ASCE 7-16 Wind Provisions

"How They Affect the Practicing Engineer"

Donald R. Scott, P.E., S.E., F.SEI, F.ASCE
Senior Principal, PCS Structural Solutions
Chair, ASCE 7-16 Wind Load Subcommittee
Chair, NCSEA Wind Engineering Committee

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- The Washington Post

  "The U.S. coast is in an unprecedented hurricane drought – why is this terrifying"

  - Average Year in US
    - 26,000 Severe Storms
    - 6 Atlantic Hurricanes
    - 1,300 Tornadoes
    - 5,000 Floods
  - Statistics
    - Since 1980 there have been 650 windstorm related deaths and $15B in losses
    - 4 out of 5 Americans live in counties that have declared weather-related disaster areas in the past six years.

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- The Washington Post
  - *"Hurricanes, large and small, have eluded U.S. shores for record lengths of time. As population and wealth along parts of the U.S. coast have exploded since the last stormy period, experts dread the potential damage and harm once the drought ends."*

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- The Washington Post
  - *"It's only a matter of time before the luck reverses and storms start bombarding the U.S. coast again."*
  - *"Hurricanes are going to hit the U.S. again and people are going to be shocked by the magnitude of the disaster," said Roger Piekle Jr., professor of environmental studies at the University of Colorado at Boulder.*

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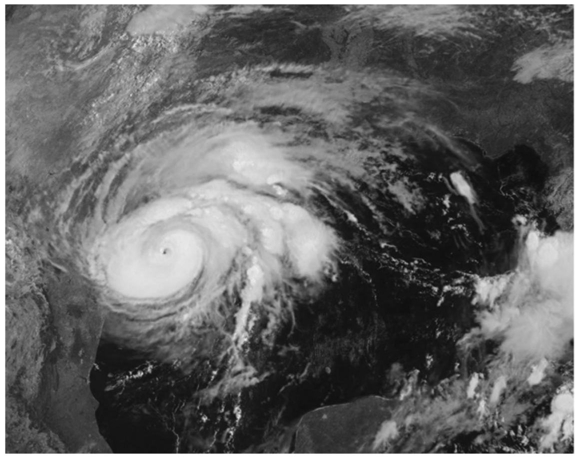

Hurricane Harvey

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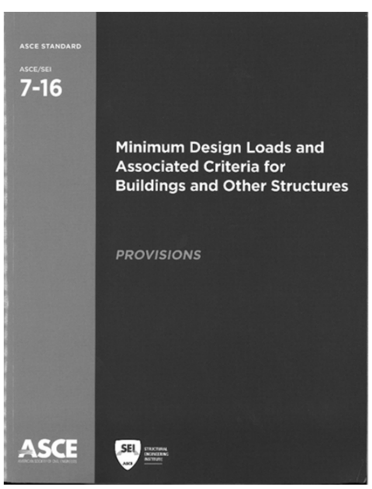

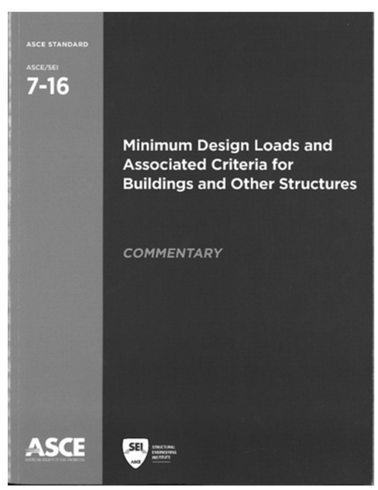

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- ASCE 7-16
  - ASCE WLSC Process
  - K_e Elevation Factor
  - Canopies
  - Rooftop Solar Arrays
  - Tornado Commentary
  - Updated Maps / New Map for Category IV Structures
  - Updated C&C Roof Pressure Coefficients

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- ASCE 7-16
  - Assembled Committee in 2012
  - 85 total membership
  - 98 proposals considered over 8 ballots

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- K_e – Elevation Factor
  - In Commentary for previous editions.

