Roofing Wind Speeds: ASCE 7, Uplift Ratings, and Warranties

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Abstract

- Does 90 lbs./sq. ft. of uplift equal 90 mph?
- Does a Factory Mutual Global-rated assembly of 1-90 equal 90 mph?
- Does the building code require a warranty wind speed of 90 mph?

An ongoing issue that frustrates the industry as a whole is the confusion in how a roofing assembly will meet the building code, will meet an uplift rating, and be warranted based on local wind speeds.

Since local wind speed is the common factor is all three, an understanding of how wind speed is used and associated to each needs to be clarified. This presentation will focus on the process, from uplift to warranty.

Speaker

Brian P. Chamberlain — Carlisle Construction Materials

BRIAN CHAMBERLAIN has been with Carlisle Construction Materials since 1987. He graduated from the University of Wisconsin at Milwaukee with a BS in architectural design. As a member of Carlisle's Design Services, he is part of a team that is responsible for all system configurations and details development, including all code-testing operations for those assemblies. He has been involved in numerous technological presentations throughout North America and Asia, offering information on unique design issues, such as energy efficiency of insulation, geographic influence on roof membrane color, roof garden assemblies, photovoltaic interfacing, moisture vapor movement, and uplift performance of roofing systems. Chamberlain is a member of RCI and CSI.

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INTRODUCTION

The following questions seem simple to answer, but they are common with building owners, designers, and contractors:

- Does 90 lbs./sq. ft. of uplift equal 90 mph?
- Does a Factory Mutual Global- (FM Global-) rated assembly of 1-90 equal 90 mph?
- Does the building code require a warranty wind speed of 90 mph?

Though these questions are common, they are all misunderstandings of what the building code requires, what FM Global's criteria are, and what is covered by roofing material manufacturers' warranties. One way to understand this is by reviewing the minimum requirement in the building code for roof assembly based on wind uplift performance, how the roofing assembly can be verified to meet the building code, and in what way a roof warranty relates to the building code and uplift pressures.

As new standards are being developed and accepted by the roofing industry, such as the 2012 International Building Code (IBC), American Society of Civil Engineers (ASCE) 7-2010, or FM Global Approval Standard 4470, just to name a few, questions like the ones above arise because of assumptions, lack of education, inexperience, and the various recommendations in the building code process.

CALCULATION UPLIFT

So where does this all begin?

In Chapter 16 of the IBC, it states that roof systems must meet uplift pressures for the specific building conditions based on calculations using ASCE 7 with the results in pounds per square foot (lbs./sq. ft.). Verification of these pressures must be executed through independent testing following testing procedures listed in FM 4450, FM 4470, ANSI/FM 4474, UL 580, or UL 1895, with the testing results reported in lbs. per sq. ft. so that comparison can be accomplished between the calculated results in lbs./sq. ft. to tested results in lbs./sq. ft.

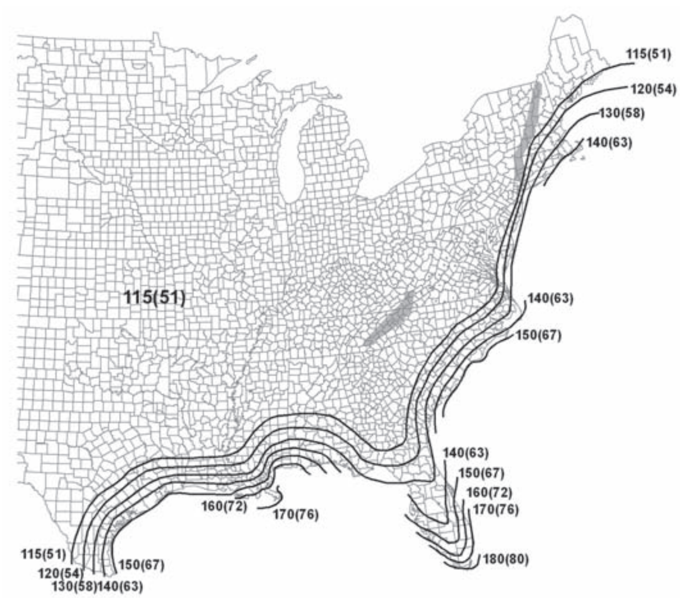


Figure 1 — Basic wind speed map, risk Category II, ASCE 7-10, Chapter 26.

The first step is calculating the uplift pressure following the ASCE 7 standard. Currently, the industry has two versions—ASCE 7-2005 or ASCE 7-2010[1]—and depending on your state or municipality, the correct version for calculations must be used, because there are slight differences between the two that must be taken into account.

Though this paper will not go fully into the math, I will limit the discussion about math to ASCE 7-2010, because as states adopt the IBC 2012, this method will be necessary. The purpose of this overview is to acknowledge that wind is important to the calculation, but it is not the sole factor that should be considered. The ASCE 7 standard is an engineer's document, so its focus is on the building's structural members and the nonstructural cladding components of a building. The result is that all building components must be installed to meet specific pressures.

In determining uplift pressures for a roof area, there are five basic factors that must be considered for a roofing installation:

1. **Building Height.** Higher roof areas will have stronger wind velocity.
2. **Building Location.** Wind maps (*Figure 1*) are included within ASCE 7 so that the local basic wind speed can be determined. The maps are based on a 3-second peak gust measured at 33 ft. (10 m) above grade in an exposure condition ("C") that is referenced as "basic wind speed."
3. **Surrounding Terrain.** The more obstructions there are around a building, the more they will break

Figure 2 – Example of Exposure D: buildings near a large body of water.

up the wind and assist in reducing the wind effect. Knowing if the building is located in an urban/suburban area, an open-terrain area, or near a large body of water becomes important (*Figure 2*). For the specific three exposure definitions (B, C, and D), refer to ASCE 7-10, Chapter 26.

