The information contained in this generic specification represents a part of WeatherBond’s recommendations. Construction materials and practices, building siting and operation, climatic conditions, and other site-specific factors will have an impact on the performance of the roofing systems. WeatherBond recommends that the building owner retain a design professional to determine appropriate design measures to be taken in order to address these factors.

<table>
<thead>
<tr>
<th>Section</th>
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<tbody>
<tr>
<td>Basic Wind Speed Map</td>
<td>DR-01-11</td>
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<tr>
<td>Codes and Wind Speed Map</td>
<td>DR-02-11</td>
</tr>
<tr>
<td>Insulation Fastening Patterns</td>
<td>DR-05-11</td>
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<tr>
<td>Withdrawal Resistance Criteria</td>
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<tr>
<td>CRRC/LEED Information</td>
<td>DR-07-11</td>
</tr>
<tr>
<td>Wood Nailers and Securement Criteria</td>
<td>DR-08-11</td>
</tr>
<tr>
<td>Considerations for Hail Design</td>
<td>DR-09-11</td>
</tr>
</tbody>
</table>
The maps included in this design reference section illustrate ground wind speeds as determined by American Society of Civil Engineers (ASCE). The data can be used when referencing the WeatherBond Specification to determine an appropriate securement method as illustrated in the various Tables contained in the Warranty Section. This information is considered to be a minimum and Specifiers and Design Professionals may use such data at their own discretion.

Fig. 1 Basic Wind Speeds – Central & Eastern United States
(See Notes on Page 2)
Notes associated to all maps:

= Special Wind Zone

1. Values are nominal design 3-second gust wind speeds in miles per hour at 33-ft above ground for Exposure C category.
2. Linear interpolation between wind contours is appropriate.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions. Seek 50-yr Mean Recurrence Interval (MRI) wind speed values from local building officials. As a minimum, increase the wind speed values by 10%.

Fig. 2. Basic Wind Speeds – Western United States
(See Notes on Page 2)
Fig. 3. Basic Wind Speeds – Western Gulf of Mexico Coastline of United States
(See Notes on Page 2)

Fig. 4. Basic Wind Speeds – Eastern Gulf of Mexico and Southern Atlantic Coastline of United States (See Notes on Page 2)
Fig. 5. Basic Wind Speeds – Mid-Atlantic and Northern Atlantic Coastline of United States (See Notes on Page 2)
Fig. 6. Basic Wind Speeds – Alaska  
(See Notes on Page 2)

<table>
<thead>
<tr>
<th>Location</th>
<th>Wind Speed</th>
<th>Equivalent</th>
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</thead>
<tbody>
<tr>
<td>Hawaii</td>
<td>105-mph</td>
<td>47-m/s</td>
</tr>
<tr>
<td>Puerto Rico</td>
<td>145-mph</td>
<td>65-m/s</td>
</tr>
<tr>
<td>Guam</td>
<td>170-mph</td>
<td>76-m/s</td>
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<tr>
<td>Virgin Islands</td>
<td>145-mph</td>
<td>65-m/s</td>
</tr>
<tr>
<td>American Samoa</td>
<td>125-mph</td>
<td>56-m/s</td>
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</tbody>
</table>

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This specification represents the applicable information available at the time of its publication. Owners, specifiers and roofing contractors should consult WeatherBond or their WeatherBond Independent Sales Representative for any information, which has subsequently been made available.
Documents sited herein may be subject to change without WeatherBond’s knowledge. Building Owners and Design Professionals are advised to obtain the latest information from the originators of the individual documents.

The information contained represents guidelines to address possible requirements as part of the building specification as listed under the Quality Assurance or Performance Article. WeatherBond recommends that the building owner retain a design professional to verify that these guidelines are appropriate.

Topics Page
Underwriters Laboratories – External Fire Test Criteria ................................................................. 2
Underwriters Laboratories – Internal Fire Test Criteria ............................................................... 3
Factory Mutual Global (FMG) Approval Testing Criteria ............................................................ 5
Determining the Proper FMG Rating _ FMG Property Loss Prevention Data Sheet 1-28 .......... 6
Determining Perimeter and Corner Enhancements – FMG PLPDS 1-29 .................................... 8
ASCE 7 ....................................................................................................................................... 10
UNDERWRITERS LABORATORIES
EXTERNAL FIRE TEST CRITERIA

Most Building Code agencies require flat roofs to have minimum performance requirements when exposed to external fire situations. The most recognized test procedure for evaluating this performance is the Underwriters Laboratories UL 790 procedure (Tests for Fire Resistance of Roof Covering Materials). This test is judged to be equivalent to the ASTM E108 procedure which is referenced in most building codes.

Under the UL 790 Test, roof coverings are rated Class "A", "B", or "C". Class "A" is the highest rating and is defined as being "effective against severe fire exposures". Depending on the category of deck (Non-Combustible or Combustible) determines the number and manner of tests required under the UL 790 procedures.

Non-Combustible Decks - Steel, Concrete, Gypsum or Fibrous Cement (minimum 2-inch thick):
- Require only Spread of Flame Tests.

Combustible Decks - Wood Planks (minimum 3/4" thick), Plywood (minimum 15/32" thick),
Oriented Strand Board - OSB (minimum 7/16" thick) or Fibrous Cement (less than 2" thick):
- Require Spread of Flame Tests
- Intermittent Flame
- Burning Brand penetration tests.

The basic criteria for determining the performance rating under each of these tests are as follows:

<table>
<thead>
<tr>
<th>SPREAD OF FLAME TEST</th>
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</thead>
<tbody>
<tr>
<td>Class A (10 minutes exposure) – 6’-0” maximum flame spread.</td>
</tr>
<tr>
<td>Class B (10 minutes exposure) – 8’-0” maximum flame spread</td>
</tr>
<tr>
<td>Class C (4 minutes exposure) – 13’-0” maximum flame spread.</td>
</tr>
</tbody>
</table>

Failure: Significant lateral flame spread (burning off the sides of the test sample) and the deck exposed upon completion of the test.

