

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:

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June 19, 2023

Subject to Renewal:

July 1, 2024



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DIVISION: 07 00 00 - THERMAL AND MOISTURE PROTECTION

SECTION: 07 05 00 - Membrane Roofing

SECTION: 07 07 00 - Roof Accessories

1 Innovative Product Evaluated^{1,2}

1.1 Quadravent®

2 Applicable Codes and Standards^{3,4}

2.1 Codes

2.1.1 IBC—15, 18, 21: *International Building Code*®

2.1.2 FBC-B—17, 20: *Florida Building Code – Building*⁵ (FL #41888)

2.1.3 FBC-R—17, 20: *Florida Building Code – Residential* (FL #41888)

2.2 Standards and Referenced Documents

2.2.1 ASCI/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 For more information, visit drjcertification.org or call us at 608-310-6748.

² 24 CFR 3280.2 “Listed or certified” means included in a list published by a nationally recognized testing laboratory, inspection agency, or other organization concerned with product evaluation that maintains periodic inspection of production of listed equipment or materials, and whose listing states either that the equipment or material meets nationally recognized standards or has been tested and found suitable for use in a specified manner. Listed. Equipment, materials, products or services included in a list published by an organization acceptable to the building official and concerned with evaluation of products or services that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services and whose Listing states either that the equipment, material, product or service meets identified standards or has been tested and found suitable for a specified purpose. Labeled. Equipment, materials or products to which has been affixed a label, seal, symbol or other identifying mark of a nationally recognized testing laboratory, approved agency or other organization concerned with product evaluation that maintains periodic inspection of the production of the above-labeled items and whose labeling indicates either that the equipment, material or product meets identified standards or has been tested and found suitable for a specified purpose.

³ This Listing is a code defined research report, which is also known as a duly authenticated report, provided by an approved agency (see IBC Section 1703.1) and/or an approved source (see IBC Section 1703.4.2). An approved agency is “approved” as an approved agency when it is ANAB accredited. DrJ Engineering, LLC (DrJ) is listed in the ANAB directory. A professional engineer is “approved” as an approved source when that professional engineer is properly licensed to transact engineering commerce. Where sealed by a professional engineer, it is also a duly authenticated report certified by an approved source. (i.e., Registered Design Professional). DrJ is an ANAB accredited product certification body.

⁴ Unless otherwise noted, all references in this Listing are from the 2021 version of the codes and the standards referenced therein. This material, product, design, service and/or method of construction also complies with the 2000-2021 versions of the referenced codes and the standards referenced therein.

⁵ All references to the FBC-B and FBC-R are the same as the 2018 IBC and 2018 IRC unless otherwise noted in the Florida Supplement at the end of this TER

3 Performance Evaluation

- 3.1 Tests, testing, test reports, research reports, duly authenticated reports and related engineering evaluations are defined as intellectual property and/or trade secrets and protected by Defend Trade Secrets Act 2018 (DTSA).⁶
- 3.2 Testing and/or inspections conducted for this TER were performed an ISO/IEC 17025 accredited testing laboratory,⁷ an ISO/IEC 17020 accredited inspection body,⁸ which are internationally recognized accreditations through International Accreditation Forum (IAF), and/or a licensed Registered Design Professional (RDP).
- 3.3 The Quadravent® was evaluated for use with modified bitumen and single-ply roof membranes installed on low-slope roofs to resist wind uplift forces:
 - 3.3.1 Wind load resistance for roof coverings in accordance with IBC Section 1504.1.
 - 3.3.2 Resistance to wind loads on non-ballasted roofs in accordance with IBC Section 1504.4⁹ and IBC Section 1504.4.1.¹⁰
- 3.4 The roof assembly design, materials and components, other than the Quadravent®, are outside the scope of this TER.
- 3.5 Any building code and/or accepted engineering evaluations (i.e. research reports, duly authenticated reports, etc.) that are conducted for this Listing were performed by DrJ Engineering, LLC (DrJ), an ISO/IEC 17065 accredited certification body and a professional engineering company operated by RDPs / approved sources. DrJ is qualified¹¹ to practice product and code compliance services within its scope of accreditation and engineering expertise, respectively.
- 3.6 Engineering evaluations are conducted with DrJ's ANAB accredited ICS code scope, which are also its areas of professional engineering competence.
- 3.7 Any regulation specific issues not addressed in this section are outside the scope of this TER.

⁶ <https://www.law.cornell.edu/uscode/text/18/part-II/chapter-90>. Whoever, with intent to convert a trade secret, that is related to a product or service used in or intended for use in or intended for use in interstate or foreign commerce, to the economic benefit or anyone other than the owner thereof, and intending or knowing that the offense will injure any owner of that trade secret, knowingly (1) steals, or without authorization appropriates, takes, carries away, or conceals, or by fraud, artifice, or deception obtains such information; (2) without authorization copies, duplicates, sketches, draws, photographs, downloads, uploads, alters, destroys, photocopies, replicates, transmits, delivers, sends, mails, communicates, or conveys such information; (3) receives, buys, or possesses such information, knowing the same to have been stolen or appropriated, obtained, or converted without authorization; (4) attempts to commit any offense described in paragraphs (1) through (3); or (5) conspires with one or more other persons to commit any offense described in paragraphs (1) through (3), and one or more of such persons do any act to effect the object of the conspiracy, shall, except as provided in subsection (b), be fined under this title or imprisoned not more than 10 years, or both. (b) Any organization that commits any offense described in subsection (a) shall be fined not more than the greater of \$5,000,000 or 3 times the value of the stolen trade secret to the organization, including expenses for research and design and other costs of reproducing the trade secret that the organization has thereby avoided.

The federal government and each state have a public records act. As the National Society of Professional Engineers states, "Engineers shall not disclose, without consent, confidential information concerning the business affairs or technical processes of any present or former client or employer, or public body on which they serve." Therefore, to protect intellectual property (IP) and TS, and to achieve compliance with public records and trade secret legislation, requires approval through the use of Listings, certified reports, technical evaluation reports, duly authenticated reports and/or research reports prepared by approved agencies and/or approved sources.

⁷ Internationally recognized accreditations are performed by members of the International Accreditation Forum (IAF). Accreditation Body and Regional Accreditation Group Members of IAF are admitted to the IAF MLA only after a stringent evaluation of their operations by a peer evaluation team, which is charged to ensure that the applicant complies fully with both international standards and IAF requirements. Once an accreditation body is a signatory of the IAF MLA, it is required to recognise certificates and validation and verification statements issued by conformity assessment bodies accredited by all other signatories of the IAF MLA, with the appropriate scope.

