Does ASCE 7-16 Really Change Everything?

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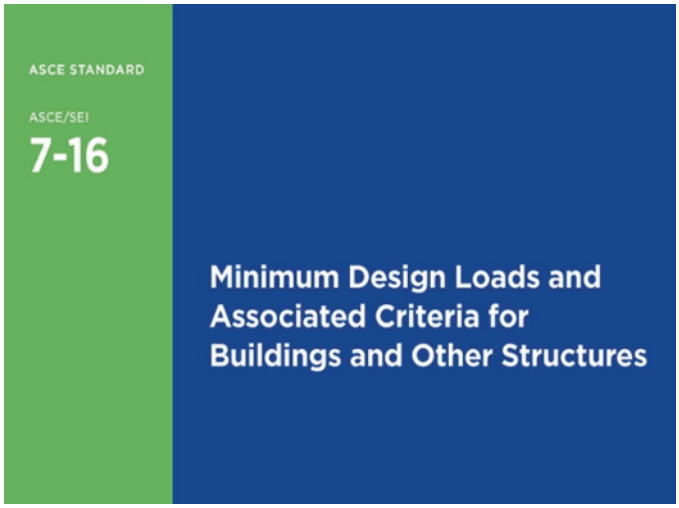
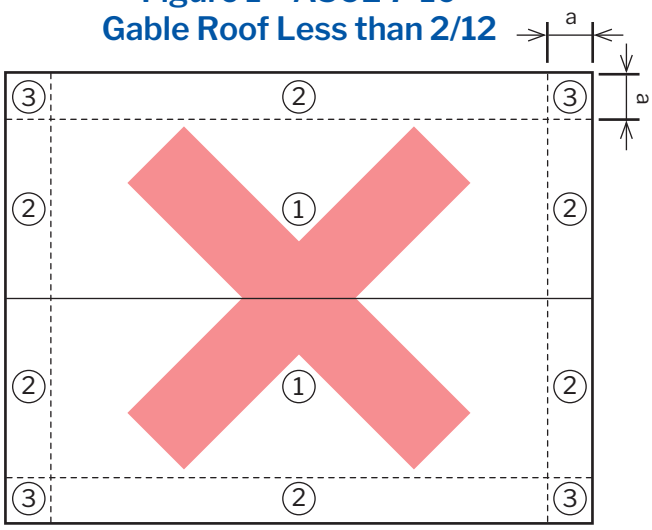


Obviously, ASCE 7-16 doesn't change everything. But it does change *almost* everything about how we attach roof coverings. More specifically, it changes the uplift (or negative pressures –referred to as "pressures" in this article) that roof coverings are required to resist. ASCE, the American Society of Civil Engineers, creates the structural standards that are referenced in the major building codes. ASCE 7 is called the *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*. That's a mouthful. The 7-16 is due to the year it was promulgated. A slightly modified version of ASCE 7-16 is the most recently adopted version in the Florida Building Code (FBC) 7th Edition (2020) that goes into effect December 31, 2020. All roof coverings except asphalt shingles and metal shingles will be impacted. Asphalt shingles use the FBC's Classification of Asphalt shingles Table 1507.2.7.1 (R905.2.6.1). Metal shingles use the FBC's Classification of Metal Roof Shingles Tested in Accordance with ASTM D3161 Table 1504.3.3 (R905.4.4.1). These tables use wind speed in miles per hour (mph) instead of pressure. All other roof coverings and roof systems must meet the FBC's requirements for components and claddings in ASCE 7-16. ASCE 7-16 didn't change the wind speeds, however it did change the coefficients used in the calculations that generally increases the pressures. The information included here should allow you to determine the proper pressures on most jobs without doing the actual calculations.

Low slope roof systems are where most contractors became familiar with roof pressure zones. For many decades we had three zones: corner (3), perimeter (2) and field (1). Corner zones (square shaped areas on outside corners) were the same depth (distance extending in from the edge) as the perimeters (rectangular shaped areas between corners) and everything else was field. This was the approach used in ASCE 7-10 which defined these as: Gable Roofs 0 ≤ 10 degrees (less than 2/12) and was used for the past several FBC code cycles (see figure 1).