<table>
<thead>
<tr>
<th>INTERMITTENT FLAME TEST</th>
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<tbody>
<tr>
<td>Class A (15 cycles, 2 minutes on, 2 minutes off)</td>
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<tr>
<td>Class B (8 cycles, 2 minutes on, 2 minutes off)</td>
</tr>
<tr>
<td>Class C (3 cycles, 1 minute on, 2 minutes off)</td>
</tr>
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</table>

<table>
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<tr>
<th>BURNING BRAND TEST</th>
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<tbody>
<tr>
<td>Class A Brand – 2000 grams (approx. 4.5 pounds)</td>
</tr>
<tr>
<td>Class B Brand – 500 grams (approx. 1.1 pounds)</td>
</tr>
<tr>
<td>Class C Brand – 9.25 grams (approx. 0.3 ounces)</td>
</tr>
</tbody>
</table>

Failure: No sustained flaming on the underside of the deck and the deck must not be exposed upon completion of the test.

It is important to remember that it is the complete assembly that is being evaluated including the deck type, insulation type and thickness, membrane type and surface treatment, if any. Mixing components which have not been tested together will void the rating. Assemblies classified for use over combustible decks may be used over non-combustible decks to achieve the same rating.

Reference DR-02-11
UNDERWRITERS LABORATORIES
INTERNAL FIRE RESISTANCE
TEST CRITERIA AND RATINGS

The P-Series/Hourly Construction ratings identify the length of time a certain building construction, consisting of specified materials, will contain a fire and retain its structural integrity. The ratings are given in hours and are identified in the current published UL Fire Resistance Directory.

The test method used is UL 263 (ASTM E119) "Fire Test of Building Construction and Materials". In this test, the roof-ceiling assembly is exposed to fire from the inside for the stipulated time period.

<table>
<thead>
<tr>
<th>Test Criteria</th>
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<tbody>
<tr>
<td>Internal Steel Temperature</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>External surface temperature</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Listed below are the general groups of numbers in the P-Series constructions and what the internal fire protection consist of. The type of interior protection is used to determine what P-Series number is applicable:

<table>
<thead>
<tr>
<th>P-SERIES NUMBER</th>
<th>TYPE OF INTERIOR PROTECTION</th>
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<tr>
<td>000 – 099</td>
<td>Concealed Grid Systems (drop ceilings)</td>
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<tr>
<td>100 – 199</td>
<td>For Future Use</td>
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<tr>
<td>200 – 299</td>
<td>Exposed Grid Systems (drop ceilings)</td>
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<tr>
<td>300 – 399</td>
<td>Mineral and Fiber Boards</td>
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<td>400 – 499</td>
<td>Metal Lathe (plaster ceilings)</td>
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<td>500 – 599</td>
<td>Gypsum Board Ceiling Systems</td>
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<td>600 – 699</td>
<td>Direct Applied Protection - Miscellaneous</td>
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<tr>
<td>700 – 799</td>
<td>Direct Applied Protection – Cementitious</td>
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<td>800 – 899</td>
<td>Direct Applied Protection - Sprayed Fiber</td>
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<td>900 - 999</td>
<td>Precast Concrete or Steel/Concrete Decks (unprotected deck)</td>
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# Internal Fire Ratings
## Construction/Systems Chart

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</table>

A = Adhered Roofing Systems
MF = Mechanically Fastened

The current published **UL Fire Resistance Directory** must be referenced for specific criteria (insulation and thermal barrier requirements, ceiling protection, etc.) needed to obtain these fire ratings.
FACTORY MUTUAL GLOBAL (FMG) APPROVAL TEST CRITERIA

Factory Mutual Global (FMG) approval requires that the roof construction and membrane assembly pass tests related to combustibility, wind resistance, hail resistance, water leakage, resistance to foot traffic and corrosion (FM Approval Standards 4450 and 4470). All of these tests must be successfully completed before a roofing assembly is classified as approved by FMG and then published on the FMG RoofNav system.

Briefly, the test criterion consists of the following:

**Combustibility**

A. Above the Deck - External
   The test method utilized is ASTM E-108 and results in a Class A, B or C external fire rating. The description can be found under the "UL External Fire Test Criteria" in this guide. The minimum thickness for a combustible deck, which FM approves, is 3/4" tongue and groove Fire Retardant treated plywood (Refer to the current published information on FMG’s website for specific deck requirements).

B. Below the Deck - Fuel Contribution (Calorimeter)
   The complete roof assembly is exposed to an internal fire source for a period of 30 minutes. The heat input is carefully controlled and monitored. The test gauges the fuel contribution from the roof assembly measured at 3, 5, 10 and 30 minute intervals. At no time can this additional fuel contribution exceed certain predetermined levels.

**Wind Resistance (also referred to as ANSI/FM 4474)**

A test panel comprising of a roof deck, thermal barrier (optional), insulation, cover board (optional), secured to the structural deck with insulation fasteners or adhesives, and roof coverings. This assembly is exposed to air pressure from below, starting at 30 psf and held at that pressure for one minute. After each minute, the air pressure is increased an additional 15 psf and held for another full minute. This increase in pressure and time is continued until failure of the assembly. The last successful pressure before failure is the rating for the assembly. The minimum rating an assembly can receive is 60 psf. (Note the results are from a pressure test in psf, not miles per hour.)

A. Fully Adhered Roofing Systems
   Adhered membrane assemblies can be tested on a 5' X 9' Uplift Table for a maximum rating of 90 psf. For a higher rating that 90 psf, the assembly must be tested on the 12’ X 24’ Uplift Table.

B. Mechanically Attached Roofing Systems
   All mechanically attached roofing systems (with field membrane securement exceeding 4 feet) are required to be tested on a 12’ X 24’ Uplift Table.

"Enhanced Wind Uplift Resistant Roof Classifications" (greater than 90 psf ratings) Adhered and Mechanically Attached Roofing Systems must be tested on the 12’ X 24’ Table resisting the noted pressures.

To determine the wind uplift rating (60 psf, 90 psf, 105 psf, etc.) appropriate for a given building, refer to the latest published FMG Property Loss Prevention Data Sheets 1-28.