⁸ Ibid.

⁹ 2018 IBC Section 1504.3

¹⁰ 2018 IBC Section 1504.3.1

¹¹ Qualification is performed by a legislatively defined Accreditation Body. ANSI National Accreditation Board (ANAB) is the largest independent accreditation body in North America and provides services in more than 75 countries. DrJ is an ANAB accredited product certification body.

4 Product Description and Materials

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

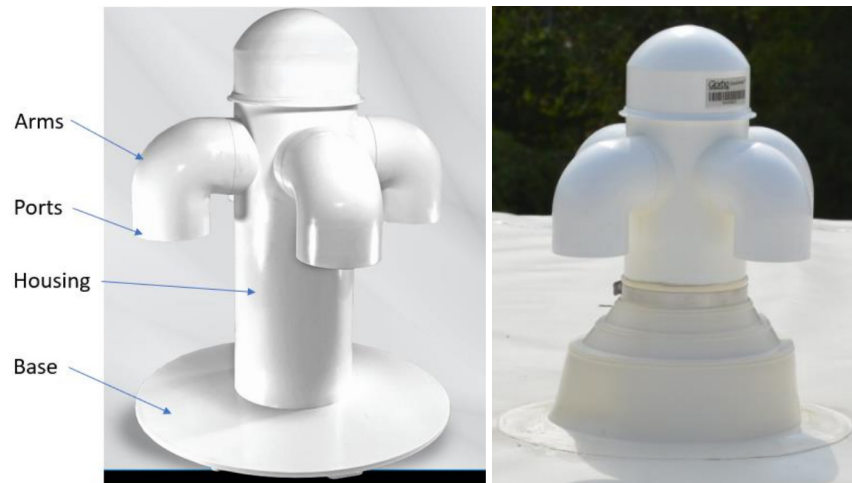


Figure 1. Quadravent® Before (left) and After (right) Installation

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

4.3.1.1 Air Distribution Strips (Scrim):

- 4.3.1.1.1 Air permeable filter fabric (loose laid) approved by Qorbo Enterprises, LLC.
- 4.3.1.1.2 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.

4.3.1.2 Roof Membrane:

- 4.3.1.2.1 Ketone Ethylene Ester (KEE) based sheet roofing membrane meeting ASTM D6754 or equivalent approved by Qorbo Enterprises, LLC.
- 4.3.1.2.2 Other modified bitumen roofing or single-ply roof membrane products can be used if they meet the material standards and installation requirements of [IBC Section 1507.11](#) or [IBC Section 1507.12](#),¹² respectively.

4.3.1.3 Air Sealing:

- 4.3.1.3.1 Bitumen, modified bitumen, built up roof, commercial air and vapor barriers, vapor barrier adhesive sheets, or other materials approved by Qorbo Enterprises, LLC.
- 4.3.1.3.2 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.

4.3.1.4 Edge Securement:

- 4.3.1.4.1 Edge metal meeting the requirements of ES 1, as required by the authority having [jurisdiction](#), or equivalent.
- 4.3.1.4.2 Roof edge must be air sealed using techniques shown in the manufacturer installation instructions or Qorbo-accepted shop drawings.
- 4.3.1.4.3 The edge securement method used for securing the edges of the roof membrane shall meet the requirements of [IBC Section 1504.6](#).¹³

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 1504.4.1](#).¹⁴

5.2 Design

- 5.2.1 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 (i.e., [owner](#) or [registered design professional](#)).
- 5.2.2 The ultimate uplift resistance for the Quadravent® is given in Table 1.

Table 1. Uplift Resistance for the Quadravent®^{3,4}

Product	Ultimate Wind Uplift Resistance ^{1,2} (psf)
Quadravent®	345
SI: 1 psf = 0.0479 kN/m ² 1. Tested in accordance with UL 1897 2. Building designer shall apply appropriate factors of safety. 3. 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 . 4. Perimeter enhancements are additive to the ultimate wind uplift resistance in accordance with Section 5.3.3.	

- 5.2.3 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.

¹² 2018 IBC Section 1507.12 and 2018 IBC Section 1507.13

¹³ 2018 IBC Section 1504.5

¹⁴ 2018 IBC Section 1504.3.1

- 5.2.4 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 1504.4¹⁵ and IBC Section 1609.5.
 - 5.2.4.1 The roof membrane shall be designed to resist the design wind load pressures for components and cladding in accordance with ASCE 7 Chapter 30.
 - 5.2.4.2 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.
 - 5.2.4.2.1 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.
 - 5.2.4.3 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.
 - 5.2.4.3.1 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.
- 5.2.5 The Quadravent® vents are positioned according to a layout plan provided for each project.
 - 5.2.5.1 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.
 - 5.2.5.2 For roofs with surface area greater than 500 ft², the number of vents per roof shall be greater than or equal to two.
 - 5.2.5.3 The maximum grid spacing between the vents is 50 ft.
 - 5.2.5.4 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.
 - 5.2.5.5 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.
 - 5.2.5.6 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®.
 - 5.2.5.7 See Appendix B for a calculation example for a roof height ≤ 60 ft.
- 5.3 Where the application falls outside of the performance evaluation, conditions of use and/or installation requirements set forth herein, alternative techniques shall be permitted in accordance with accepted engineering practice and experience. This includes but is not limited to the following areas of engineering: mechanics or materials, structural, building science, and fire science.

6 Installation

- 6.1 Installation shall comply with the approved construction documents, the manufacturer installation instructions, this TER and the applicable building code.
- 6.2 In the event of a conflict between the manufacturer installation instructions and this TER, the more restrictive shall govern.
- 6.3 A copy of the manufacturer published installation instructions shall be available at all times on the jobsite during installation.
- 6.4 Installation of the roofing membrane shall be in accordance with the roofing membrane manufacturer specifications and the approved construction documents.
- 6.5 The roof shall have flashing installed in accordance with IBC Section 1503.2 and the manufacturer installation instructions.
- 6.6 The roof covering used in the roof assembly shall meet the requirements of IBC Section 1507.

¹⁵ 2018 IBC Section 1504.3



6.7 Installation Procedure

6.7.1 Documentation Review:

- 6.7.1.1 Review the design documents for the specific roof.
- 6.7.1.2 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.

