under the membrane through the large slits and aligned per the design specifications.

6.6.7.4 Orient the Quadravent® per the layout design, which is typically determined by the location of the Quadravent® as shown in Figure 5.

6.6.7.5 Lift the boot to expose the clamp and position the clamp at the top of the cut triangles of the membrane (Figure 4) and torque down.
6.6.7.6 Lower the boot such that the boot flange makes contact with the membrane. Weld the boot flange to the membrane per the membrane manufacturer’s specification. The finished product should look similar to Figure 1. The resultant roof assembly cross section at the Quadravent® is shown in Figure 6.

![Figure 6: Detailed Drawing of Resulting Typical Roof Assembly at the Quadravent®](image)

7 TEST ENGINEERING SUBSTANTIATING DATA

7.1 Uplift resistance in accordance with *FM 4474* and *UL 1897* conducted by Nemo Etc., LLC, an ISO 17025 accredited facility and UL Third Party-Test-Data Program Participant.

7.2 Wind tunnel testing at the National Institute for Aviation Research (NIAR), Wichita State University, an ISO 17025 accredited facility.

7.3 Computational Fluid Dynamics (CFD) Study by Rand Corp.

7.4 Some information contained herein is the result of testing and/or data analysis by other sources which conform to *IBC Section 1703* and relevant professional engineering law. DrJ relies on accurate data from these sources to perform engineering analysis. DrJ has reviewed and found the data provided by other professional sources to be credible.

7.5 Where appropriate, DrJ’s analysis is based on design values that have been codified into law through codes and standards (e.g., *IBC*, *IRC*, *NDS®*, and *SDPWS*). This includes review of code provisions and any related test data that aids in comparative analysis or provides support for equivalency to an intended end-use application. Where the accuracy of design values provided herein is reliant upon the published properties of commodity materials (e.g., lumber, steel, and concrete), DrJ relies upon the grade mark, stamp, and/or design values provided by raw material suppliers to be accurate and conforming to the mechanical properties defined in the relevant material standard.
8 FINDINGS

8.1 When used and installed in accordance with this TER and the manufacturer’s installation instructions, the product(s) listed in Section 1.1 are approved for the following:

8.1.1 Use to resist wind loads on low-slope roofs with loose-laid membranes.

8.2 *IBC* Section 104.11 (*IRC* Section R104.11 and *IFC* Section 104.9 are similar) states:

104.11 Alternative materials, design and methods of construction and equipment. The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code...Where the alternative material, design or method of construction is not approved, the building official shall respond in writing, stating the reasons the alternative was not approved.

8.3 This product has been evaluated in the context of the codes listed in Section 2 and is compliant with all known state and local building codes. Where there are known variations in state or local codes applicable to this evaluation, they are listed here.

8.3.1 No known variations

9 CONDITIONS OF USE

9.1 Roof assembly materials must meet the requirements listed in Section 4.3.

9.2 Where required by the building official, also known as the authority having jurisdiction (AHJ) in which the project is to be constructed, this TER and the installation instructions shall be submitted at the time of permit application.

9.3 Any generally accepted engineering calculations needed to show compliance with this TER shall be submitted to the AHJ for review and approval.

9.4 Design loads shall be determined in accordance with the building code adopted by the jurisdiction in which the project is to be constructed and/or by the Building Designer (e.g., owner or registered design professional).

9.5 At a minimum, this product shall be installed per Section 6 of this TER.

9.6 This product is manufactured under a third-party quality control program in accordance with *IBC* Section 104.4 and 110.4 and *IRC* Section R104.4 and R109.2.

9.7 The actual design, suitability, and use of this TER, for any particular building, is the responsibility of the owner or the owner's authorized agent. Therefore, the TER shall be reviewed for code compliance by the building official for acceptance.

9.8 The use of this TER is dependent on the manufacturer’s in-plant QC, the ISO/IEC 17020 third-party quality assurance program and procedures, proper installation per the manufacturer’s instructions, the building official’s inspection, and any other code requirements that may apply to demonstrate and verify compliance with the applicable building code.
10 IDENTIFICATION

10.1 The product(s) listed in Section 1.1 are identified by a label on the board or packaging material bearing the manufacturer's name, product name, TER number, and other information to confirm code compliance.

10.2 Additional technical information can be found by contacting Qorbo Enterprises, LLC at qorboenterprises.com or info@qorboenterprises.com.

11 REVIEW SCHEDULE

11.1 This TER is subject to periodic review and revision. For the most recent version of this TER, visit drjcertification.org.