**Hail Resistance**

FMG’s hail resistance test is a simulated test to evaluate the performance of the roof covering and substrate against damage by hail. Failure results if cracking, puncturing or tearing of the membrane and/or substrate occurs. The results listed as either meeting SH (severe hail) or MH (moderate hail) criteria. Refer to FMG Property Loss Prevention Data Sheet 1-34, Hail Damage for additional information.

**Water Leakage**
A simulated test to evaluate the performance of a field applied seam when subjected to ponded water for a 7 day period. Failure results if any sign of leakage is observed.

**Resistance to Foot Traffic**

A simulated test to evaluate the performance of the roof covering when subjected to a 200 pound load a minimum of 5 times over the same area. Failure results if cracking, puncturing or tearing occurs.

**Corrosion Resistance (Kesternich Test)**

The Kesternich Test is a simulated test to evaluate the corrosion resistance of metal components when exposed to sulfurous acid (acid rain) over a 15 day (cycle) period. Failure results if more than 15% rust develops.

**Additional Information**

In addition to the above referenced test criteria, Factory Mutual Global also references numerous Property Loss Prevention Data Sheets which include recommendations for items such as deck securement, perimeter nailer attachment methods, additional insulation fastening for adhered systems and additional insulation and membrane fastening for mechanically attached systems at roof perimeters and corners. These sheets must be referenced when Factory Mutual is the insuring company. Some of the necessary Property Loss Prevention Data Sheets include:

- 1-0 Safeguards During Construction, Alteration and Demolition
- 1-9 Roof Anchorage
- 1-13 Chimneys
- 1-20 Protection Against Exterior Fire Exposure
- 1-22 Maximum Foreseeable Loss
- 1-28 Wind Design
- 1-28R Roof Systems
- 1-29 Roof Deck Securement and Above Deck Roof Components
- 1-30 Repair for Wind Damage Roof Systems
- 1-31 Metal Roof Systems
- 1-32 Existing PVC Roof Covers
- 1-33 Safeguarding Torch-Applied Roof Installations
- 1-34 Hail Damage
- 1-35 Green Roof Systems
- 1-49 Perimeter Flashing
- 1-52 Field Uplift Tests
- 1-54 Roof Loads for New Construction

**Determining FMG Rating Needed**

Use FMG Property Loss Prevention Data Sheet 1-28 To Determine Uplift Pressure and Rating Required. FMG Data Sheet 1-28 calculations conform with the American Society of Civil Engineers (ASCE 7) with the requirement that the building importance factor = 1.15

**Required Building Information**

- Identify Building Height
- Peak Gust Wind Zone
- Openings (Open, Partially Enclosed, or Enclosed)
- Determine “Ground Roughness”
  - B: Urban/Suburban Areas, Well Wooded, Closely Spaced Buildings (includes large cities)
  - C: Open Terrain, Flat Open Country, Scattered Buildings less than 30’ High
  - D: Adjacent to Bodies of Water
- With the above information, use pre-calculated tables within the FMG Data Sheet 1-28 to find “basic outward pressure”.
- “Basic Outward Pressure” is then multiplied by a Safety Factor of 2 resulting in the “Factored Pressure”
• Apply to the “Factored Pressure” are the appropriate pressure multipliers for the roof slope, zone, and enclosed or partially enclosed buildings, to determine the “Design Pressures” for the field, perimeter, and corners.
• Note: ASCE 7 does not identify a safety factor.

EXAMPLE of using FMG Data Sheet 1-28

Building located in Akron, OH: 90 MPH Wind Zone
Building Height: 60 Feet
Building Openings: Enclosed
Roof Slope: Less than 7°

Portion of Table Exposure “C” from FM 1-28:

<table>
<thead>
<tr>
<th>Ht. Above Ground (FT)</th>
<th>WIND ISOTACH (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤ 85</td>
</tr>
<tr>
<td>0-15</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td></td>
</tr>
<tr>
<td>89</td>
<td></td>
</tr>
</tbody>
</table>

Basic Outward Pressure = 27 psf
Safety Factor = x2
Multipliers:

Portion of Table 6 from FM 1-28:

<table>
<thead>
<tr>
<th>Mean Roof Height (h)</th>
<th>Roof Slope</th>
<th>Enclosed Building</th>
</tr>
</thead>
<tbody>
<tr>
<td>h ≤ 60 ft</td>
<td>≤ 7°</td>
<td>Zone 1(Field)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.0</td>
</tr>
</tbody>
</table>

Final results:

<table>
<thead>
<tr>
<th>Area of Roof</th>
<th>Calculation</th>
<th>Result (psf)</th>
<th>Min. Rated Assembly (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field</td>
<td>27 x 2 x 1 =</td>
<td>54</td>
<td>60</td>
</tr>
<tr>
<td>Perimeter*</td>
<td>27 x 2 x 1.68 =</td>
<td>91</td>
<td>105</td>
</tr>
<tr>
<td>Corner*</td>
<td>27 x 2 x 2.53 =</td>
<td>137</td>
<td>150</td>
</tr>
</tbody>
</table>

*Perimeter and corner dimensions are calculated as follows:

For building height ≤ 60 ft: .4 x the building height or .1 x the width (whichever is less), but not less than 4% the width.
For buildings > 60 ft: .1 x the width
AFTER reviewing FMG Data Sheet 1-28 to determine the field uplift pressure, the system designer can either use the corner pressure rating for the whole roof area or look at the field rating pressure and follow the FMG Data Sheet 1-29 for possible corner and perimeter enhancements to compensate the increase pressures over field rated assembly.

**Fully Adhered Membrane Assemblies**

**Field uplift pressure ≤ 75 psf**

- **Prescriptive enhancements for insulation fasteners and plates:**
  - **Perimeter Areas:** increase fastening density of insulation 50% more than the number tested for use in the field, but result cannot be less than 1 fastener per 2 square feet (16 fasteners per 4’x8’ board).
  - **Corner Areas:** fastening density must be 1 fastener per 1 square foot (32 fasteners per 4’x8’ board).