4. **Building Openings.** The more openings in a building, the greater the chance of internal pressures increasing in a wind event. It is important to know if the building is enclosed, partially enclosed, or open (*Figure 3*). For a complete definition of building openings, refer to ASCE 7-10, Chapter 26.
5. **Building Use.** This factor is based on how important the building is to the surrounding infrastructure in terms of people's safety. An example would be a school or a hospital compared to a warehouse. Though a warehouse owner might not want his building harmed during a natural disaster, the other two buildings are very important for the protection of children and for assistance to those harmed during a natural disaster. Refer to ASCE 7-10 for a complete definition of Risk Categories I, II, or III/IV.

All the data listed above are plugged into the following formulas, and the result is uplift pressure in lbs./sq. ft.:

$$q_z = 0.00256 \times K_z \times K_{zt} \times K_d \times V^2 \times .06$$

- 0.00256 = numerical coefficient to be used except where sufficient climatic data are available
- K_Z = velocity pressure exposure coefficient evaluated at height z = h
- K_{Zt} = topographic factor as defined in ASCE 7-10, Section 26.8
- K_d = wind directionality factor in ASCE 7-10, Table 26.6-1
- V^2 = basic wind speed obtained from ASCE 7-10, Figures 26.5-1A through 26.5-1C.
- .06 = load factor to convert to allowable stress design[2]

Figure 3 – Example of an open warehouse.

$$P \text{ (pressure)} = q_z\,[(GC_p) - (GC_{pi})]$$

- GC_p = external pressure coefficient and gust-effect factor
- GC_{pi} = internal pressure coefficient and gust-effect factor

For a complete understanding of the calculation method, refer to *Wind Pressures on Low-Slope Roofs*, RCIF Publication No. 01.01.[3]

SAFETY FACTOR

After the results have been completed, there are a number of organizations, such as FM Global, ASTM D6630, NRCA, and ANSI/SPRI that recommend a safety factor. Though a safety factor is important for the design professional to consider, it is not required by the IBC or ASCE 7-10.

In addition, material manufacturers submit their results from the testing assemblies (described later in this paper) to the ICC Evaluation Service (ICC-ES), Miami-Dade Building Code Compliance Office's Product Control Division, and Trinity ERD (Exterior Research & Design, LLC) for review and incorporation into the published reports. These organizations do not publish the tested results but use "factored tested load capacity" of the assemblies. The way to determine factored tested load capacity is by taking the tested uplift load capacity (L_t) and dividing by a safety factor, usually 2, as shown in the following formula:

Factored Tested Load Capacity = Tested Uplift Load Capacity (L_t)/2 lbs./sq. ft.

Both methods are acceptable, but if desired, one or the other should be specified in the architectural roofing specification. This is important, because at the time of bid, those associated with the bid process will know that additional uplift criteria are being specified beyond the building code. Otherwise, the minimum requirements of the building code will be followed.

Since a safety factor is only a recommendation at this time, it is the intent of this paper to focus on what is required by the building code. It should be understood that the building code represents a minimum requirement, and designers should always consider going beyond the building code.

RESPONSIBILITY

The person responsible for doing the uplift calculation is the design professional, who should list the results in the architectural specification. In some cases, they are included correctly; but unfortunately, most Division 7 specifications for roofing assemblies attempt to place the responsibility on the roofing contractor or installer, who is typically not an engineer.

At a panel discussion held at the 2013 Carolinas Roofing & Sheet Metal Contractors Association, Inc. (CRSMCA) in Raleigh, NC, the responsibility for doing the calculations was discussed, and the panel's engineer and specifier agreed that a roofing contractor should not bid on the project unless he or she had the calculation results from the design professional who specified the roofing assembly.

Though this is a nice idea, the industry does not allow enough time during the bidding process for this communication. With the push for the bid and the architectural roofing specification making the calculations the contractor's responsibility, the contractor is forced to request assistance from the roofing materials manufacturer or some other source.

Please understand that the above is in reference to new construction. In reroofing or re-covering of an existing roof area, which might be negotiated between the contractor and the building owner without a licensed design professional involved, the building owner or the contractor should

Quick Reference Table Building Risk Category II, Exposure C 115 MPH Peak Gust Wind Zone			
Building Height, ft.	**Field Design Load, psf**	**Perimeter Design Load, psf**	**Corner Design Load, psf**
0-15	-20.4	-34.2	-51.5
20	-21.6	-36.2	-54.5
25	-22.5	-37.8	-56.9
30	-23.5	-39.4	-59.3
40	-24.9	-41.8	-63.0
50	-26.1	-43.8	-66.0
60	-27.1	-45.4	-38.4

Figure 4 – Partial ANSI/SPRI WD-1, Page 13.

hire a licensed design professional to verify the uplift pressures.

Material manufacturers want to be as service oriented as possible, so they will act upon these requests, do the calculations, and present the pressures for a given building roof area, but they clarify that such results should be verified by a local licensed engineer or design professional. The demand for this assistance has increased steadily over the years, which in turn has generated a number of published documents and online calculators.

One such document is the American National Standards Institute/Single Ply Roofing Industry (ANSI/SPRI) "WD-1: Wind Design Guide Standard Practice for Roofing Assemblies," approved July 10, 2012,[4] which is based on ASCE 7-10 and is focused on roofing installation. This document offers guidance on how this general process works, including charts of calculated results (*Figure 4*) without using a wind directionality factor for a standard building and assists the designer in determining the uplift pressures.