6.7.2 Air Seal the Underlying Substrate:

- 6.7.2.1 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.
- 6.7.2.2 A floating membrane from an existing roof cannot be the primary air-seal for the underlying substrate.

6.7.3 Roof Recovering:

- 6.7.3.1 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:
 - 6.7.3.1.1 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.
 - 6.7.3.1.2 The primary air seal of the existing roof is not from a loose-laid membrane.
- 6.7.3.2 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.

6.7.4 Insulate:

- 6.7.4.1 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.
- 6.7.4.2 Mechanical fasteners cannot be used to install insulation on top of the air-sealed underlying substrate.

6.7.5 Install Air Distribution Strips (Scrim):

- 6.7.5.1 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.
- 6.7.5.2 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.
- 6.7.5.3 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.
- 6.7.5.4 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.

- 6.7.5.5 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.
- 6.7.5.6 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 6.7.5.5.

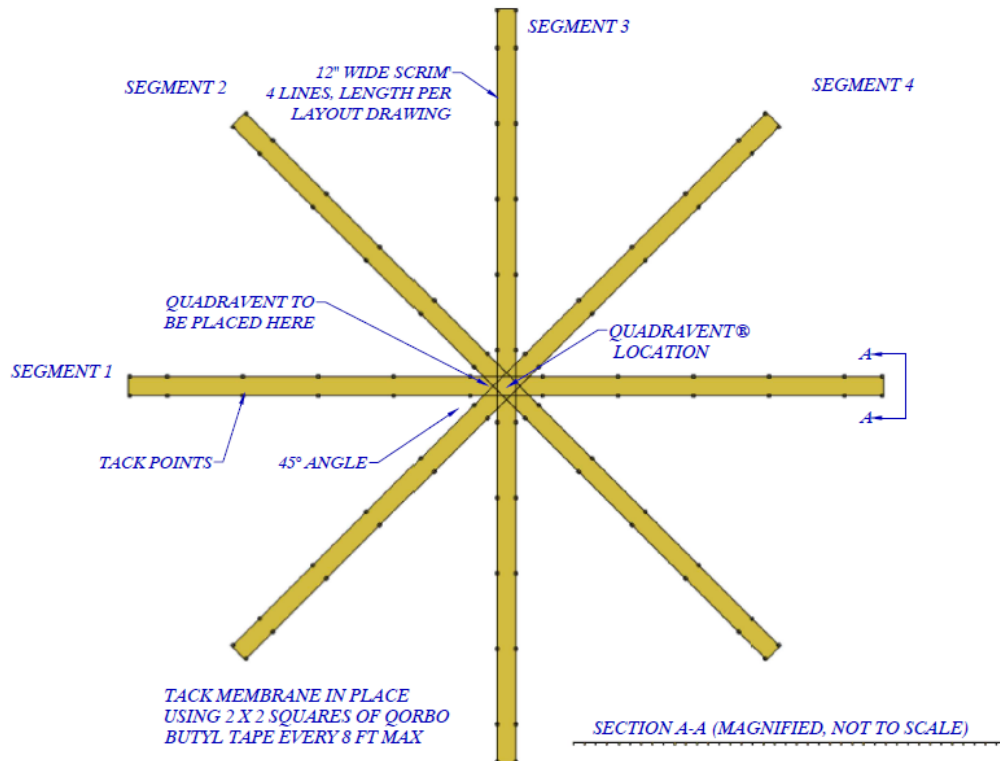


Figure 2. Scrim Layout and Cross Section Showing Proper Orientation of Scrim

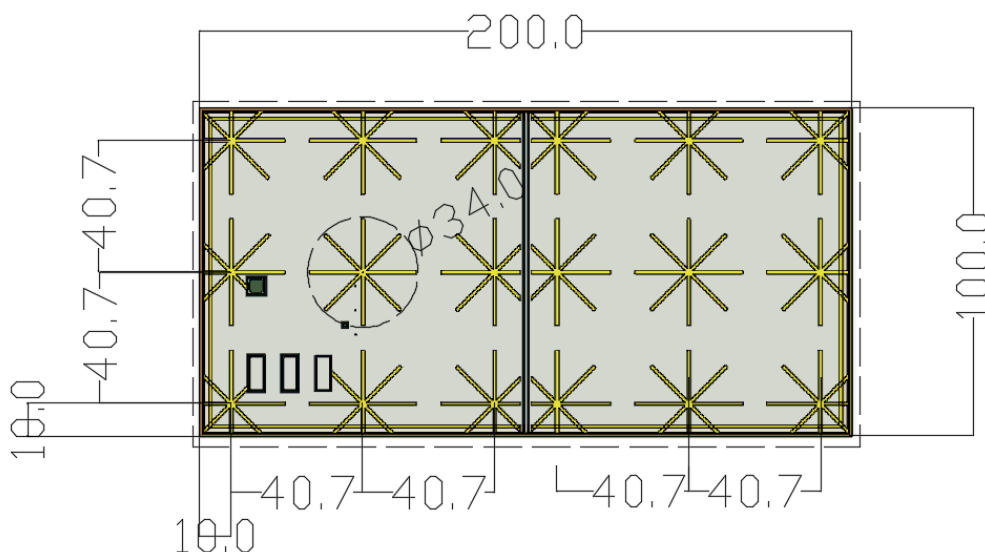


Figure 3. Detail of Star Scrim Patterns and Edge Scrim Layout

- 6.7.5.7 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.
- 6.7.5.8 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 .

6.7.6 *Install and Air Seal the Membrane:*

- 6.7.6.1 Sheets of membrane are welded together per manufacturer 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.
- 6.7.6.2 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 installation manual and/or in the membrane manufacturer installation guide, whichever is the more stringent.

6.7.7 *Install the Quadravent® with Preinstalled Boot:*

- 6.7.7.1 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).