- **Prescriptive enhancements for insulation adhered with ribbon type adhesives:**
  - **Perimeter Areas:** ribbon spacing shall be 60% the distance used in the field (typically this will be maximum 6-inch spacing).
  - **Corner Areas:** ribbon spacing shall be 40% the distance used in the field (typically this will be maximum 4-inch spacing).

**Field uplift pressure > 75 psf:**

Use one of the two following methods to install perimeter and corner areas on adhered systems utilizing mechanically attached insulations (this includes a mechanically attached bottom layer with subsequent layers attached with adhesive).

**Method #1:** Install an adhered roofing assembly in the perimeter and corner areas that meet the wind uplift rating as determined by FMG Data Sheet 1-28.
Portion of Table Exposure “C” from FM1-28:

<table>
<thead>
<tr>
<th>Ht. Above Ground (FT)</th>
<th>WIND ISOTACH (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤ 85</td>
</tr>
<tr>
<td>0-15</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td></td>
</tr>
<tr>
<td>89</td>
<td></td>
</tr>
</tbody>
</table>

Basic Outward Pressure = 41 psf
Safety Factor = x2
Multipliers:

Portion of Table 6 from FM 1-28:

<table>
<thead>
<tr>
<th>Mean Roof Height (h)</th>
<th>Roof Slope</th>
<th>Enclosed Building</th>
</tr>
</thead>
<tbody>
<tr>
<td>h ≤ 60 ft</td>
<td>≤ 7°</td>
<td>Zone 1(Field)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Zone 2 (Perimeter)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Zone 3 (Corner)</td>
</tr>
</tbody>
</table>

Final Results:

<table>
<thead>
<tr>
<th>Area of Roof</th>
<th>Calculation</th>
<th>Result (psf)</th>
<th>Min. Rated Assembly (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field</td>
<td>41 x 2 x 1 =</td>
<td>82</td>
<td>90</td>
</tr>
<tr>
<td>Perimeter*</td>
<td>41 x 2 x 1.68 =</td>
<td>138</td>
<td>150</td>
</tr>
<tr>
<td>Corner*</td>
<td>41 x 2 x 2.53 =</td>
<td>208</td>
<td>210</td>
</tr>
</tbody>
</table>

Note: Within the FMG 1-29 a table conservative calculations has been included, which may be greater than using the FMG 1-28.

Method #2: Use a mechanically attached assembly in the perimeter and corner areas following the guidelines specified in FMG 1-29.

As an example, assuming a 90 psf rating is required. The perimeter and corner fastening layout is determined using any **mechanically attached assembly** that has passed 90 psf uplift testing.

Assume a 9-1/2’ row-to-row spacing (10’ wide membrane) with fasteners spaced 6” on center passes 90 psf uplift testing. The perimeter and corner row spacing will be a maximum of 60% and 40% of the tested spacing, respectively. Therefore, the perimeter row-to-row spacing would be a maximum of 5.7’ and the corner row-to-row spacing would be a maximum 3.8’, all with fasteners spaced 6” on center.

If desired, the membrane can be adhered across the entire roof area, with the mechanical attachments in the perimeters and corners installed through the top of membrane.
Example

<table>
<thead>
<tr>
<th>Approved Field Sheet Width</th>
<th>10-foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perimeter Securement Width</td>
<td>6-foot</td>
</tr>
<tr>
<td>Corner Securement Width</td>
<td>4-foot</td>
</tr>
</tbody>
</table>

All securement fastening shall be at the same rate as Field Sheet Approval

ASCE 7 Compliance

ANSI/SPRI WD-1: Wind Design Standard Practice for Roofing Assemblies

FM Global (FMG) is an insurance standard and is required to be followed if the building is FMG insured, however it is not a building code standard. The International Building Code requires that each roofing assembly must be certified to meet or exceed the calculated pressures following the ASCE 7.

The ANSI/SPRI WD-1 provides a two-part methodology for determining the wind uplift pressures at roof deck for non-ballasted single-ply roofing system assemblies. (Refer to the ANSI/SPRI RP-4 Standard for wind design requirements of ballasted single-ply roofing systems).

A. **First Part:** Within the WD-1 are Quick Reference Tables to assist in determination of the rooftop wind uplift design pressures for the field, perimeter and corner areas of a building. The Quick Reference Tables are based on ASCE 7-05 and can only be used if a particular building meets the published criteria.
EXAMPLE using Quick Reference Tables

Building located in Arkon, OH: 90 MPH Wind Zone
Building Height: 60 Feet
Building Openings: Enclosed
Roof Slope: Less than 7°
Building Category: II

Portion of Table Exposure “C” from WD-1

<table>
<thead>
<tr>
<th>Building Height (FT)</th>
<th>Field Design Load (psf)</th>
<th>Perimeter Design Load (psf)</th>
<th>Corner Design Load (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>-27.6</td>
<td>-46.3</td>
<td>-69.7</td>
</tr>
<tr>
<td>89</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B. Second Part: Select an appropriate roofing system assembly by comparing the Factored Tested Load Capacity of that assembly to the wind uplift design pressures determined from the First Part. To determine the Factored Tested Load Capacity a safety factor is applied to the tested wind uplift resistance before comparison to the wind uplift design pressures.

Factored Tested Load Capacity = Tested Uplift Resistance / Safety Factor

Example:
Tested Uplift Resistance of a roofing assembly = 60 psf.
Chosen Safety Factor: 2

60 psf / 2 = 30 psf (Factored Tested Load Capacity)

Comparing the results against the uplift design pressures we see that the system exceeds the field pressure (-27.6 psf) but is less than the perimeter and corners. To compensate for the additional pressures, the tested assembly would need to be enhanced.

C. Extrapolation Method for Perimeter/Corner Insulation or Membrane Attachment

To determine the enhancement requirements depends on the method of installation for the adhered or mechanically attached membrane system.

1. Adhered membrane system with insulation secured with insulation fasteners and plates:

   \[ F_n = \frac{(F_t \times L_d)}{L_t} \]

   \( F_n \) is the number of fasteners per board needed to meet the perimeter or corner design load.
   \( F_t \) is the number of fasteners per board used to achieve the tested load capacity.
   \( L_d \) is the calculated design load for the corner area of the roof, psf.
   \( L_t \) is the factored tested load capacity.