In addition to this document, there are web-based calculators; but each has its own limitations, and at best, they offer good guidance for the designer. Even so, the overall responsibility for confirming these results lies with the specifier through an engineer, architect, or other qualified design professional (*Figure 5*).

The results determine the uplift pressures for each zone area of the roof: field, perimeter, and corners. Take note that the corner will typically have the highest uplift pressure. As an example, in *Figure 5*, the uplift pressure in the corner for a 30-ft.-high building is -50.5 lbs./sq. ft.

TESTING

So what should the designer do with this number?

The designer should review roof assemblies and their associated reports in uplift resistance to confirm which assembly meets or exceeds the calculated uplift pressures.

The process by which a material manufacturer tests an assembly is by following the testing procedure described in FM 4450, FM 4470, ANSI/FM 4474, UL 580, or UL 1895. The most common testing manufacturers request of independent laboratories (such as American Testing, Inc.; Atlantic & Caribbean Roof Consulting, LLC; and PRI Asphalt Technologies, Inc., to name a few), is ANSI/FM 4474[5], which is just the uplift testing portion of FM 4470.

TESTING PROCEDURE

The standard procedure for the uplift test starts with the roofing material manufacturer building a mock-up of the proposed roof assembly on either a 5- x 9-ft. or 12- x 24-ft. table. The 5- x 9-ft. table is limited to a rated system up to 90 lbs./sq. ft., with limitations to mechanically secured membranes and base sheets; while the 12- x 24-ft. table

Project Information

Job Name **Warehouse**	City **Anaheim**	State **California**
User Name **Helpful Person**	Email **HP@hp.com**	
Street Address **Highway**	City **Anaheim**	State **California**
Roof Dimensions (ft.) **100 x 100**	Building Height (ft.) **30**	Basic Wind Speed (mph) **115**
Exposure Type **C**	Internal Pressure **Enclosed Buildings (0.18)**	Risk Category **Category II**
Membrane Type **EPDM**	Deck Type **22 Gauge or Heavier Steel**	Safety Factor **1**

Basic Uplift Pressure

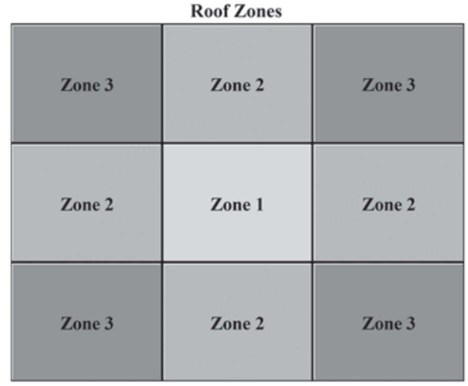
Constant	Kz	Kzt	Kd	V_z^2	ASL	Qz
0.00256	Velocity Pressure Coefficient	Wind Speed Coefficient	Directionality Factor	Basic Wind Speed	Allowable Strength Load	Lbs./Sq. Ft.
0.00256	**0.98**	**1**	**0.85**	**13225**	**0.6**	**17**

Zone Uplift Pressure

Pressure Zones	Coefficient	Basic Velocity Pressure	Zone Uplift Pressure (psf)
Zone 1 (Field)	-1	17	-20.0
Zone 2 (Perimeter)	-1.8	17	-33.6
Zone 3 (Corner)	-2.8	17	-50.5

Zones	Zone Uplift Pressure (psf)	Safety Factor	Design Pressure (psf)
1 - Field	-20.0	1	-20.0
2 - Perimeter	-33.6	1	-33.6
3 - Corner	-50.5	1	-50.5

Roof Zones



Note: If parapet heights are 3 ft. (0.915-m) or greater, perimeter pressures can be used for corner pressures.

Figure 5 – Results from Carlisle Construction Materials' ASCE 7 calculator.

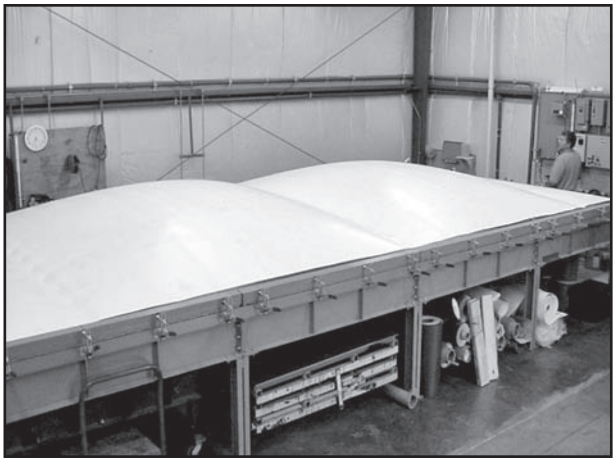


Figure 6 – Mechanically fastened membrane system tested on a 12- x 24-ft. table.

allows for a rated system greater than 90 lbs./sq. ft. and wider spacing of membrane securement. Refer to ANSI/FM 4474, paragraph 5.1.2, for complete limitations.

Once installed, the perimeter of the table is sealed airtight, and positive pressure—measured in lbs. per sq. ft.—is pumped from underneath the roofing assembly. The test is meant to simulate the negative pressure of wind trying to pull off the roof assembly as the wind blows across.

At the start of the test, the assembly is subjected to 30 lbs./sq. ft. of positive pressure. This pressure is held for one minute, and then an additional 15 lbs./sq. ft. is added, for a total of 45 lbs./sq. ft., which is also held for one minute. This process continues until a failure mode occurs, at which time the system is rated at the last pressure the assembly held for one minute (*Figure 6*).