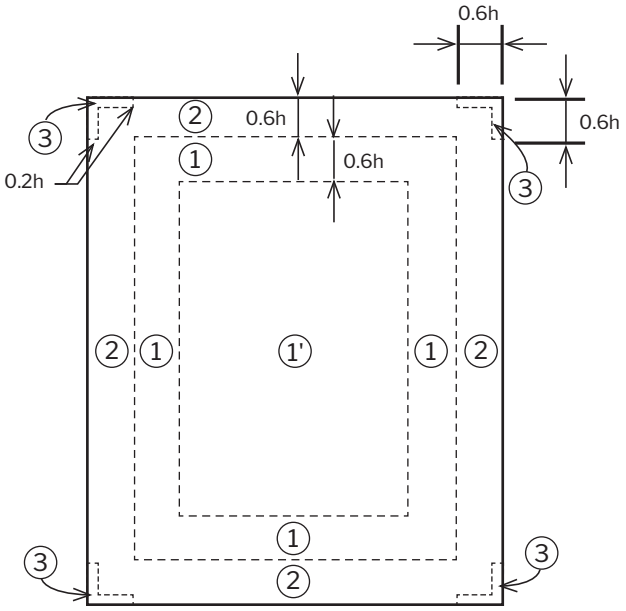
Figure 1 – ASCE 7-10 Gable Roof Less than 2/12



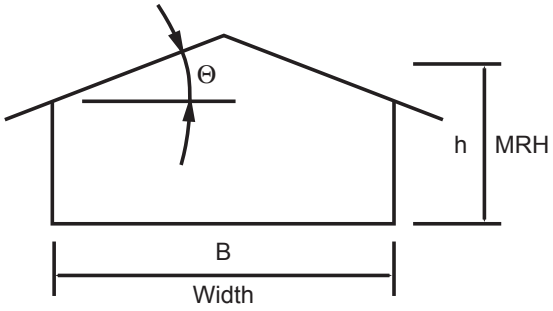
The zones for low slope roofs are more complex in ASCE 7-16. First, they are now defined as: Gable and Flat Roofs 0 ≤ 7 degrees (less than 1.5/12), Zone 3 (corners) are now L-shaped and the depth is equal to 20 percent of the building height. The length of the L is equal to 60 percent of the building height. These are the areas that have the highest pressures and will require additional attachment. Zone 2 (perimeter) will extend further into the roof and inside the corner zones. The depth of Zone 2 is equal to 60 percent of the building height. Zone 2 will have the second highest pressure and will also require additional attachment. Zone 1 is located inside of Zone 2. The depth of Zone 1 is also equal to 60 percent of the building height. This is considered the base zone for the required uplift resistance. ASCE 7-16 has a new zone referred to as Zone 1 prime or 1', also called the interior zone. If the building height is relatively low when compared to a fairly large footprint, the roof may have this Zone 1'. Zone 1' will have slightly lower pressures than Zone 1 (see figure 2, next page).

Depending on the height and outside dimensions the layout of the zones can vary greatly (see figure 3, next page).

Figure 2 – ASCE 7-16
Gable and Flat Roofs 1.5/12



Mean Roof Height

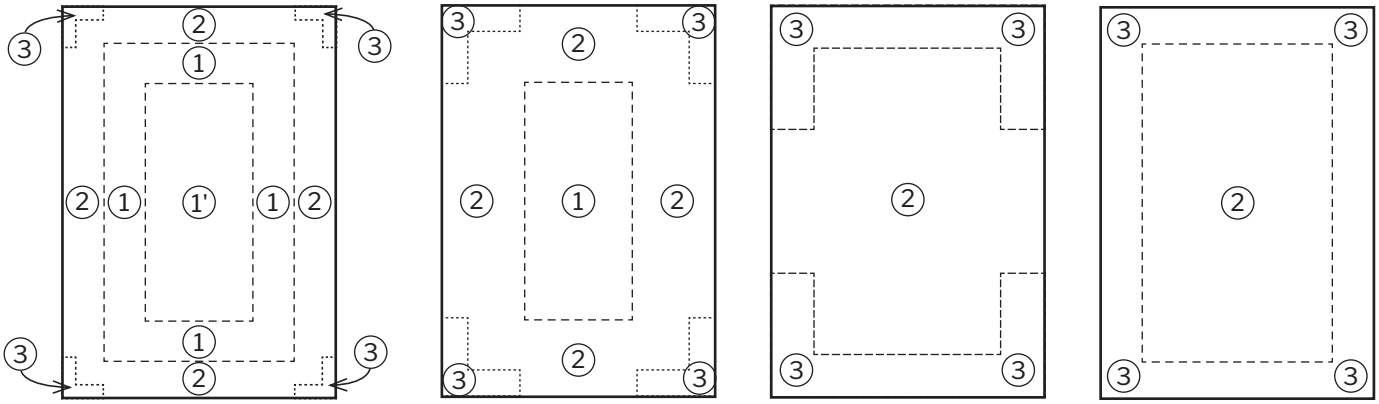


B = Horizontal dimension of the building in feet.

h = Mean Roof Height (MRH) in feet (eave height plus ridge height divided by 2).