   Example:
   Single-ply membrane adhered to 2-inch thick polyisocyanurate secured to a steel deck with 8 insulation fasteners per 4’ x 8’.
   
   Perimeter: \( F_n = \frac{(8 \times 46.3)}{30} = 12.35 \) (total of 13 insulation fasteners and plates)
   Corner: \( F_n = \frac{(8 \times 69.7)}{30} = 18.59 \) (total of 19 insulation fasteners and plates)

2. Fully Adhered membrane system with insulation secured with insulation adhesives (ribbons):

   \[ R_n = \frac{R_t}{(L_d / L_t)} \]
Rn is the ribbon/bead spacing needed to meet the design load, inches. 
Rt is the ribbon/bead spacing used to achieve the tested load capacity, inches. 
Ld is the calculated design load for the perimeter and corner areas of the roof, psf. 
Lt is the factored tested load capacity, psf.

**Example:**
Single-ply membrane adhered to 2-inch thick polyisocyanurate adhered to a concrete deck with insulation adhesive with maximum ribbon spacing being no greater than 12-inches.

**Perimeter:** 
\[ Rn = \frac{12}{(46.3 / 30)} = 7.79 \text{ (maximum ribbon spacing = 7.5")} \]

**Corner:** 
\[ Rn = \frac{12}{(69.7 / 30)} = 5.17 \text{ (maximum ribbon spacing = 5")} \]

3. **Mechanically Attached Membrane System**

\[ IAn = \frac{(Lt \times \text{Row Spacing} \times \text{Fastening Density})}{Ld} \]

IAn is row spacing between fastening density, ft.
Lt is the factored tested load capacity, psf.
Row Spacing is the distance between rows of membrane securement, ft.
Fastening Density is rate of membrane securement in seam on center, ft.
Ld is the calculated design load for the perimeter or corner area of the roof, psf.

**Example:**
10-ft wide single-ply membrane mechanically attached in the field along the seams at a rate of 12-inches on center.

**Perimeter:** 
\[ IAn = \frac{(30 \times 10 \times 1)}{46.3} = 6.48 \text{ (maximum row spacing = 6-ft)} \]

**Corner:** 
\[ IAn = \frac{(30 \times 10 \times 1)}{69.7} = 4.30 \text{ (maximum row spacing = 4-ft)} \]

D. **Perimeter and corner dimensions**

For building height ≤ 60 ft: .4 x the building height or .1 x the width (whichever is less), but not less than 4% the width.
For buildings > 60 ft: .1 x the width

<table>
<thead>
<tr>
<th>Corner</th>
<th>Perimeter</th>
<th>Corner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perimeter</td>
<td>Field</td>
<td>Perimeter</td>
</tr>
<tr>
<td>Corner</td>
<td>Perimeter</td>
<td>Corner</td>
</tr>
</tbody>
</table>

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This specification represents the applicable information available at the time of its publication. Owners, specifiers and roofing contractors should consult WeatherBond or their WeatherBond Independent Sales Representative for any information, which has subsequently been made available.
The information contained represents guidelines to address possible requirements as part of the building specification as listed under the Quality Insurance or Performance Article. WeatherBond recommends that the building owner retain a design professional to verify that these guidelines are appropriate.

When enhanced insulation fastening is required as prescribed in Factory Mutual Loss Prevention Data Sheet 1-29, ANSI/SPRI WD-1, or Miami-Dade County, the specifier may consider the enclosed insulation pattern securements. **NOTE:** All insulation and underlayments shown are the minimum thickness required for the established rating.

**Insulation Patterns for boards 4’ x 4’ in size**

![Diagram of Insulation Patterns](image)

Only FM 1-90 for:
- 2” XP Polyiso or XFP Polyiso
- 1/2” XFP HD Plus Cover Board
- 5/8” Dens Deck Prime or Securock

Only FM 1-90 for:
- 1/2” Securock
- 1-1/2” XP Polyiso
6 Insulation Fasteners & Plates

**FM 1-90 for:**
1/4” Dens Deck Prime

**FM 1-75 for:**
1/4” Securock

8 Insulation Fasteners & Plates

**FM 1-90 for all except:**
1” XP Polyiso (recover only)
9 Insulation Fasteners & Plates

Fastening pattern should only be used when required by FM for perimeter or corner enhancement

10 Insulation Fasteners & Plates

**FM 1-150 for:**

2” XP Polyiso (EPDM and TPO)

1/2” Securock (EPDM and TPO)

**FM 1-135 for:**

2” XP Polyiso (PVC)

**FM 1-105 for:**

½” Dens Deck Prime

**FM 1-90 for:**

1-1/2” XP Polyiso (Recover)
Fastening pattern should only be used when required by FM for perimeter or corner enhancement.

**FM I-285 for:**

1/2" Dens Deck Prime (Fleece)

**FM 1-225 for:**

2" SecurShield
1/2" Securock

**FM 1-195 for:**

2" XP Polyiso (EPDM and TPO)

References DR-05-11
Insulation Patterns for boards 4’ x 8’ in size

8 Insulation Fasteners & Plates

FM 1-90 for:
2” XP Polyiso or XFP Polyiso
1/2” XFP HD PlusCover Board
5/8” Dens Deck Prime or Securock

10 Insulation Fasteners & Plates

FM 1-90 for:
1/2” Securock
1-1/2” XP Polyiso

11 Insulation Fasteners & Plates

FM 1-90 for:
1-1/2” XP Polyiso

12 Insulation Fasteners & Plates

FM 1-90 for:
1/4” Dens Deck Prime
FM 1-75 for:
1/4” Securock

References DR-05-11
15 Insulation Fasteners & Plates

Fastening pattern should only be used when required by FM for perimeter or corner enhancement

16 Insulation Fasteners & Plates

**FM 1-90 for all except:**

1” XP Polyiso (Recover Only)

17 Insulation Fasteners & Plates

**FM 1-105 for:**

7/16” OSB (EPDM)

**FM 1-150 for:**

7/16” OSB (TPO)

**FM-120 for:**

7/16” OSB (PVC)

18 Insulation Fasteners & Plates

Fastening pattern should only be used when required by FM for perimeter or corner enhancement warranty.
**FM 1-150 for:**

- 2” XP Polyiso (EPDM and TPO)
- 1/2” Securock (EPDM and TPO)

**FM 1-135 for:**

- 2” XP Polyiso (PVC)

**FM 1-105 for:**

- 1/2” Dens Deck Prime

**FM 1-90 for:**

- 1” XP Poyiso (Recover)

Fastening pattern should only be used when required by FM for perimeter or corner enhancement or required.
Fastening pattern should only be used when required by FM for perimeter or corner enhancement.