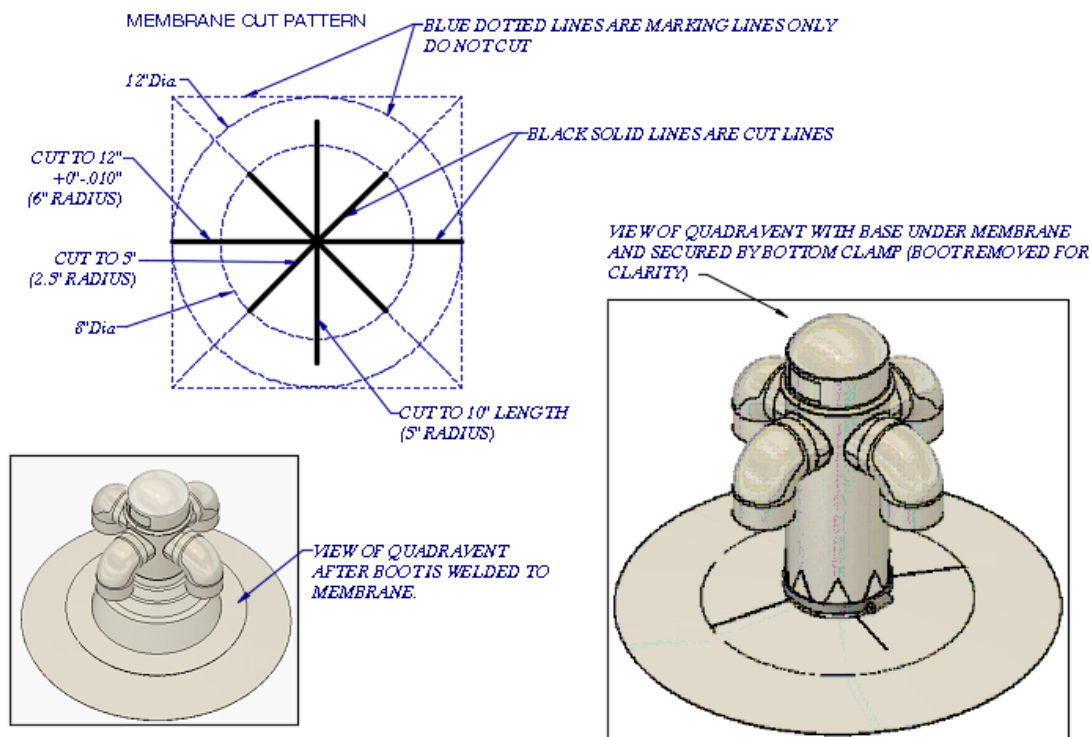


Figure 4. Detailed Drawing of Membrane Cut Pattern

- 6.7.7.2 The location of each Quadravent® cut pattern should coincide with the center of the scrim star pattern below the membrane.
- 6.7.7.3 Place a Quadravent® at each cut pattern with the flange positioned under the membrane through the large slits and aligned per the design specifications.
- 6.7.7.4 Orient the Quadravent® per the layout design, which is typically determined by the location of the Quadravent® as shown in Figure 5.

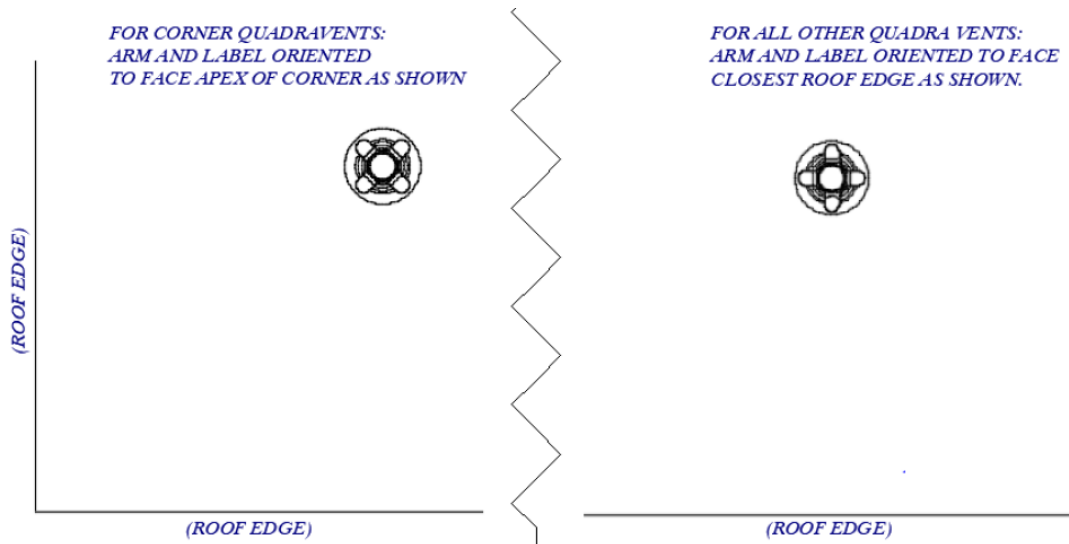


Figure 5. Detailed Drawing of Quadravent® Orientation

- 6.7.7.5 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.
- 6.7.7.6 Lower the boot such that the boot flange makes contact with the membrane. Weld the boot flange to the membrane per the membrane manufacturer specification. The finished product should look similar to Figure 1. The resultant roof assembly cross section at the Quadravent® is shown in Figure 6.