Ground elevation above sea level		Ground elevation adjustment factor
ft	(m)	Ke
0	(0)	1.00
1000	(305)	0.96
2000	(610)	0.93
3000	(914)	0.90
4000	(1219)	0.86
5000	(1524)	0.83
6000	(1829)	0.80

  - K_e permitted to always be taken as 1.0

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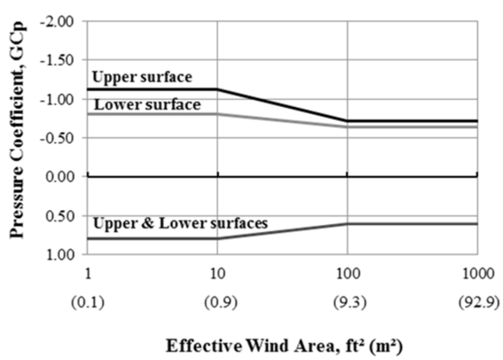
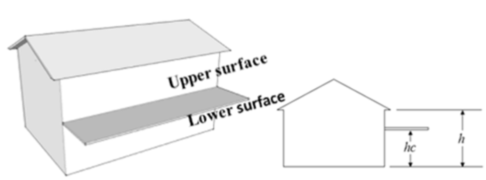
- Canopies





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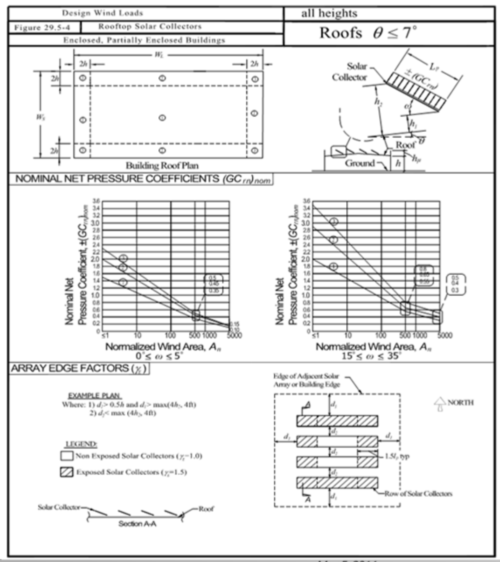
- Rooftop Solar



May 5, 2014

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- Tornado Commentary
  - Tornadoes not considered in the body of the standard because probability of strike of a EF0 or EF1 in the central US is in the order of a 4,000 MRI event.
  - For a EF4 or EF5 strike the probability of a particular building being impacted is 10^{-7} (which equates to a 10,000,000 year MRI event).

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- Tornado Commentary
  - Current commentary is two paragraphs
  - Proposed commentary is 16 pages
  - Includes examples with recommended design parameters for tornadic winds
  - Prompted by recent tornado outbreaks

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- Tornado Commentary
  - Tornado Wind Speeds and Probabilities
  - Wind Pressures induced by Tornadoes vs. other Wind Storms
  - Designing for Occupant Protection
  - Designing to Minimize Building Damage
  - Designing to Maintain Building Operation
  - Designing Trussed Communication Towers for Wind-Borne Debris

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- ASCE 7-16 – Wind Speed Maps
  - Reviewed MRI for all maps
    - Provide consistency with Chapter 1 Target Reliabilities
    - Separate maps for Risk Category III and IV
  - Revise Maps to incorporate additional years of data and updated analysis and modeling methods
  - Fix known problems in Special Wind Regions and Alaska maps

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Table C.1.3.1a Acceptable Reliability (Maximum Annual Probability of Failure) and Associated Reliability Indexes[1] (β) for Load Conditions that Do Not Include Earthquake[2]

Basis	Risk Category I	Risk Category II	Risk Category III	Risk Category IV
Failure that is not sudden and does not lead to widespread progression of damage	$P_F = 1.25 \times 10^{-4}$/yr $\beta = 2.5$	$P_F = 3.0 \times 10^{-5}$/yr $\beta = 3.0$	$P_F = 1.25 \times 10^{-5}$/yr $\beta = 3.25$	$P_F = 5.0 \times 10^{-6}$/yr $\beta = 3.5$
Failure that is either sudden or leads to widespread progression of damage	$P_F = 3.0 \times 10^{-5}$/yr $\beta = 3.0$	$P_F = 5.0 \times 10^{-6}$/yr $\beta = 3.5$	$P_F = 2.0 \times 10^{-6}$/yr $\beta = 3.75$	$P_F = 7.0 \times 10^{-7}$/yr $\beta = 4.0$
Failure that is sudden and results in widespread progression of damage	$P_F = 5.0 \times 10^{-6}$/yr $\beta = 3.5$	$P_F = 7.0 \times 10^{-7}$/yr $\beta = 4.0$	$P_F = 2.5 \times 10^{-7}$/yr $\beta = 4.25$	$P_F = 1.0 \times 10^{-7}$/yr $\beta = 4.5$

[1] The reliability indexes are provided for a 50-year service period, while the probabilities of failure have been annualized. The equations presented in Section 2.3.6, Load Combinations for Nonspecified Loads, are based on reliability indices for 50 years because the load combination requirements in 2.3.2 are based on the 50-year maximum loads.