Θ = Angle of roof plane from horizontal (slope or pitch).

Figure 3 – ASCE 7-16



Buildings with least horizontal dimension greater than 2.4h.

Buildings with least horizontal dimension greater than 1.2h but less than 2.4h.

Buildings with least horizontal dimension less than 1.2h and largest horizontal dimension greater than 1.2h.

Buildings with largest horizontal dimension less than 1.2h.

Under ASCE 7-10, gable shaped roofs with slopes greater that 1.5/12 (7 degrees) to 12/12 (45 degrees) used the same three zones as low slope roofs described above (see figure 4, page 20).

Under ASCE 7-10, hip-shaped roofs with slope greater that 1.5/12 (7 degrees) to 6/12 (27 degrees), also used the same three zones as low slope roofs described above (see figure 5, page 20).

With ASCE 7-16, it is considerably more complex. For roofs with slopes from 1.5/12 (7 degrees) to 12/12 (45 degrees), there are also new zones. For gable roofs, there are now six zones: 3r, 3e, 2e, 2r, 2n and 1. Zone 3r (r = ridge) typically sees the highest pressures. These are significantly higher than under ASCE 7-10 for the same roof areas. Zones 3e (e = eave), 2e, 2r and 2n (n = neutral) see intermediate pressures. The severity can interchange between zones depending on mean roof height, roof slope and building dimensions. Zone 1 sees the least amount of pressure (see figure 8, page 22).

For hip roofs under ASCE 7-16 there are now four zones: 3, 2e, 2r and 1. Again, Zone 3 sees the highest pressures. Zones 2e and 2r see intermediate pressures. Zone 1 sees the least (see figure 7, page 20).

You can see that an understanding of how these zones are defined and configured is critical for installing roof systems that meet the building code requirements. Hopefully, the above information and

diagrams have helped with this.

The next step is to determine the pressures that need to be resisted in these zones and how to get that information. With new construction, this information should be shown on the plans. This should include the size and locations of the zones. Make sure you are looking at the values for components and cladding. These should be for V_{asd} –Allowable Stress Design (ASD) which is 60 percent of the V_{ult} – Ultimate Stress Design (ULT). This is due to the Design Wind Speed Conversion in the standard. More on ASD and ULT later.