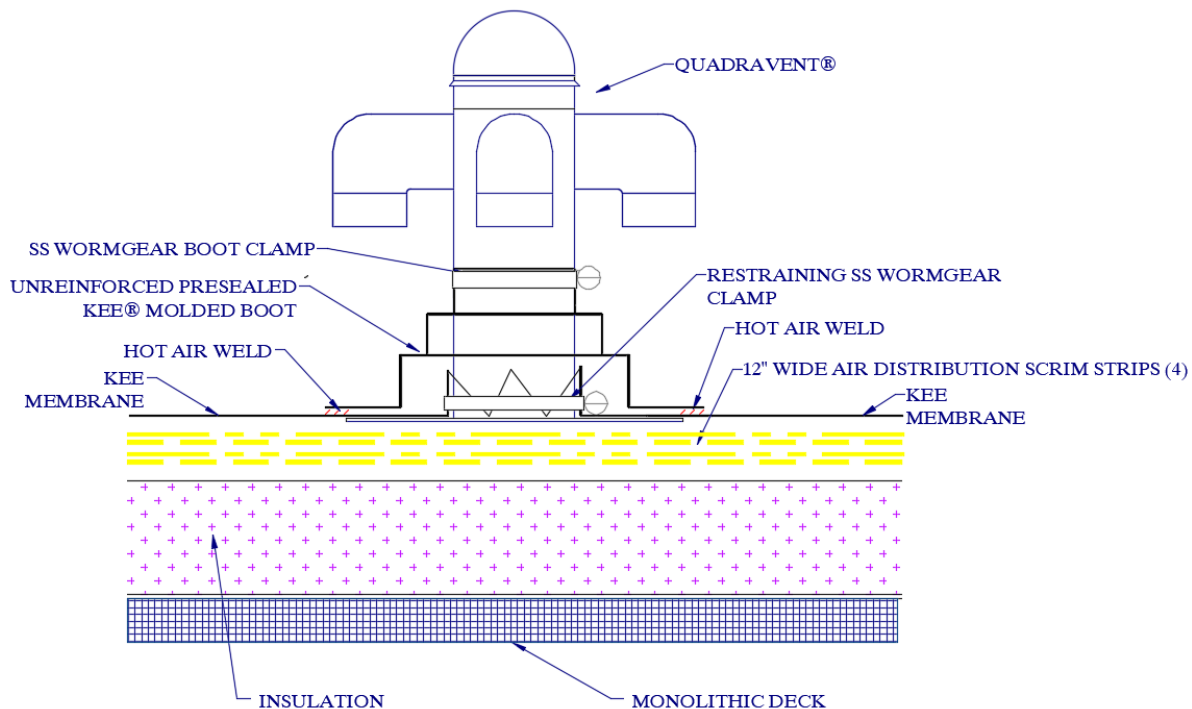


Figure 6. Detailed Drawing of Resulting Typical Roof Assembly at the Quadravent®

7 Substantiating Data

- 7.1 Testing has been performed under the supervision of a professional engineer and/or under the requirements of ISO/IEC 17025 as follows:
 - 7.1.1 Uplift resistance in accordance with FM 4474 and UL 1897
 - 7.1.2 Wind tunnel testing
 - 7.1.3 Computational Fluid Dynamics (CFD) Study
- 7.2 Information contained herein may include the result of testing and/or data analysis by sources that are approved agencies (i.e., ANAB accredited agencies), approved sources (i.e., RDPs), and/or professional engineering regulations. Accuracy of external test data and resulting analysis is relied upon.
- 7.3 Where pertinent, testing and/or engineering analysis is based upon provisions that have been codified into law through state or local adoption of codes and standards. The developers of these codes and standards are responsible for the reliability of published content. DrJ's engineering practice may use a code-adopted provision as the control sample. A control sample versus a test sample establishes a product as being equivalent to the code-adopted provision in terms of quality, strength, effectiveness, fire resistance, durability, and safety.
- 7.4 The accuracy of the provisions provided herein may be reliant upon the published properties of raw materials, which are defined by the grade mark, grade stamp, mill certificate, Listings, certified reports, duly authenticated reports from approved agencies, and research reports prepared by approved agencies and/or approved sources provided by the suppliers of products, materials, designs, assemblies and/or methods of construction. These are presumed to be minimum properties and relied upon to be accurate. The reliability of DrJ's engineering practice, as contained in this TER, may be dependent upon published design properties by others.
- 7.5 Testing and engineering analysis: The strength, rigidity and/or general performance of component parts and/or the integrated structure are determined by suitable tests that simulate the actual conditions of application that occur and/or by accepted engineering practice and experience.¹⁶
- 7.6 Where additional condition of use and/or code compliance information is required, please search for Quadravent® on the DrJ Certification website.

8 Findings

- 8.1 As delineated in Section 3, Quadravent® has performance characteristics that were tested and/or meet pertinent standards and is suitable for use pursuant to its specified purpose.
- 8.2 When used and installed in accordance with this TER and the manufacturer installation instructions, Quadravent® shall be approved for the following applications:
 - 8.2.1 Use to resist wind loads on low-slope roofs with loose-laid membranes.
- 8.3 Any application specific issues not addressed herein can be engineered by an RDP. Assistance with engineering is available from Qorbo Enterprises, LLC.
- 8.4 IBC Section 104.11 (IRC Section R104.11 and IFC Section 104.10¹⁷ are similar) in pertinent part 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. 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.

¹⁶ See Code of Federal Regulations (CFR) Title 24 Subtitle B Chapter XX Part 3280 for definition.

¹⁷ 2018 IFC Section 104.9

- 8.5 **Approved:**¹⁸ Building codes require that the building official shall accept duly authenticated reports¹⁹ or research reports²⁰ from approved agencies and/or approved sources (i.e., licensed RDP) with respect to the quality and manner of use of new products, materials, designs, services, assemblies, or methods of construction.
- 8.5.1 Acceptability of an approved agency, by a building official, is performed by verifying that the agency is accredited by a recognized accreditation body of the International Accreditation Forum (IAF).
- 8.5.2 Acceptability of a licensed RDP, by a building official, is performed by verifying that the RDP and/or their business entity is listed by the licensing board of the relevant jurisdiction.
- 8.5.3 Federal law, Title 18 US Code Section 242, requires that where the alternative product, material, service, design, assembly, and/or method of construction is not approved, the building official shall respond in writing, stating the reasons why the alternative was not approved, as denial without written reason deprives a protected right to free and fair competition in the marketplace.
- 8.6 DrJ is an engineering company, employs RDPs and is an ISO/IEC 17065 ANAB-Accredited Product Certification Body – Accreditation #1131.
- 8.7 Through ANAB accreditation and the IAF Multilateral Agreements, this TER 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.*” IAF specifically says, “*Once an accreditation body is a signatory of the IAF MLA, it is required to recognise certificates and validation and verification statements issued by conformity assessment bodies accredited by all other signatories of the IAF MLA, with the appropriate scope.*”²¹

9 Conditions of Use

- 9.1 Material properties shall not fall outside the boundaries defined in Section 3.
- 9.2 As defined in Section 3, where material and/or engineering mechanics properties are created for load resisting design purposes, the resistance to the applied load shall not exceed the ability of the defined properties to resist those loads using the principles of accepted engineering practice.
- 9.3 Roof assembly materials must meet the requirements listed in Section 4.3. When required by adopted legislation and enforced by the building official, also known as the authority having jurisdiction (AHJ) in which the project is to be constructed:
- 9.4 When required by adopted legislation and enforced by the building official, also known as the authority having jurisdiction (AHJ) in which the project is to be constructed:
- 9.4.1 Any calculations incorporated into the construction documents shall conform to accepted engineering practice, and, when prepared by an approved source, shall be approved when requirements of adopted legislation are met.
- 9.4.2 This TER and the installation instructions shall be submitted at the time of permit application.
- 9.4.3 This product has an internal quality control program and a third-party quality assurance program.
- 9.4.4 At a minimum, this product shall be installed per Section 6 of this TER.
- 9.4.5 The review of this TER, by the AHJ, shall be in compliance with IBC Section 104 and IBC Section 105.4.
- 9.4.6 This product has an internal quality control program and a third party quality assurance program in accordance with IBC Section 104.4, IBC Section 110.4, IBC Section 1703, IRC Section R104.4 and IRC Section R109.2.