28 Insulation Fasteners & Plates

30 Insulation Fasteners & Plates

Fastening pattern should only be used when required by FM for perimeter or corner enhancement.
32 Insulation Fasteners & Plates

**FM 1-225 for:**

2” XFP Polyiso

1/2” Securock

**FM 1-195 for:**

2” XP Polyiso (EPDM and TPO)
Withdrawal Resistance Criteria

May 2012

The information contained represents guidelines to address possible requirements as part of the building specification as listed under the Quality Assurance or Performance Article. WeatherBond recommends that the building owner retain a design professional to verify that these guidelines are appropriate.

A. The following chart indicates the appropriate WeatherBond Fastener for use with the referenced roof deck and includes the minimum pullout and fastener penetration requirements for membrane/insulation securement on Mechanically Attached Roofing Systems and for insulation attachment on Adhered assemblies.

<table>
<thead>
<tr>
<th>Deck Type</th>
<th>Minimum Pullout</th>
<th>Approved WeatherBond Fastener</th>
<th>Minimum Penetration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel, 22 gauge or heavier</td>
<td>425 pounds</td>
<td>HPW or Sure-Tite Fasteners (4)</td>
<td>3/4&quot;</td>
</tr>
<tr>
<td></td>
<td>360 pounds</td>
<td>HPW, HPWX, ASAP or InsulTite Fasteners</td>
<td>3/4&quot;</td>
</tr>
<tr>
<td>Steel, less than 22 gauge</td>
<td>300 pounds</td>
<td>HPW, HPWX, ASAP or InsulTite Fasteners</td>
<td>3/4&quot;</td>
</tr>
<tr>
<td>Lightweight Insulating Concrete over Steel (3)</td>
<td>360 pounds</td>
<td>HPW, HPWX, ASAP or InsulTite Fasteners (Adhered) HPW or Sure-Tite Fasteners (4) (Mech. Attached)</td>
<td>3/4&quot;</td>
</tr>
<tr>
<td>Structural Concrete, rated 3,000 psi or greater</td>
<td>800 pounds</td>
<td>CD-10 or MD 14-10</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Wood Planks</td>
<td>360 pounds</td>
<td>HPW, HPWX, ASAP or InsulTite Fasteners (Adhered) HPW or Sure-Tite Fasteners (4) (Mech. Attached)</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Oriented Strand Board (OSB) minimum 7/16&quot; thick and minimum 15/32&quot; thick Plywood (5)</td>
<td>210 pounds Mechanically Attached</td>
<td>HPW or Sure-Tite (Mechanically Attached)</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td></td>
<td>210 pounds Adhered</td>
<td>HPW or HPWX Fastener (Adhered)</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Gypsum</td>
<td>300 pounds</td>
<td>GypTec or Lite-Deck</td>
<td>1-1/2&quot; (GypTec) 2&quot; (Lite Deck)</td>
</tr>
<tr>
<td>Cementitious Wood Fiber</td>
<td>300 pounds</td>
<td>GypTec</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td></td>
<td>225 pounds</td>
<td>Adhered Only</td>
<td></td>
</tr>
</tbody>
</table>

Notes:

1. Mechanically Attached Roofing Systems are not permitted over corrugated steel decks, regardless of gauge.
2. Mechanically Attached Roofing Systems are not permitted over steel decks less than 22 gauge unless used in conjunction with lightweight insulating concrete and acceptable pullouts are obtained using HPW or Sure-Tite Fasteners.
3. Fasteners are installed through the lightweight insulating concrete into the steel deck below.
4. Sure-Tite Fasteners can be used on Mechanically Attached Roofing Systems in conjunction with ST Metal Fastening Bars.
5. 7/16" OSB or 5/8" OSB and 15/32" 3-Ply Plywood 3-Ply or 15/32" 5-Ply Plywood.

B. Withdrawal resistance testing may be conducted by an independent laboratory, fastener manufacturer or a representative of WeatherBond on the following roof decks.
1. **Fully Adhered Roofing Systems:**
   a. Cementitious wood fiber or gypsum decks – GypTec or Lite-Deck (gypsum decks only) Fasteners or an approved fastener by others.
   b. Steel decks lighter than 22-gauge - WeatherBond HPW, HPWX, ASAP, InsulTite Fasteners or an approved fastener by others.
   c. Oriented strand board (OSB) decks (less than 5/8" thick) - WeatherBond HPW, HPW-XL or an approved fastener by others.

2. **Mechanically Attached Roofing Systems:**
   a. Cementitious wood fiber or gypsum decks – GypTec Fastener
   b. Lightweight insulating concrete over steel decks lighter than 22 gauge - WeatherBond HPW or Sure-Tite (with ST Fastening Bars). Fasteners must penetrate the steel deck below the lightweight concrete.
   c. Minimum 7/16" thick oriented strand board (OSB) decks - WeatherBond HPW or Sure-Tite (with ST Fastening Bars)
   d. Minimum 5/8" thick oriented strand board (OSB) decks - WeatherBond HPW or Sure-Tite (with ST Fastening Bars) Fasteners
   e. Plywood decks less than 5/8" thick - WeatherBond HPW or Sure-Tite (with ST Fastening Bars)

3. On all other acceptable roof decks, a withdrawal resistance test is strongly recommended.

C. **Withdrawal Resistance Procedures:**
   1. On retrofit projects, a core cutter shall be used to remove existing roofing material prior to conducting the withdrawal resistance test (even if the existing roofing membrane is specified to remain). Existing roofing materials will contribute to a higher, misleading pullout value.
   2. The following minimum trial fastener samples must be installed and tested over the roof deck at each level:
      a. For each roof level of 5,000 sq. ft. or less, conduct a minimum of 3 pullouts.
      b. For each roof level greater than 5,000 sq. ft. and less than 20,000 sq. ft., conduct a minimum of 10 pullouts.
      c. For each roof level greater than 20,000 sq. ft. and less than 50,000 sq. ft., conduct a minimum of 15 pullouts.
      d. For each roof level greater than 50,000 sq. ft. and less than 100,000 sq. ft., conduct a minimum of 20 pullouts.
      e. For each roof level greater than 100,000 sq. ft., conduct a minimum of 1 pullout per each 5,000 sq. ft.