The minimum rating any assembly can earn is 60 lb./sq. ft. Please note that the laboratory test for a 90-lb./sq.-ft. assembly only lasts for five minutes.

Failure Mode for Adhered Membrane Assemblies

- If the membrane separates from insulation
- If the insulation facer delaminates
- If the insulation boards break

Failure Mode for Mechanically Fastened Membrane Assemblies

- If the fasteners pull out of the deck
- If the membrane ruptures (*Figure 7*)

COMPARISON

Once the roof assembly's strength is determined through this test and reported, we can compare its uplift rating to the ASCE 7 calculations. For example, if the corner pressure were -50.5 lbs./sq. ft., the minimum acceptable rated assembly would be 60 lbs./sq. ft.

If it happens that the calculated perimeter and corner pressures are greater than the reported uplift performance of the assembly, the IBC and ASCE 7 do not offer any guidance other than the assembly must have been tested to meet or exceed those pressures. There are a number of documents published that offer recommendations on how to enhance the rated assembly to compensate for those additional pressures, such as ANSI/SPRI WD-1 and FM Global Loss Prevention Data Sheet 1-29, but they are not required by the building code. The design professional will have to decide which if any of these recommendations to include in his or her specification.

SPECIFICATIONS

Architectural specifiers incorporate the above process in their architectural roof specifications; but unfortunately, depending on how they are written, this create its own confusion. Where this process should be listed in the quality assurance or performance articles, the wording can be misleading. The best way this can be handled is by actually inserting the results of the ASCE 7 testing in the referenced articles and requiring certification that the specified roofing assembly meets or exceeds those results. Since, based on my personal review, most specification writers do not seem to include this information, I offer the following statement that could be modified:

> The specified roofing assembly must have been successfully tested by a qualified testing agency following ANSI/FM 4474 to resist the design uplift pressures calculated according to American Society of Civil Engineers (ASCE) 7 and after multiplying the results with a safety factor (determined and provided by a design professional), but assembly uplift pressures shall be not less than 60 lbs./sq. ft.

Another very common listing in architectural roof specification is FM Global. Specifiers feel that inclusion of FM Global will guarantee that the roof installation will be of high quality. Though FM Global follows a very similar process as the IBC, there are some subtle differences. Keep in mind that all FM Global documents are for buildings insured by them, so their documents are not building code but rather their insurance standards. In addition, their documents have no public review and comments associated with them. FM Global can modify or change its documents and publish them without notifying the industry.

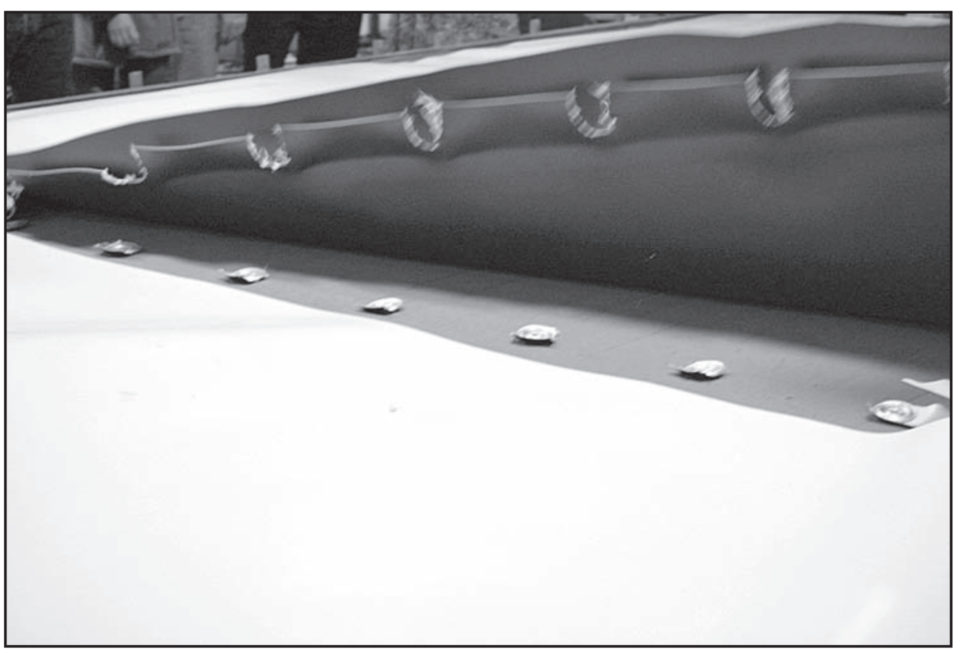


Figure 7 – Seam plates bent and cut through the single-ply roof membrane.

FM Global Property Loss Prevention Data Sheet 1-28,[6] (which is based on ASCE 7-05), offers very similar information to that presented in ANSI/SPRI WD-1, where precalculated charts of uplift pressures based on building location and height are included. FM Global's beginning pressures are typically higher, because in their calculation, they classify all of their buildings as the highest category or importance factor, even if they are not hospitals or schools.

In addition, they also include a safety factor, so the end-result pressures are higher. Note: Though these calculations are not required by the IBC, they are required for FM Global-insured buildings. As a recommendation, FM 1-28 should only be used in association with FM Global-insured buildings, and the calculation of the uplift pressures should be completed by an FM Global engineer. After all, they are insuring the building and enforcing their published enhancements, which are not required by the IBC, so they should be the responsible party to assist the design professional.