¹⁸ Approved is an adjective that modifies the noun after it. For example, Approved Agency means that the Agency is accepted officially as being suitable in a particular situation. This example conforms to IBC/IRC/IFC Section 201.4 where the building code authorizes sentences to have an ordinarily accepted meaning such as the context implies.

¹⁹ <https://up.codes/viewer/wyoming/ibc-2021/chapter/17/special-inspections-and-tests#1707.1>

²⁰ <https://up.codes/viewer/wyoming/ibc-2021/chapter/17/special-inspections-and-tests#1703.4.2>

²¹ <https://iaf.nu/en/about-iaf-mla/#:~:text=required%20to%20recognise>



- 9.4.7 The application of this product in the context of this TER is dependent upon the accuracy of the construction documents, implementation of installation instructions, inspection as required by IBC Section 110.3, IRC Section R109.2 and any other regulatory requirements that may apply.
- 9.5 The approval of this TER by the AHJ shall comply with IBC Section 1707.1, where legislation states in pertinent part, “*the building official shall accept duly authenticated reports from approved agencies in respect to the quality and manner of use of new materials or assemblies as provided for in Section 104.11”*, all of IBC Section 104, and IBC Section 105.4.
- 9.6 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 (i.e., owner or RDP).
- 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.

10 Identification

- 10.1 The product listed in Section 1.1 is identified by a label on the board or packaging material bearing the manufacturer 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, visit drjcertification.org.
- 11.2 For information on the status of this TER, contact DrJ Certification.

12 Approved for Use Pursuant to US and International Legislation Defined in Appendix A

- 12.1 Quadravent® is included in this TER published by an approved agency that is concerned with evaluation of products or services, maintains periodic inspection of the production of listed materials or periodic evaluation of services, and whose TER Listing states either that the material, product, or service meets identified standards or has been tested and found suitable for a specified purpose. This TER meets the legislative intent and definition of being acceptable to the AHJ.

Appendix A

1 Legislation that Authorizes AHJ Approval

- 1.1 **Fair Competition:** State legislatures have adopted Federal regulations for the examination and approval of building code referenced and alternative products, materials, designs, services, assemblies and/or methods of construction that:
 - 1.1.1 Advance Innovation,
 - 1.1.2 Promote competition so all businesses have the opportunity to compete on price and quality in an open market on a level playing field unhampered by anticompetitive constraints, and
 - 1.1.3 Benefit consumers through lower prices, better quality, and greater choice.
- 1.2 **Adopted Legislation:** The following local, state, and federal regulations affirmatively authorize QuadraVent® to be approved by AHJs, delegates of building departments, and/or delegates of an agency of the federal government:
 - 1.2.1 Interstate commerce is governed by the Federal Department of Justice to encourage the use of innovative products, materials, designs, services, assemblies and/or methods of construction. The goal is to “protect economic freedom and opportunity by promoting free and fair competition in the marketplace.”
 - 1.2.2 Title 18 US Code Section 242 affirms and regulates the right of individuals and businesses to freely and fairly have new products, materials, designs, services, assemblies and/or methods of construction approved for use in commerce. Disapproval of alternatives shall be based upon non-conformance with respect to specific provisions of adopted legislation, and shall be provided in writing stating the reasons why the alternative was not approved, with reference to the specific legislation violated.
 - 1.2.3 The federal government and each state have a public records act. In addition, each state also has legislation that mimics the federal Defend Trade Secrets Act 2018 (DTSA).
 - 1.2.3.1 Compliance with public records and trade secret legislation requires approval through the use of listings, certified reports, Technical Evaluation Reports, duly authenticated reports and/or research reports prepared by approved agencies and/or approved sources.
 - 1.2.4 For new materials²² that are not specifically provided for in any building code, the design strengths and permissible stresses shall be established by tests, where suitable load tests simulate the actual loads and conditions of application that occur.
 - 1.2.5 The design strengths and permissible stresses of any structural material shall conform to the specifications and methods of design using accepted engineering practice.²³
 - 1.2.6 The commerce of approved sources (i.e., registered PEs) is regulated by professional engineering legislation. Professional engineering commerce shall always be approved by AHJs, except where there is evidence, provided in writing, that specific legislation has been violated by an individual registered PE.
 - 1.2.7 The AHJ shall accept duly authenticated reports from approved agencies in respect to the quality and manner of use of new materials or assemblies as provided for in IBC Section 104.11.²⁴

²² <https://up.codes/viewer/wyoming/ibc-2021/chapter/17/special-inspections-and-tests#1706.2>

²³ IBC 2021, Section 1706.1 Conformance to Standards

²⁴ IBC 2021, Section 1707 Alternative Test Procedure, 1707.1 General

- 1.3 **Approved²⁵ by Los Angeles:** The Los Angeles Municipal Code (LAMC) states in pertinent part that the provisions of LAMC are not intended to prevent the use of any material, device, or method of construction not specifically prescribed by LAMC. The Department shall use Part III, Recognized Standards in addition to Part II, Uniform Building Code Standards of Division 35, Article 1, Chapter IX of the LAMC in evaluation of products for approval where such standard exists for the product or the material and may use other approved standards, which apply. Whenever tests or certificates of any material or fabricated assembly are required by Chapter IX of the LAMC, such tests or certification shall be made by a testing agency approved by the Superintendent of Building to conduct such tests or provide such certifications. The testing agency shall publish the scope and limitation(s) of the listed material or fabricated assembly.²⁶ The Superintendent of Building roster of approved testing agencies is provided by the Los Angeles Department of Building and Safety (LADBS). The Center for Building Innovation (CBI) Certificate of Approval License is TA24945. Tests and certifications found in a CBI Listing are LAMC approved. In addition, the Superintendent of Building shall accept duly authenticated reports from approved agencies in respect to the quality and manner of use of new materials or assemblies as provided for in the California Building Code (CBC) Section 1707.1.²⁷
- 1.4 **Approved by Chicago:** The Municipal Code of Chicago (MCC) states in pertinent part that an Approved Agency is a Nationally Recognized Testing Laboratory (NRTL) acting within its recognized scope and/or a certification body accredited by the American National Standards Institute (ANSI) acting within its accredited scope. Construction materials and test procedures shall conform to the applicable standards listed in the MCC. Sufficient technical data shall be submitted to the building official to substantiate the proposed use of any product, material, service, design, assembly and/or method of construction not specifically provided for in the MCC. This technical data shall consist of research reports from approved sources (i.e., MCC defined Approved Agencies).
- 1.5 **Approved by New York City:** The NYC Building Code 2022 (NYCBC) states in pertinent part that an approved agency shall be deemed²⁸ an approved testing agency via ISO/IEC 17025 accreditation, an approved inspection agency via ISO/IEC 17020 accreditation, and an approved product evaluation agency via ISO/IEC 17065 accreditation. Accrediting agencies, other than federal agencies, must be members of an internationally recognized cooperation of laboratory and inspection accreditation bodies subject to a mutual recognition agreement²⁹ (i.e., ANAB, International Accreditation Forum (IAF), etc.).