Figure 4 – ASCE 7-10
Gable Roofs 1.5/12 to less than 12/12

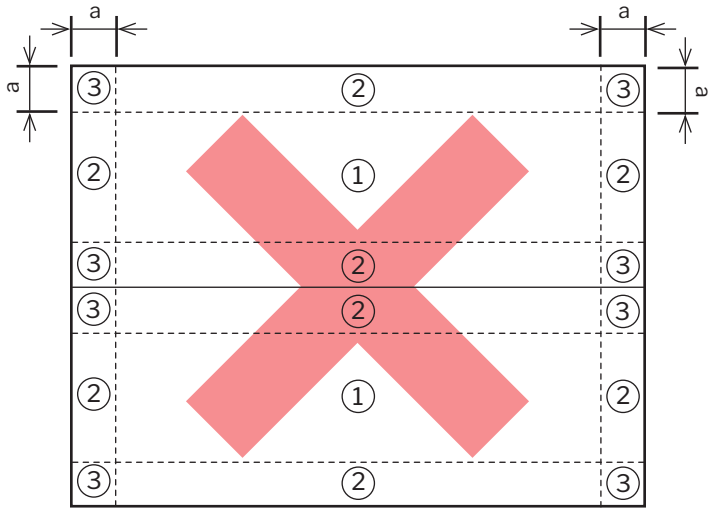


Figure 5 – ASCE 7-10
Hip Roofs 1.5/12 to less than 6/12

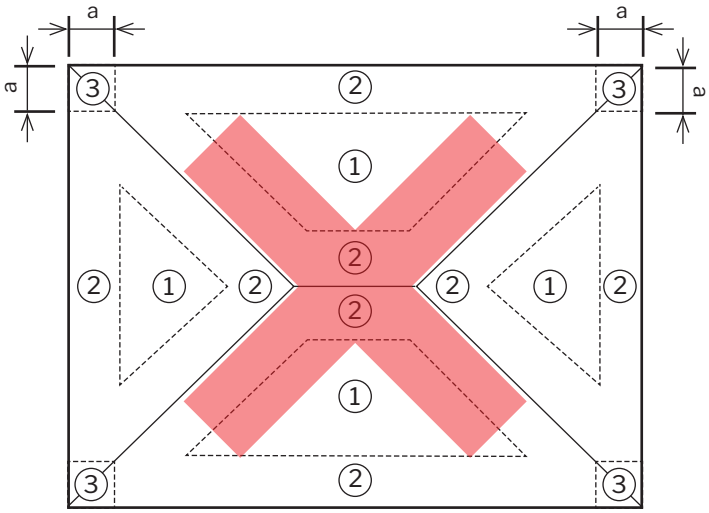


Figure 6 – ASCE 7-16
Gable and Flat Roofs
1.5/12 to less than 12/12

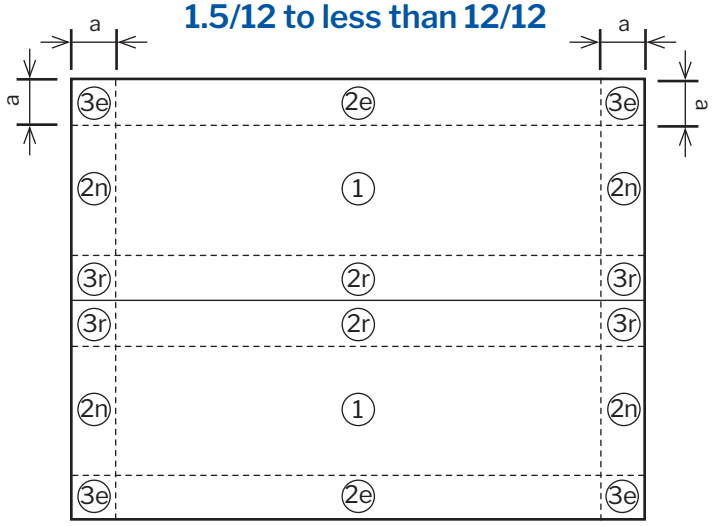
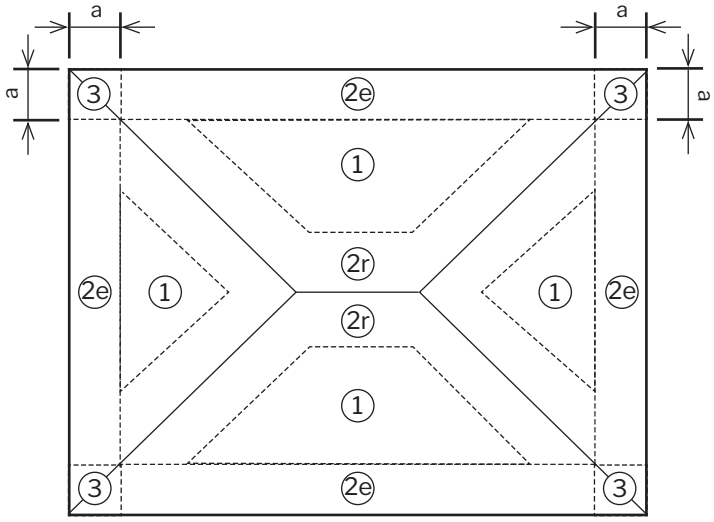


Figure 7 – ASCE 7-16
Hip Roofs 1.5/12 to less than 12/12



What about reroofing? If you are the prime contractor on the alteration (a reroof is a Level 1 alteration) then you must have a way to establish this information. Roofing contractors are very fortunate to have some great free resources available to help figure this out. Before we can get the results, we need to have general information about the specific job.

These include:

- Job address including the county
- Roof shape (flat, gable or hip)
- Roof slope or pitch (rise in run or degrees)
- Mean roof height (eave height + ridge height / 2)
- Building width and length (not including overhangs)
- Risk Category (I, II, III or IV)
- Exposure Category (B, C or D)
- Roof system type
- Applicable design wind speed for the site

Let's start with risk categories I, II, III or IV. The risk categories are based on use or type of occupancy of the building.