This author's recommendation is that if the building being specified is not FM Global-insured, that FM Global should not be listed or referenced in the specification, for who would be available to confirm that the installation of the roof assembly will meet the FM Global installation criteria? Material manufacturers can assist in certifying that their assembly has been rated by FM Global and would meet the uplift pressure results, but they only inspect for their warranty criteria, not FM Global installation criteria.

Along with publishing their own calculations and installation criteria, FM Global also does its own testing following standard FM 4470, which includes ANSI/FM 4474. FM 4470 is more than just testing for uplift, it includes tests involving internal and external fire, hail, foot traffic, seam, and fastener corrosion testing. FM Global labels its tested assemblies based on the uplift rating, such as FM Class 1-90 SH. The "90" listed in this rating means the assembly is rated up to 90 lbs./sq. ft. of uplift pressure, not a 90-mph wind speed.

So the answer to the first two questions:

- Does 90 lbs./sq. ft. of uplift equal 90 mph?
- Does an FM Global-rated assembly of 1-90 equal 90 mph?

...is, no, they do not.

Figure 8 – Wind effects on a building (National Weather Service Weather Forecast Office).

The basic wind speed is one factor in the calculation in determining uplift but not the sole concern. The requirement is to prove that the specified assembly has been tested and rated accordingly for the specific building calculated uplift pressures.

Because uplift pressure is so critical in determining the correct roofing assembly, some specifiers have attempted to make ASCE 7 or calculated uplift results included in the warranty. What needs to be understood is that the calculations are static, and the pressure applied in the laboratory test ANSI/FM 4474 is perpendicular to the roof assembly and nondynamic. The calculations and testing do give guidance to a designer on proper installation, but common sense points to the fact that buildings receive wind pressure from many directions and locations other than just the exterior across the roofing assembly. These additional wind pressures can infiltrate into the assembly unintentionally, causing unexpected failures if the building is not properly designed and installed. Most people understand that these conditions are outside of the roofing material manufacturer's control, and most membrane manufacturers have this clarified under the warranty limitation. Even so, because of all the uncontrollable variables, it becomes very difficult for a material manufacturer to define what the warranty is responsible for if uplift is included. I have found one warranty that attempts to warrant uplift, but it includes the following statement if wind damage should occur: "At the building owner's expense, a report from a licensed engineer certifying failure was not caused by wood blocking, decking, or other building components must be submitted."

Most of the failures within a roof assembly after a major wind event will be from other forces, such as flying debris causing damage to the roof assembly, breaking outer surfaces or windows, weak design of metal edging or coping, etc., which will allow additional pressure to be introduced into the assembly (*Figure 8*). Though ASCE 7 is a good method, it is a standard used throughout the U.S. and other parts of the world and does not address every variable the design professional would need to be concerned about. This is one of the reasons that safety factors are promoted, but these safety factors are applied to the roof assembly but may not be applied to other components that might fail and cause the roof system to fail. Just as the IBC is the minimum criterion for a building, common sense and experience need to be applied to any building design, not a warranty. If surveyed, one would discover that most manufacturers will not cover uplift forces, but most will include wind coverage in some fashion within their warranties.

No.	Category	Miles Per Hour
7	Moderate Gale (near gale)	32-38
8	Fresh Gale (gale)	39-46
9	Strong Gale	47-54
10	Whole Gale (storm)	55-63
11	Storm (violent storm)	64-72
12	Hurricane	73-136

Figure 9 – Partial Beaufort wind speed scale.

WIND SPEED LISTED ON A ROOFING SYSTEM WARRANTY

Though IBC requires the specifier to determine the correct roofing system design by comparing calculated uplift pressures with test-rated pressures, the document does not require that a building owner obtain a warranty or guarantee from the manufacturer.7 None of the building code standards mention a warranty being required. Seldom, if ever, do building owners require other components of the building to carry a wind speed warranty (i.e., roof deck, walls, windows, etc.), yet all of these building components must meet the pressures indicated in ASCE 7. In contrast, if, after a storm event, the siding of the building is damaged, the building owner will turn to his insurance company, not the siding manufacturer.

So if few other component manufacturers offer wind speed warranties, why do most roofing material manufacturers?

When single-ply roofing manufacturers entered the industry, they had to differentiate themselves from more traditional and well-known built-up roofing (BUR) material. To do this, they had to offer something as an incentive that BUR did not offer, which at that time was simply bonded through the contractor. So they offered a roof warranty; and, eventually, wind coverage was included.

Deciding on how they wanted to list wind speed in the warranty, they first used terms such as “strong gale-force winds,” which came from the Beaufort wind speed scale. Even today, some manufacturers use “strong gale-force winds” or “windstorms” to define their wind coverage. The partial Beaufort wind speed scale chart in *Figure 9* shows “strong gale-force” starts at 47 mph, while “windstorm” starts at 64 mph. Though material manufacturers use these terms in correspondence to their wind speed coverage, the scale was originally based on the nautical term “knots,” which were converted to wind speeds at 10 meters above sea level.

As other roofing material manufacturers included wind speed coverage, some roofing material manufacturers had to consider how they could again place themselves apart, so some started to put the actual numerical wind coverage on the warranty in miles per hour. At first they only offered coverage up to 55 mph, which is a step above “strong gale.” When this number became common, it was decided by some manufacturers to up it to 72 mph—1 mph less than a hurricane.