[2] Commentary to Section 2.5 includes references to publications that describe the historic development of these target reliabilities.

Failure that is sudden and results in widespread progression of damage $P_F = 5.0 \times 10^{-6}$/yr $\beta = 3.5$ $P_F = 7.0 \times 10^{-7}$/yr $\beta = 4.0$ $P_F = 2.5 \times 10^{-7}$/yr $\beta = 4.25$ $P_F = 1.0 \times 10^{-7}$/yr $\beta = 4.5$

[1] The reliability indexes are provided for a 50-year service period, while the probabilities of failure have been annualized. The equations presented in Section 2.3.6, Load Combinations for Nonspecified Loads, are based on reliability indices for 50 years because the load combination requirements in 2.3.2 are based on the 50-year maximum loads.

[2] Commentary to Section 2.5 includes references to publications that describe the historic development of these target reliabilities.

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MRI Design Wind Speed Maps

Risk Category	Target Beta (Ch. 1)	Current Map MRI	Proposed Map MRI
I	2.50	300	300
II	3.00	700	700
III	3.25	1,700	1,700
IV	3.50	1,700	3,000

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- Incorporate analysis of additional wind climate data for non-hurricane winds
  - More stations and more years of data
  - Account for terrain exposure at anemometer locations
- Revised inland winds developed using threshold exceedance approach (Pintar and Simiu, 2014)
  - Thunderstorms ~ thunderday methodology
  - Extratropical storm modeling ~ Method of storms (Cook, 1983)
- Update to hurricane model for northeast coast
- Update all 7 existing maps
  - 3 in the Standard and 4 (serviceability) in Commentary
- Add a new 3,000 year map for RC IV structures

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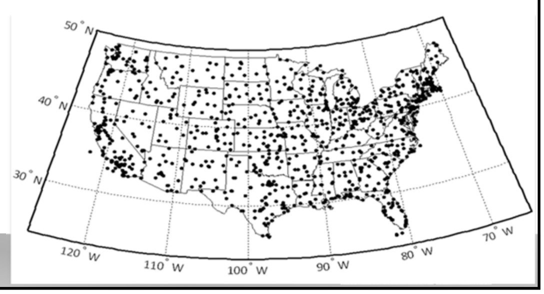
- Update to non-Hurricane Wind Speeds
- Existing wind speeds (non-hurricane) have not been updated since ASCE 7-95
- More years of wind data and more stations available now
  - 1995: 485 stations with 5+ years data
  - Now: ≈1,000 stations with 5+ years data
- Regional variability in extreme wind climate not captured in current maps



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- Exposure Conditions in Eastern US
- Correction for Terrain Exposure at Anemometer Locations
  - Compute z_o from wind data for stations having applicable data, apply correction factor based on station average z_o
  - For the stations where no objective roughness estimate is available, use a regional average value and corresponding correction

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- Estimate Station Average Roughness Length - z_o

ASCE 7
Exposure C
z_0=0.03 m

Yellow - < 0.05 m
Green – 0.05 – 0.10 m
Blue – 0.10 – 0.20 m
Red - > 0.2 m

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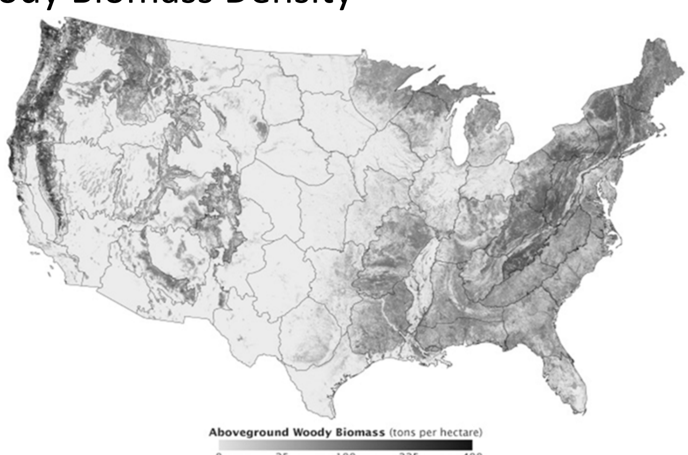
- Woody Biomass Density