   **Note:** On projects with multiple roof levels, when pullouts are conducted on the main roof level, smaller canopies, overhangs, penthouses, etc., of 1,000 square feet or less will not require pullout tests providing these areas consist of the same decking material as the main roof level.

   3. The trial fastener installations should be tested in various locations of the roof deck including roof corners and perimeters (areas parallel to the edge of the roof with a width which is 0.4 times the building height).

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Reference DR-06-11
The table below illustrates membrane properties as they pertain to reflectivity, emittance, recyclability and test methods. The data can be referenced when compliance with CRRC standards and LEED pre-requisites are required. Other LEED compliant information could be obtained by contacting WeatherBond. Additional LEED information is contained in various Technical Data Bulletins.

WeatherBond RBR EPDM (white) Membranes - WeatherBond PRO TPO Membranes (White/Gray/Tan)
WeatherBond PRO PVC Membranes (White)

<table>
<thead>
<tr>
<th>Physical Property</th>
<th>Test Method</th>
<th>WeatherBond RBR EPDM</th>
<th>WeatherBond PRO TPO</th>
<th>WeatherBond PRO PVC</th>
<th>WeatherBond PRO PVC with Elvaloy/FRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Membrane Color</td>
<td></td>
<td>White</td>
<td>White</td>
<td>Gray/Tan</td>
<td>White</td>
</tr>
<tr>
<td>ENERGY STAR – Initial solar reflectance</td>
<td>SSR</td>
<td>0.84</td>
<td>0.87</td>
<td>NA / 0.68</td>
<td>0.87</td>
</tr>
<tr>
<td>ENERGY STAR – Solar reflectance after 3 years (cleaned)</td>
<td>SSR</td>
<td>0.80</td>
<td>0.83</td>
<td>NA / 0.64</td>
<td>0.61</td>
</tr>
<tr>
<td>CRRC – Initial solar reflectance</td>
<td>ASTM C1549</td>
<td>0.76</td>
<td>0.79</td>
<td>0.46 / 0.71</td>
<td>0.87</td>
</tr>
<tr>
<td>CRRC – Solar reflectance after 3 years (uncleaned)</td>
<td>ASTM C1549</td>
<td>0.64</td>
<td>0.70</td>
<td>0.43 / 0.64</td>
<td>0.61</td>
</tr>
<tr>
<td>CRRC – Initial thermal emittance</td>
<td>ASTM C1371</td>
<td>0.90</td>
<td>0.90</td>
<td>0.89 / 0.86</td>
<td>0.95</td>
</tr>
<tr>
<td>CRRC – Thermal emittance after 3 years (uncleaned)</td>
<td>ASTM C1371</td>
<td>0.87</td>
<td>0.86</td>
<td>0.88 / 0.87</td>
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<tr>
<td>LEED – Thermal emittance</td>
<td>ASTM E408</td>
<td>0.91</td>
<td>0.95</td>
<td>0.95 / 0.95</td>
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<td>Solar Reflective Index (SRI)</td>
<td>ASTM E1980</td>
<td>105</td>
<td>110</td>
<td>55 / 88</td>
<td>110</td>
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<tr>
<td>LEED – Pre-consumer recycled content</td>
<td></td>
<td>0%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>LEED – Post-consumer recycled content</td>
<td></td>
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</tr>
<tr>
<td>LEED – Manufacturing location</td>
<td></td>
<td>Carlisle, PA or Greenville, IL</td>
<td>Senatobia, MS or Tooele, UT</td>
<td>Senatobia, MS or Tooele, UT</td>
<td>Hillside, NJ</td>
</tr>
</tbody>
</table>

Note: WeatherBond RBR EPDM (Black) Membrane: SRI 9; Pre-consumer recycled content 3%; Post-consumer recycled content; Manufacturing Location Carlisle, PA and Greenville, IL.

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Wood Nailers and Securement Criteria
(Factory Mutual Loss Prevention Data Sheet 1-49)

May 2012

The information contained represents guidelines to address possible requirements as part of the building specification as listed under the Quality Assurance or Performance Article. WeatherBond recommends that the building owner retain a design professional to verify that these guidelines are appropriate.

One of the most often overlooked details on a roofing system is the attachment method for wood nailers at the perimeter of the roof. Factory Mutual Global (FMG) publishes design recommendations for the attachment of wood nailers to various substrates and for the attachment of perimeter flashing details to wood nailers. This information is contained in Factory Mutual's Property Loss Prevention Data Sheet 1-49. In accordance with that Data Sheet, the information listed below should be referenced when selecting an appropriate perimeter attachment method.

General Criteria

A **horizontal wood nailer** is used to provide an effective substrate for some installation details and for other roof accessories. In addition, it is used to provide solid protection for the edge of the membrane underlayment. Minimum thickness of the nailer must be such that the top of the nailer is flush with the top of the membrane underlayment.

1. The width of the nailers must exceed the width of the metal flange of edgings, scuppers, etc.

2. When treated lumber is specified, it is recommended that only lumber that has been pressure treated with salt preservatives be specified. Lumber treated with any of the wood preservatives such as, Creosote, Pentachlorophenol, Copper Naphthenate and Copper 8-quinolinolate will adversely affect the membrane when in direct contact and are, therefore, **unacceptable**.

   If non-treated lumber is to be specified, it must be stored to protect from moisture sources. A seal should be provided between the non-treated lumber and a concrete or gypsum substrate (similar to a sill sealer).