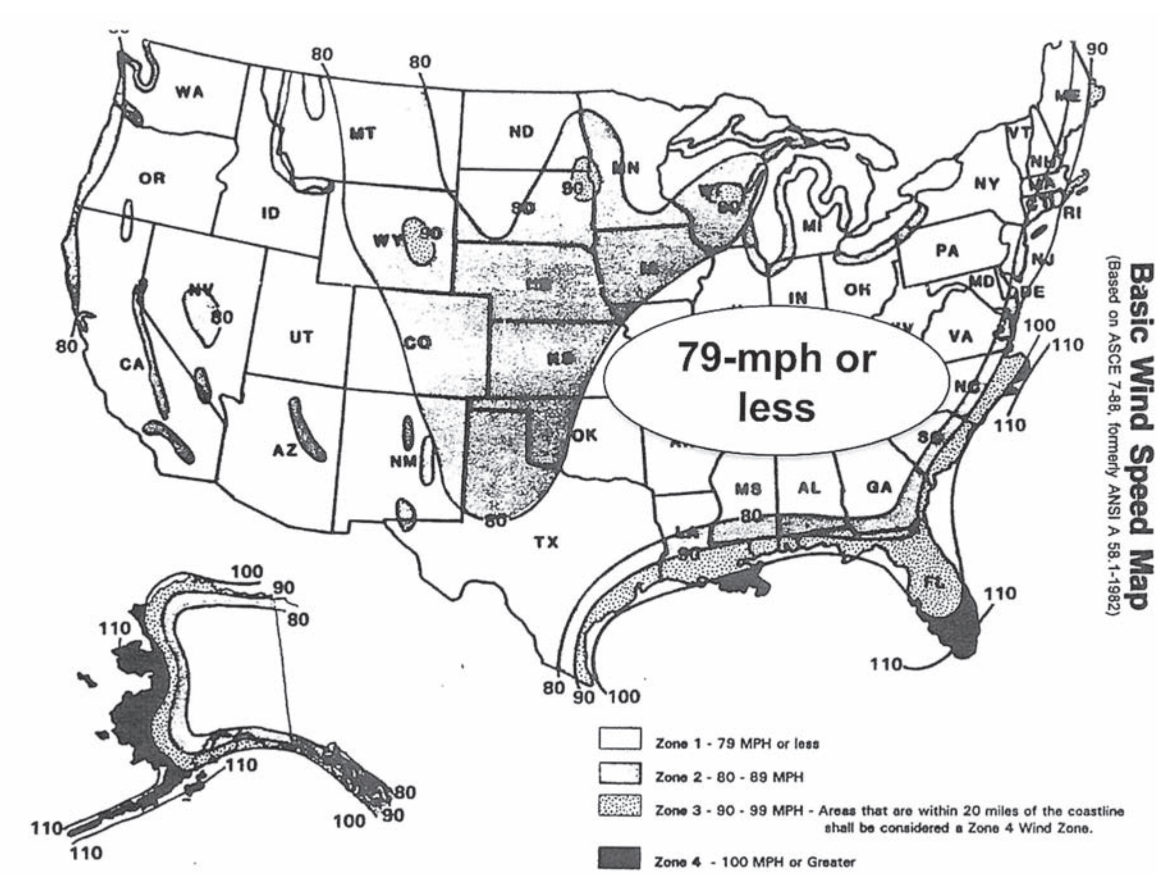


Figure 10 – Basic wind speed map, ASCE 7-88.

As some roofing material manufacturers played the warranty game, ASCE 7 was being used more and more, including a revision of the ASCE 7-05 wind speed maps from “fastest mile” (*Figure 10*), where most of the U.S. was shown to be 79 mph or less, to “3-second peak gust wind” (*Figure 11*), which shows most of the U.S. is 90 mph.

When this document changed, specifiers and building owners began to notice their buildings were located in a 90-mph wind zone, and the warranty listed only 55 mph. They started to question the material manufacturer to learn why they were not getting 90-mph coverage, even though the system was installed following the correct uplift rating.

In an attempt to minimize this confusion and again to separate from the competition, some roofing material manufacturers started offering 90-mph and greater wind coverage. Even today, with the latest version of ASCE 7-10 and the new wind speed maps, specifiers are asking why they cannot get even higher wind speed coverage (*Figure 12*).

When a request for a high wind speed is specified, typically manufacturers attempt to incorporate stronger, more-durable products, because though they are membrane roofing manufacturers and not insurance companies, they need to limit their liability as much as possible. These products might incorporate any or all of the following: a stronger facer on the polyisocyanurate, a thick cover board, additional fastening requirements, stronger adhesives, and thicker and specialty-type membranes.

Building owners and specifiers hope that by specifying a higher wind speed warranty, they will receive a more durable system. Though in most instances this is true, the assumption that all manufacturers offer the same warranty coverage is incorrect. Since manufacturers' warranties are marketing tools to assist in selling the materials, the roofing manufacturers can control their coverage of the wind speed by how they write the warranty.

Owners and specifiers both need to be aware of the many different terms that are used and what assemblies could be offered that would be durable. They should not assume that warranty length and wind speed coverage dictate sustainability. Upon reading through the warranties, one will learn that some offer very good coverage, while others are written so that very competitive assemblies can be installed without offering any coverage in the warranty.[8]

Here are some terms that are actually used in warranties today. The numbers in parentheses show the related wind speeds in mph; but typically, they are not defined as to where they might be measured or the measurement of time (fastest mile or 3-second peak gust wind speed):

- No mention of a wind speed (0 mph)
- "Windstorms" (64-72-mph)
- "Full gale-force" (46 mph)
- The actual wind speed printed from 38 to 120 mph
- "Gale force" (46 mph)
- Beaufort wind scale #8 (46 mph)
- "Gales excluded" (31 mph)
- "Capped at 38 mph"
- Wind speed coverage prorated (loses a portion of the wind coverage every year)