- **Risk Category I** – low risk: temporary, storage or agricultural facilities, etc.
- **Risk Category II** – typical buildings: homes, apartments, stores, offices, manufacturing and warehouses, etc.
- **Risk Category III** – substantial hazard: most schools, high occupancy buildings, nursing homes and other important buildings that are not risk category IV.
- **Risk Category IV** – essential facilities: medical facilities with surgery or emergency services, fire and police stations, emergency shelters and emergency operation centers, etc.

Understanding which risk category applies to your building will allow you to find the proper design wind speed map or enter that information in the programs we will discuss later. Once you have the proper map, you can find the site location and follow the contour lines to find the design wind speed (see figure 8). You can interpolate between the wind speed but keep in mind that some counties use the higher wind speed for the entire county. This is sometimes true even for counties that are split by wind speeds contours.

Hazards by Location

ATC Hazards by Location (https://hazards.atcouncil.org) is a great free tool that will allow you to enter an address and then it will produce a windspeed and wind map for that location. The wind speed is shown based on the risk category I, II, III or IV. Remember, it will usually be category II. The map makes it easy to see the next higher windspeed contour line. You can use this windspeed to be conservative (safe).

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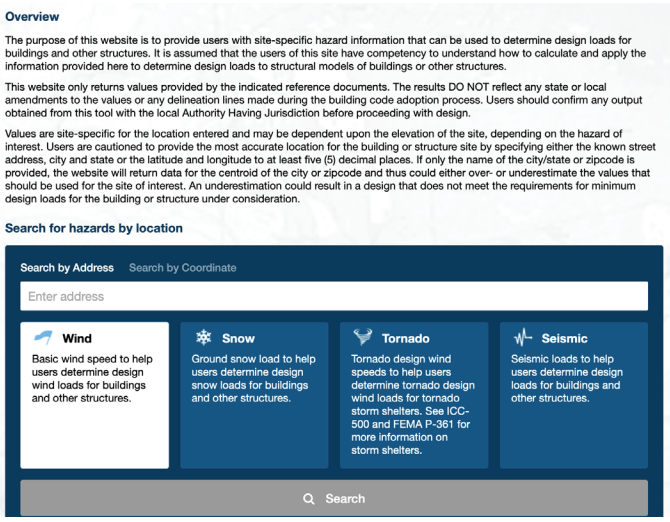
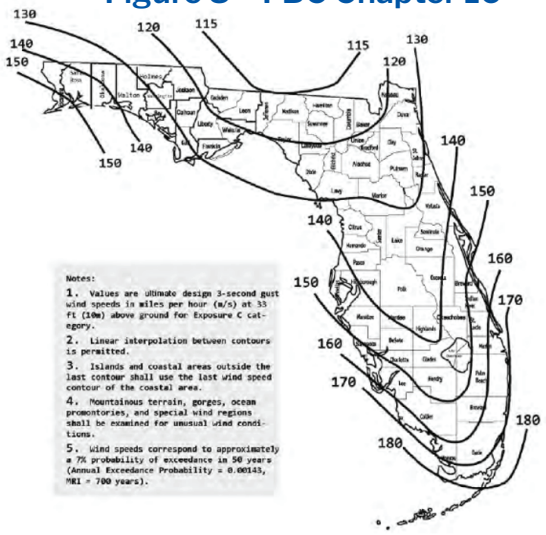


Figure 8 – FBC Chapter 16



It also states whether or not you are in a wind-borne debris region. Note the wind speed and risk category for the next step. Save the report for your job file.

We now have our appropriate windspeed, but before we can move on to the next website that will give you a final report, you will need another piece of information. What exposure category is the building in?

The exposure categories are B, C and D. They are based on surface roughness, which are also categories B, C and D.

- **Surface Roughness B** – urban and suburban areas, wooded areas or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger.
- **Surface Roughness C** – open terrain with scattered obstructions having heights generally less than 30 feet. This category includes flat open country and grasslands.
- **Surface Roughness D** – flat unobstructed areas and water surfaces. This category includes smooth mud flats, salt flats and unbroken ice.
- **Exposure B** – shall apply where surface roughness B prevails in the windward direction for a distance of at least 2,600 feet or twenty times the height. For buildings whose mean roof height is less than or equal to 30 feet, the upwind distance may be reduced to 1,500 feet.
- **Exposure C** – shall apply for all cases where Exposure B or D does not apply.
- **Exposure D** – shall apply where surface roughness D prevails in the upwind direction for a distance of greater than 5,000 feet. Exposure D shall also apply where the ground surface roughness immediately upward of the site is B or C and the site is within a distance of 600 feet or 20 times the building height, whichever is greater, from an Exposure D condition.