²⁵ See Section 8 for the distilled building code definition of **Approved**

²⁶ Los Angeles Municipal Code, SEC. 98.0503. TESTING AGENCIES

²⁷ https://up.codes/viewer/california/ca-building-code-2022/chapter/17/special-inspections-and-tests#1707.1

²⁸ New York City, The Rules of the City of New York, § 101-07 Approved Agencies

²⁹ New York City, The Rules of the City of New York, § 101-07 Approved Agencies

- 1.6 **Approved by Florida:** Statewide approval of products, methods, or systems of construction shall be approved, without further evaluation, by 1) A certification mark or listing of an approved certification agency, 2) A test report from an approved testing laboratory, 3) A product evaluation report based upon testing or comparative or rational analysis, or a combination thereof, from an approved product evaluation entity; 4) A product evaluation report based upon testing or comparative or rational analysis, or a combination thereof, developed and signed and sealed by a professional engineer or architect, licensed in Florida. For local product approval, products or systems of construction shall demonstrate compliance with the structural wind load requirements of the Florida Building Code (FBC) through one of the following methods; 1) A certification mark, listing, or label from a commission-approved certification agency indicating that the product complies with the code; 2) A test report from a commission-approved testing laboratory indicating that the product tested complies with the code; 3) A product-evaluation report based upon testing, comparative or rational analysis, or a combination thereof, from a commission-approved product evaluation entity which indicates that the product evaluated complies with the code; 4) A product-evaluation report or certification based upon testing or comparative or rational analysis, or a combination thereof, developed and signed and sealed by a Florida professional engineer or Florida registered architect, which indicates that the product complies with the code; 5) A statewide product approval issued by the Florida Building Commission. The Florida Department of Business and Professional Regulation (DBPR) website provides a listing of companies certified as a Product Evaluation Agency (i.e., EVLMiami 13692), a Product Certification Agency (i.e., CER10642), and as a Florida Registered Engineer (i.e., ANE13741).
- 1.7 **Approved by Miami-Dade County (i.e., Notice of Acceptance [NOA]):** A Florida statewide approval is an NOA. An NOA is a Florida local product approval. By Florida law, Miami-Dade County shall accept the statewide and local Florida Product Approval as provided for in Florida legislation 553.842 and 553.8425.
- 1.8 **Approved by New Jersey:** Pursuant to Building Code 2018 of New Jersey in IBC Section 1707.1 General,³⁰ it states: “In the absence of approved rules or other approved standards, the building official shall accept duly authenticated reports from approved agencies in respect to the quality and manner of use of new materials or assemblies as provided for in the administrative provisions of the Uniform Construction Code (N.J.A.C. 5:23)”.³¹ Furthermore N.J.A.C 5:23-3.7 states: Municipal approvals of alternative materials, equipment, or methods of construction. **(a) Approvals:** Alternative materials, equipment, or methods of construction shall be approved by the appropriate subcode official provided the proposed design is satisfactory and that the materials, equipment, or methods of construction are suitable for the intended use and are at least the equivalent in quality, strength, effectiveness, fire resistance, durability and safety of those conforming with the requirements of the regulations. 1. A field evaluation label and report or letter issued by a nationally recognized testing laboratory verifying that the specific material, equipment, or method of construction meets the identified standards or has been tested and found to be suitable for the intended use, shall be accepted by the appropriate subcode official as meeting the requirements of (a) above. 2. Reports of engineering findings issued by nationally recognized evaluation service programs, such as, but not limited to, the Building Officials and Code Administrators (BOCA), the International Conference of Building Officials (ICBO), the Southern Building Code Congress International (SBCCI), the International Code Council (ICC), and the National Evaluation Service, Inc., shall be accepted by the appropriate subcode official as meeting the requirements of (a) above. The New Jersey Department of Community Affairs has confirmed that technical evaluation reports, from any accredited entity listed by ANAB, meets the requirements of item 2 given that the listed entities are no longer in existence and/or do not provide “reports of engineering findings”.

³⁰ https://up.codes/viewer/new_jersey/ibc-2018/chapter/17/special-inspections-and-tests#1707.1

³¹ <https://www.nj.gov/dca/divisions/codes/codreg/ucc.html>

- 1.9 **Approved by the Code of Federal Regulations Manufactured Home Construction and Safety Standards:** Pursuant to Title 24, Subtitle B, Chapter XX, Part 3282.14³² and Part 3280,³³ the Department encourages innovation and the use of new technology in manufactured homes. The design and construction of a manufactured home shall conform with the provisions of Part 3282 and Part 3280 where key approval provisions in mandatory language follow: 1) “All construction methods shall be in conformance with accepted engineering practices”; 2) “The strength and rigidity of the component parts and/or the integrated structure shall be determined by engineering analysis or by suitable load tests to simulate the actual loads and conditions of application that occur.”; and 3) “The design stresses of all materials shall conform to accepted engineering practice.”
- 1.10 **Approval by US, Local, and State Jurisdictions in General:** In all other local and state jurisdictions, the adopted building code legislation states in pertinent part that:
- 1.10.1 For new materials that are not specifically provided for in this code, the design strengths and permissible stresses shall be established by tests.³⁴
 - 1.10.2 For innovative alternative products, materials, designs, services and/or methods of construction, in the absence of approved rules or other approved standards...the building official shall accept duly authenticated reports (i.e., listing and/or research report) from approved agencies with respect to the quality and manner of use of new materials or assemblies.³⁵ A building official approved agency is deemed to be approved via certification from an accreditation body that is listed by the International Accreditation Forum³⁶ or equivalent.
 - 1.10.3 The design strengths and permissible stresses of any structural material...shall conform to the specifications and methods of design of accepted engineering practice performed by an approved source.³⁷ An approved source is defined as a PE subject to professional engineering laws, where a research and/or a technical evaluation report certified by a PE, shall be approved.
- 1.11 **Approval by International Jurisdictions:** The USMCA and GATT agreements provide for approval of innovative materials, products, designs, services, assemblies and/or methods of construction through the Technical Barriers to Trade agreements and the International Accreditation Forum (IAF) Multilateral Recognition Arrangement (MLA), where these agreements:
- 1.11.1 Permit participation of conformity assessment bodies located in the territories of other Members (defined as GATT Countries) under conditions no less favourable than those accorded to bodies located within their territory or the territory of any other country,
 - 1.11.2 State that conformity assessment procedures (i.e., ISO/IEC 17020, 17025, 17065, etc.) are prepared, adopted, and applied so as to grant access for suppliers of like products originating in the territories of other Members under conditions no less favourable than those accorded to suppliers of like products of national origin or originating in any other country, in a comparable situation.
 - 1.11.3 State that conformity assessment procedures are not prepared, adopted, or applied with a view to or with the effect of creating unnecessary obstacles to international trade. This means that conformity assessment procedures shall not be more strict or be applied more strictly than is necessary to give the importing Member adequate confidence that products conform to the applicable technical regulations or standards.