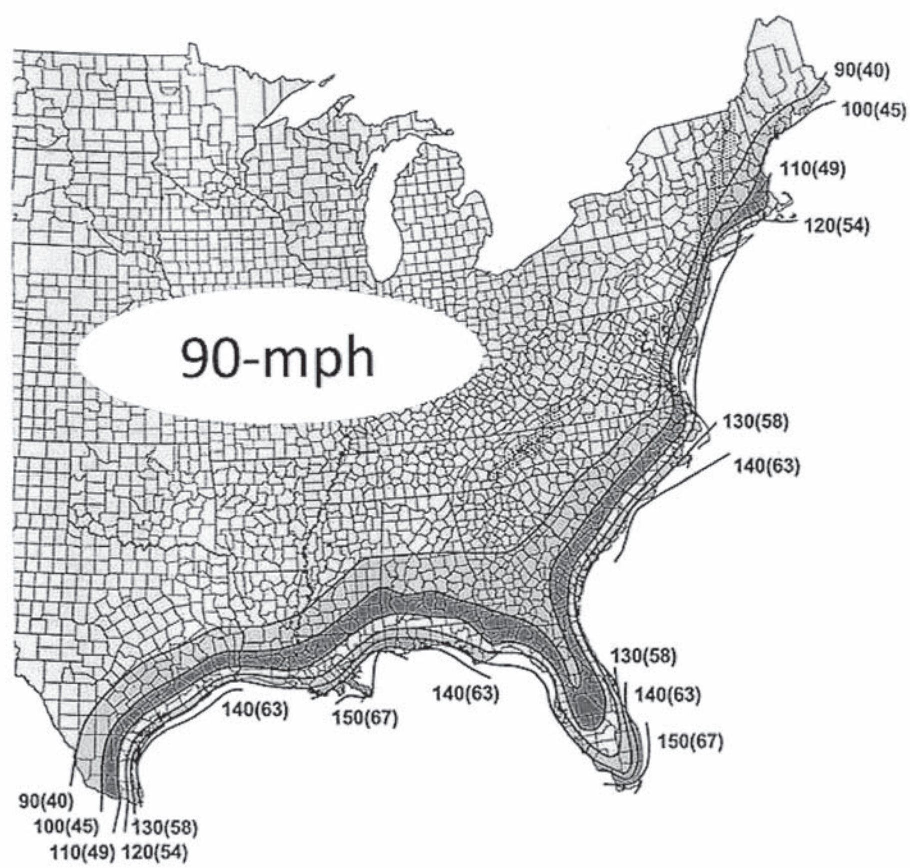


Figure 11 – Basic wind speed map, ASCE 7-05.

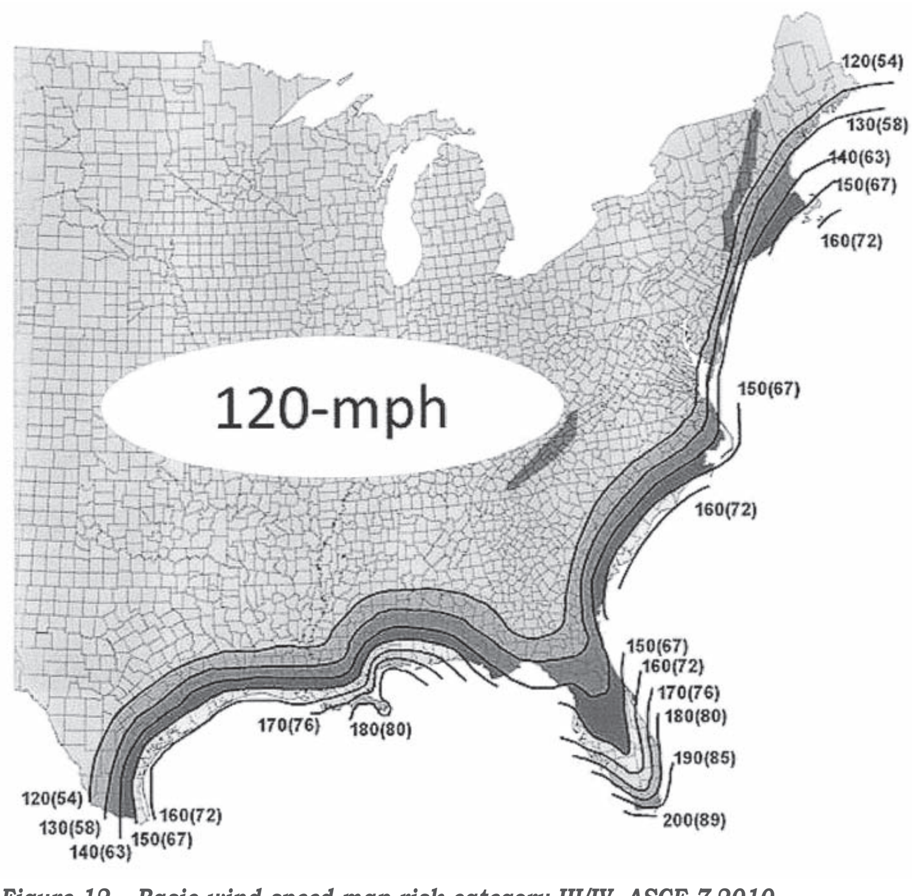


Figure 12 – Basic wind speed map risk category III/IV, ASCE 7-2010.