11.2 For information on the current status of this TER, contact DrJ Certification.
APPENDIX A

Design Example using Allowable Stress Design and ASCE 7-10 Table 30.4-1 Steps to Determine C&C Wind Loads Enclosed and Partially Enclosed Low-rise Buildings

Step 1: Determine risk category, see Table 1.5-1

Risk Category = III

Step 2: Determine the basic wind speed, $V$, for applicable risk category, see Fig. 26.5-1A, B or C

$V_{ult} = 120$

$V = V_{ult}$ in ASCE 7-10

Step 3: Determine wind load parameters:

$K_d := 0.85$

Wind directionality factor, see Section 26.6 and Table 26.6-1

Exposure Category = C

Exposure category B, C or D, see Section 26.7

$K_{st} := 1$

Topographic factor, see Section 26.8 and Fig. 26.8-1

Enclosure Classification = Partially Enclosed

Enclosure classification, see Section 26.10

$GC_{pu} := 0.55$

Internal pressure coefficient, see Section 26.11 and Table 26.11-1

Step 4: Determine velocity pressure exposure coefficient, see Table 30.3-1

$h := 50$

Height of flat roof

$z := h$

Height above ground level

$K_h := 1.09$

Velocity pressure exposure coefficient evaluated at height $z = h$

Step 5: Determine velocity pressure, Eq. 30.3-1

$q_h := 0.00256 \cdot K_h \cdot K_{st} \cdot K_d \cdot V^2 = 34.15$
Step 6: Determine external pressure coefficient, Fig. 30.4-2A for flat roofs

\[
GC_{p,\text{zone1}} := -1.0 \quad & \text{Negative external pressure coefficient for Zone 1, rounded up to h=10 ft}
\]

\[
GC_{p,\text{zone2}} := -1.8 \quad & \text{Negative external pressure coefficient for Zone 2, rounded up to h=10 ft}
\]

\[
GC_{p,\text{zone3}} := -2.8 \quad & \text{Negative external pressure coefficient for Zone 3, rounded up to h=10 ft}
\]

Step 7: Calculate wind pressure, Eq. 30.4-1

\[
p_{\text{zone1}} := q_h \cdot \left( GC_{p,\text{zone1}} - GC_{p,\text{i}} \right) = -52.9
\]

\[
p_{\text{zone2}} := q_h \cdot \left( GC_{p,\text{zone2}} - GC_{p,\text{i}} \right) = -80.3
\]

\[
p_{\text{zone3}} := q_h \cdot \left( GC_{p,\text{zone3}} - GC_{p,\text{i}} \right) = -114.4
\]

CHECK: All wind pressures are less than the nominal wind uplift resistance.

Roof Dimensions:

\[
l := 100 \quad \text{Length of roof}
\]

\[
w := 100 \quad \text{Width of roof}
\]

\[
A := l \cdot w = 10000 \quad \text{Area of roof}
\]

\[
a := 0.1 \cdot l = 10
\]

\[
A_{\text{zone3}} := 4 \cdot a \cdot a = 400 \quad \text{Area of Zone 3}
\]

\[
A_{\text{zone2}} := \left( 2 \cdot a \cdot (l - (2 \cdot a)) + (2 \cdot a \cdot (w - (2 \cdot a)) \right) = 3200 \quad \text{Area of Zone 2}
\]

\[
A_{\text{zone1}} := \left( l - (2 \cdot a) \right) \cdot \left( w - (2 \cdot a) \right) = 6400
\]

\[
A_{\text{total}} = A_{\text{zone1}} + A_{\text{zone2}} + A_{\text{zone3}} = 10000 \quad \text{Area of Zone 3}
\]
Minimum Number of Quadravents Calculation: Using the uplift resistance of the Quadravent provided in the TER, calculate the required number of vents for the roof area.

\[ R_{ASD} = 0.6 \]  
ASD reduction factor to account for \( V_{ult} \) wind loads

\[ P_{ult} = 345 \]  
Ultimate wind uplift resistance of the Quadravent, psf

\[ DSF = 2 \]  
Design safety factor used per FM 4474 for example only. Other design safety factors may be used where applicable.

\[ P_N := \frac{P_{ult}}{DSF} = 172.5 \]  
Nominal wind uplift resistance of the Quadravent, psf

\[ A_T = 12 \times 24 = 288 \]  
Surface area of test, ft^2

\[ F_N := P_N \cdot A_T = 49680 \]  
Nominal force resistance per Quadravent, lb

\[ L_{W,zone1} := A_{zone1} \cdot p_{zone1} = -338813 \]  
Wind load on Zone 1

\[ L_{W,zone2} := A_{zone2} \cdot p_{zone2} = -256842 \]  
Wind load on Zone 2

\[ L_{W,zone3} := A_{zone3} \cdot p_{zone3} = -45767 \]  
Wind load on Zone 3

\[ L_W := -(L_{W,zone1} + L_{W,zone2} + L_{W,zone3}) \cdot R_{ASD} = 384853 \]  
Total wind load on the roof, lb

\[ N_{vents} := \frac{L_W}{F_N} = 8 \]  
Minimum number of vents required

NOTE: Vents are spaced according to the requirements set forth in the TER and the Quadravent roof system design provided by Qorbo Enterprises LLC.