Generally, most typical sites will be Exposure B. Areas that adjoin ponds and lakes, golf courses etc. may be Exposure C. Others that are on open water, such as oceans, gulfs, bays and larger lakes – or perhaps a highway or runway – will probably be Exposure D. If in doubt, use the next higher exposure category to be conservative. Make a note of the exposure category you've decided on.

If you are installing a tile roof covering, refer to the *6th Edition of FRSA-TRI Florida High Wind Concrete and Clay Tile Installation Manual* or the *High Velocity Hurricane Zone (HVHZ) Roofing Application Standard (RAS) 118, 119 or 120*.

For other than tile and the shingle roofs mentioned earlier, the final step is finding the size of the roof zones and their pressures. Again, we have a great free tool to help us: NRCA provides www.roofwinddesigner.com. With the information we now have, we can go on the site and set up an account (a very simple process). Once that's done, enter a roof area name (main roof, etc.), job name, address, city, county and zip code.

Then enter the building length, width, mean roof height, roof configuration and slope and parapet walls if applicable.

Next enter the building configuration: enclosed or open (note: partially enclosed buildings will require additional engineering calculations). Most typical buildings are considered enclosed.

The Exposure Category B, C or D is then entered.

The Risk Category I, II, III or IV (usually II) is entered next.

Then enter the wind speed from the wind maps or from the ATC site prepared earlier.

And finally, the roof deck type and roof covering type need to be entered.

The site is user-friendly and will provide much of the information needed to make the proper decision for your entries. You can also save your jobs on the site for future use. Many thanks to NRCA.

Once this is done, you will be able to generate a great report. It will give you the size of the zones (shown as "a") and the appropriate pressures. Make sure to use the V_{asd} – allowable stress design (ASD) portion of the report. Print the report for your files.

The information you now have will allow you to

match the required pressures to your roof system attachment for the appropriate roof zones. You can get this from the FBC's Product Approval or Miami-Dade Notice of Acceptance (NOA). Or, request the attachment requirements from the manufacturer for the appropriate base area (Zone 1) pressure. This information should show that the system was tested up to a specific pressure and the attachment needed. As long as the resistance to pressure meets or exceeds the required pressure you are good to go. In most cases you can extrapolate (increase accordingly) the amount of attachment for the zones with higher pressure.

I know this is complex stuff. Believe me, I know! This is the world we live in. So, ASCE 7-16 doesn't really change everything: we will still use adhesives and fasteners, just more of them in different places. If you are a roofing contractor who wants to install code-compliant roof systems, an understanding of ASCE 7-16 is critical. I hope this information helps. The approach described is not by any means the only way to get there, but it is a way that I think we can work with and learn to understand.

FRM

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ASCE 7-16 Notes

Applies to all roof coverings except asphalt shingles and metal shingles
Wind speeds did not change between ASCE 7-10 and 7-16
but the coefficients used in calculations increased pressures

V_{asd} – Allowable stress design

V_{ult} – Ultimate stress design

B – Horizontal dimension of the building in feet.

h – Mean Roof Height (MRH) in feet (eave height plus ridge height divided by 2).

Θ – Angle of roof plane from horizontal (slope or pitch).

Roof Zones

r – ridge

e – eave

n – neutral

Risk Categories

Risk Category I – Low risk, temporary, storage or agricultural facilities, etc.

Risk Category II – Typical buildings – homes, apartments, stores, offices, manufacturing and warehouses, etc.

Risk Category III – Substantial hazard – most schools, high occupancy buildings, nursing homes and other important buildings that are not risk category IV.

Risk Category IV – Essential facilities – medical facilities with surgery or emergency services, fire and police stations, emergency shelters and emergency operations centers, etc.

Online Tools

ATC Hazards by Location
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NRCA Roof Wind Designer
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Exposure Categories

Surface Roughness B – Urban and suburban areas, wooded areas or other terrain with numerous closely spaced obstructions having the size of a single-family dwelling or larger.

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