Rooftop Wind Speed

Exposure "C"

Ground Wind Speed (10m or 33-ft)

Building Height (ft.)	55	72	80	90	100
75	86	112	124	140	155
120	90	118	130	146	163
200	95	124	137	155	172
300	100	130	144	162	180
400	102	134	148	167	185

$Vr = 0.854 \times W^{0.985} \times H^{0.108}$

(Calculations developed by UBC and converted to Peak Gust Winds in MPH)

Figure 13 – Rooftop wind speeds, Uniform Building Code.

In combination with these terms, "where the wind is measured" can be written into the warranty:

- "Ground wind speed" = 33 ft.
- "Rooftop wind speed" = building height
- No mention = allowing the manufacturer to decide at the time of the wind event

Where the wind speed is measured can be important when one considers that the higher the roof area is, the greater the wind speed will be. Remember that ASCE 7 specifies that building height is one of the five factors in determining the correct uplift. Though most warranties are measured at "ground wind speed," which is defined as 33 ft. (10 m) from the ground surface (the same height at which airports and the ASCE 7 basic wind speed is measured), some warranties have the phrase "rooftop wind speed." As an example, if the building has a 300-ft.-high roof area and the warranty lists a 100-mph "rooftop wind speed," the "ground wind speed" would be 55 mph. In reverse, a 100-mph "ground wind speed" warranty would actually cover winds up to 180-mph at that height (*Figure 13*). Note that this is wind speed vs. wind speed and has nothing to do with uplift in lbs./sq. ft.

For warranty coverage, the higher the roof area, the greater the wind speed, so if you are considering wind speed coverage, "ground wind speed" offers better coverage on a higher building.

With so many options available from assemblies to warranty coverage, the building owner will need to be assisted on what first would be a durable assembly for his building and location, and compare this with good coverage by a warranty (not the other way around or just a number in miles per hour). The assembly also should be assessed outside of warranty considerations, so when contractors go through the bidding process, items are not clouded by different promises.

The request for higher wind speeds beyond the minimum a material manufacturer would offer should be incorporated into the "warranty" section of the Division 7 roofing specification. The "quality assurance" and the "performance" sections make sure that the roof system will meet the building code, so any reference to wind speed would be related to ASCE 7 calculations, not warranty criteria. The warranty section is what is being requested from the roofing material manufacturer. If the specifier does not list any additional wind coverage in the warranty section, material manufacturers can default to their minimum offered wind speed coverage. As long as the desired warranty wind speed is listed in the warranty section, the specifier will know that the contractors will bid as instructed, based on the material manufacturer's criteria for that warranty.

Another common question is how much uplift does a 90-mph warranty offer?

Though we could do the math backwards, it doesn't really mean anything, because there is no test a manufacturer can do that would actually rate the assembly in mph. So there is no method to determine a verification of the roofing assembly in mph that would be equal to or greater than the basic wind speed in mph. As stated earlier, the basic wind speed is one factor out of five in the uplift calculation in lbs./sq. ft. This is the reason we use ASCE 7—so that a comparison and verification can be completed in lbs./sq. ft.

So what is the relationship between basic wind speeds based on ASCE 7 and warranties?

Since most manufacturers do not or will not include code compliance or uplift performance within the coverage of the warranty, the answer is none. If a manufacturer is willing to include this type of coverage, the owner should read the warranty very closely and understand everything that is being offered.

Uplift Pressures ≠ Wind Speed on a Warranty

The warranty wind speed offered by roofing material manufacturers is not based on uplift ratings. Ratings are results from static laboratory tests that could last only 5 to 10 minutes—possibly more, depending on the strength of the assembly. A 20-year warranty has approximately 1,051,200 ten-minute increments, which, if one thinks about it, is a lot of responsibility for a 10-minute test. When deciding on wind speed coverage, a roofing materials manufacturer considers basically two factors:

1. How can more durable products be incorporated into the assembly and still be competitive?
2. More importantly, has the material manufacturer installed a similar project and did it perform historically well?

SUMMARY

In conclusion and to show how simple the process is for determining the correct roofing assembly for a specific building:

1. Determine the building "uplift pressure" using ASCE 7 calculations, which should be completed by a locally licensed or qualified design professional.
2. Review the roofing assembly's "reported pressure" collected from the manufacturer results and rat-

ings from ANSI/FM 4474 or other test methods listed in the IBC.

3. Compare and verify the "correct assembly." Reported pressures must be equal to or greater than the calculated pressures. If the design professional wishes to consider a safety factor of his choosing, this is where it would be considered—be it to multiply the factor by the ASCE 7 results or by dividing the reported assembly pressures.

After these three basic steps are completed, the designer can look at the products and assembly details to see what could be enhanced beyond the building code for the building owner's needs.

Once the assembly has been decided, warranties should be considered and read thoroughly to confirm that the wind coverage meets the building owner's needs and is easily understood. Keep in mind: When higher wind speed coverage is requested from the material manufacturer, additional enhancements may be necessary to qualify for the warranty. When required, these additional enhancements will likely increase the cost of the total assembly and may increase the cost of the warranty being purchased.

One way to mitigate the cost to a building owner, after determining the uplift pressures and the preferred roofing assembly, is to specify the higher-performing products and details associated for higher wind speed warranty assemblies, but only request from the manufacturer a lower wind warranty to avoid the additional cost of the warranty for that higher wind speed.

Bear in mind, if we related this process to baking cupcakes, the ASCE 7 would be a recipe, while the roofing assembly would be the batter. Mixed together and baked (roof assembly installed), we have a nice tasty cupcake, but a cupcake is also covered with icing (the warranty). The choice of a type of wind speed warranty coverage can be made with the realization the icing on the cupcake isn't necessary to hold the cupcake structure or the roof together. This should assist in turning the focus away from warranties and looking more directly for quality and durable roofing assemblies and installation.

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