³² <https://www.ecfr.gov/current/title-24/subtitle-B/chapter-XX/part-3282/subpart-A/section-3282.14>

³³ <https://www.ecfr.gov/current/title-24/subtitle-B/chapter-XX/part-3280>

³⁴ IBC 2021, Section 1706 Design Strengths of Materials, 1706.2 New Materials. Adopted law pursuant to IBC model code language 1706.2.

³⁵ IBC 2021, Section 1707 Alternative Test Procedure, 1707.1 General. Adopted law pursuant to IBC model code language 1707.1.

³⁶ Please see the ANAB directory for building official approved agencies.

³⁷ IBC 2021, Section 1706 Design Strengths of Materials, Section 1706.1 Conformance to Standards Adopted law pursuant to IBC model code language 1706.1.



- 1.11.4 **Approved:** The purpose of the IAF MLA is to ensure mutual recognition of accredited certification and validation/verification statements between signatories to the MLA, and subsequently acceptance of accredited certification and validation/verification statements in many markets based on one accreditation for the timely approval of innovative materials, products, designs, services, assemblies and/or methods of construction. Accreditations granted by IAF MLA signatories are recognised worldwide based on their equivalent accreditation programs, therefore reducing costs and adding value to businesses and consumers.

Appendix B

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

$$V_{ult} := 120$$

$$V := V_{ult}$$

$V = V_{ult}$ 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

$$K_{zt} := 1$$

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

Enclosure Classification = Partially Enclosed

Enclosure classification, see Section 26.10

$$GC_{pi} := 0.55$$

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

$$q_h := 0.00256 \cdot K_h \cdot K_{zt} \cdot K_d \cdot V^2 = 34.15$$

Step 6: Determine external pressure coefficient, Fig. 30.4-2A for flat roofs

$$GC_{p_zone1} := -1.0$$

Negative external pressure coefficient for Zone 1, rounded up to h=10 ft

$$GC_{p_zone2} := -1.8$$

Negative external pressure coefficient for Zone 2, rounded up to h=10 ft

$$GC_{p_zone3} := -2.8$$

Negative external pressure coefficient for Zone 3, rounded up to h=10 ft

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

$$p_{zone1} := q_h \cdot (GC_{p_zone1} - GC_{pi}) = -52.9$$

$$p_{zone2} := q_h \cdot (GC_{p_zone2} - GC_{pi}) = -80.3$$

$$p_{zone3} := q_h \cdot (GC_{p_zone3} - GC_{pi}) = -114.4$$

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

Roof Dimensions:

$$l := 100$$

Length of roof

$$w := 100$$

Width of roof

$$A := l \cdot w = 10000$$

Area of roof

$$a := 0.1 \cdot l = 10$$

$$A_{zone3} := 4 \cdot a \cdot a = 400$$

$$A_{zone2} := (2 \cdot a \cdot (l - (2 \cdot a))) + (2 \cdot a \cdot (w - (2 \cdot a))) = 3200$$

Area of Zone 1

$$A_{zone1} := (l - (2 \cdot a)) \cdot (w - (2 \cdot a)) = 6400$$

Area of Zone 2

$$A_{total} := A_{zone1} + A_{zone2} + A_{zone3} = 10000$$

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

$$A_T := 12 \cdot 24 = 288$$

Surface area of test, ft²

$$F_N := P_N \cdot A_T = 49680$$

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.



Issue Date: January 23, 2023
Subject to Renewal: July 1, 2024

FBC Supplement to TER 1906-01

REPORT HOLDER: Qorbo Enterprises, LLC

1 Evaluation Subject

1.1 Quadravent®

2 Purpose and Scope

2.1 Purpose

2.1.1 The purpose of this Technical Evaluation Report (TER) supplement is to show Quadravent®, recognized in TER 1906-01, has also been evaluated for compliance with the codes listed below as adopted by the Florida Building Commission.

2.2 *Applicable Code Editions*

2.2.1 *FBC-B—17, 20: Florida Building Code – Building (FL #41888)*

2.2.2 *FBC-R—17, 20: Florida Building Code – Residential (FL #41888)*

3 Conclusions

3.1 Quadravent®, described in TER 1906-01, complies with the FBC-B and FBC-R and is subject to the conditions of use described in this supplement.

3.2 Where there are variations between the IBC and IRC and the FBC-B and FBC-R applicable to this TER, they are listed here:

3.2.1 FBC-B Section 104.4 and Section 110.4 are reserved.

3.2.2 FBC-R Section R104 and Section R109 are reserved.

3.2.3 FBC-B Section 110.3 replaces IBC Section 110.3

3.2.4 FBC-B Section 1503.2 replaces IBC Section 1503.2

3.2.5 FBC-B Section 1504.3 replaces IBC Section 1504.4

3.2.6 FBC-B Section 1504.5 replaces IBC Section 1504.6

3.2.7 FBC-B Sections 1507.12 and 1507.13 replaces IBC Section 1507.12

4 Conditions of Use

4.1 Quadravent®, described in TER 1906-01, must comply with all of the following conditions:

4.1.1 All applicable sections in TER 1906-01.

4.1.2 The design, installation, and inspections are in accordance with additional requirements of FBC-B Chapter 16 and Chapter 17, as applicable.