3. Methods used to fasten the nailer vary with building conditions; however, it is essential that secure attachment of durable stock be accomplished. Factory Mutual Loss Prevention Data Bulletin 1-49 (Perimeter Flashing) contains options for the spacing and sizing of fasteners based on the project wind zone.

- Wood nailers that are anchored to steel, wood or masonry decking should not be less than 2" X 6" nominal (minimum1-1/2" X 5-1/2").

- Wood nailers should be Douglas Fir, Southern Yellow Pine or of wood having similar decay resistant properties.
Attachment to Masonry Walls

When fastening to a masonry wall, a 1/2 inch diameter anchor bolt is placed 48 inches on center at an 8 inch minimum depth (12 inches minimum when masonry walls are composed of lightweight aggregate or cinder) as shown in Figure 1. Each anchor bolt is positioned (staggered if the wood nailer is wider than 6 inches) in a block core or air space and tightly filled with concrete to the depth of the bolt.

Note: Plastic parts must not be used with masonry anchors.

FMG has specific requirements concerning filling of cores or voids in the top course of cinder blocks.

For example:

Projects requiring 75-psf or 90-psf ratings - fill the entire top course.
Projects requiring 60-psf ratings - fill only required where anchor bolts are positioned (48 inches on center in the field, 24 inches on center at roof corners).

At outside corners, the fastening density must be increased within the first 8 feet in each direction by positioning anchor bolts 24 inches on center.

An alternate method may be used by installing 3/8 inch diameter anchor bolts spaced 32 inches apart. For outside corners, bolts are fastened 16 inches apart, 8 feet from each side of the corner. If additional wood nailers are needed, refer to Figure 5 for attachment of additional wood nailers.

Attachment to Steel and Wood Decking

- Penetration of the fasteners should be to the top flutes only. The fasteners must be staggered as shown in Figure 2.
- The staggered fastening pattern should be increased within 8 feet from outside corners as shown in Figure 3A.
- If the perimeter nailer is to be secured to a steel angle, anchor bolts must be positioned at 48 inch centers as show in Figure 4.
- On wood decks, the staggered fastening pattern with galvanized steel screws should be utilized as shown in Figure 2.

Caution: Attention should be paid to the FMG requirement which calls for galvanized steel washers (minimum 5/8 inch outside diameter) to be used in conjunction with galvanized screws. This requirement is not recognized in most cases and most often forgotten.

Attachment of Additional Wood Nailers

- When additional wood nailers are required, they must be attached with galvanized nails or lag screws that penetrate into the bottom nailer at 1-1/4 inches using a staggered fastening pattern in two rows at 24 inches apart as shown in Figure 5.
- The increased fastening density within 8 feet from outside corners is still required and must comply with Figure 3.
- The Data Sheet also contains important information pertaining to attachment of metal fascia/edging especially for those edgings which are shop fabricated.
- Even though not emphasized in the Data Sheet, contractors should examine or question existing conditions to determine if existing wood nailers are attached in compliance with the above criteria. If not, existing wood
nailers should be refastened using one of these options and additional wood nailers must be secured following Figure 5.

Projects where Factory Mutual is the insurance underwriter should be reviewed by the local Factory Mutual office for specific criteria.

![Diagram](image)
**FIGURE 2 - ROOF EDGE WOOD BLOCKING - SCREW FASTENER ANCHORAGE**

**FIGURE 3A - WOOD BLOCKING CORNER ANCHORAGE 3'-0" FROM CORNER**

**FIGURE 3B - TYPICAL ROOF EDGE WOOD BLOCKING - SCREW FASTENER ANCHORAGE**

FM APPROVED SCREW FASTENERS: HEADLOCK TOP OR WASHERS @ 1'-0" O.C. STAGGERED
CONTINUOUS 2" x 8" WOOD NAILER
RIGID INSULATION
STEEL ROOF DECK
NOTES:
1. 3/4" Ø ANCHOR BOLTS @ 48" O.C.
2. AT 8'-0" CORNERS: FASTENING DOUBLED (24" O.C. MAX)

FIGURE 4 - ROOF EDGE WOOD BLOCKING - THROUGH BOLT ANCHORS
NOTES:
1. AT 8'-0' CORNERS, FASTENERS DOUBLED (12" O.C. IN EACH ROW).

FM APPROVED SCREW FASTENERS @ 2'-0" O.C. STAGGERED
CONTINUOUS TOP WOOD NAILER
RIGID INSULATION
CONTINUOUS SHIM
CONTINUOUS ROOF EDGE NAILER
STEEL ROOF DECK

FIGURE 5

STEEL WOOD DECK SCREW FASTENERS AS FOLLOWS:
- 2 X 4 - 2 SCREW FASTENERS
- 2 X 6 - 3 SCREW FASTENERS
- 2 X 8 - 4 SCREW FASTENERS

2X WOOD BLOCKING
BEVEL TO 45°

FIGURE 6 - MITERED WOOD JOINT DETAIL
Considerations for Hail Design

May 2012

The information contained represents guidelines to address possible requirements as part of the building specification as listed under the Quality Assurance or Performance Article. WeatherBond recommends that the building owner retain a design professional to verify that these guidelines are appropriate.

The map below (Figure 1) depicts areas of the United States that are more prone to hail storms. In areas of potential hail, the use of a thicker roofing membrane is recommended to provide greater puncture resistance.

1. Large hail areas may warrant the use of thicker conventional EPDM or TPO membrane in conjunction with a rigid membrane underlayment.

2. To eliminate possible damage of membranes, the substrate below the membrane should be adhered. Insulation fasteners and plates are not recommended for use directly beneath the membrane (except where used for membrane securement).

3. The use PVC membrane is not recommended in Hail Zones greater than 1 inch in diameter, unless specifically approved.

![U.S. Hail Zone Map](image)

**Fig. 1 – U.S. Hail Zone Map**

- **Yellow**: 0.5" – 1.0" Hail
- **Green**: 1.0" – 2.0" Hail
- **Blue**: 2.0" – 4.0" Hail

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