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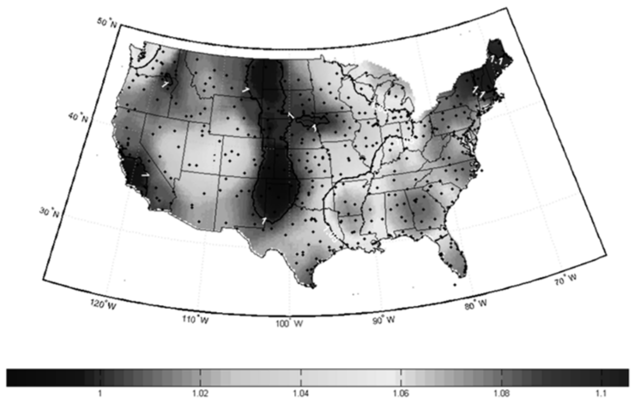
- Regional Correction Factor from Station Roughness



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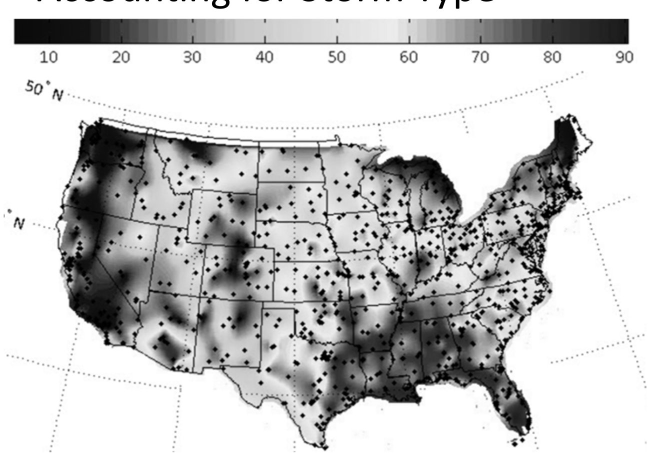
- Accounting for Storm Type



Extreme wind climate clearly dominated by different storm types in different parts of the country

*Excluding maxima from tropical cyclones

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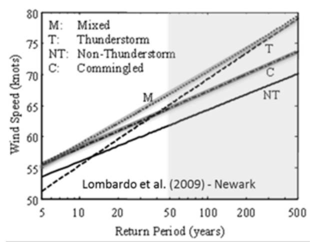
- Accounting for Storm Type
  - Distributions for different storm types shown to be different (Lombardo et al., 2009)
  - Failure to account for storm types separately can lead to unconservative estimates
  - To include storm types separately can use a "mixed" distribution



- $P(V \le v) = P(V_T \le v)\, P(V_{NT} \le v)$
- M: Mixed
- C: Current Method

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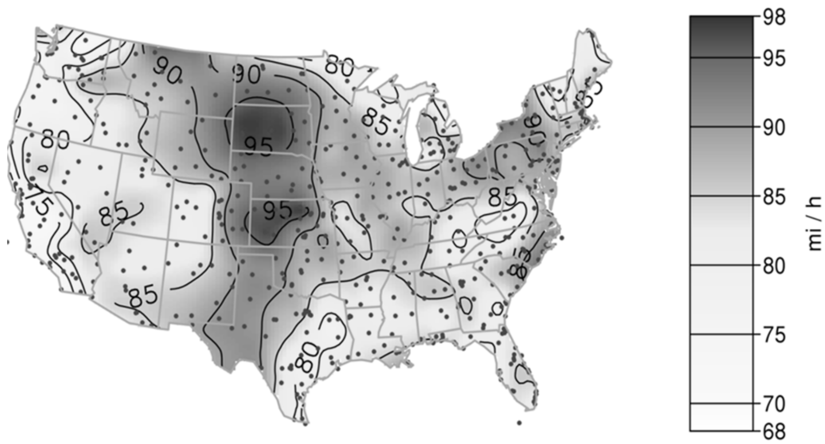
- Non-Hurricane 50 year MRI Map



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- Non-Hurricane 50 year MRI Map – ASCE 7-95

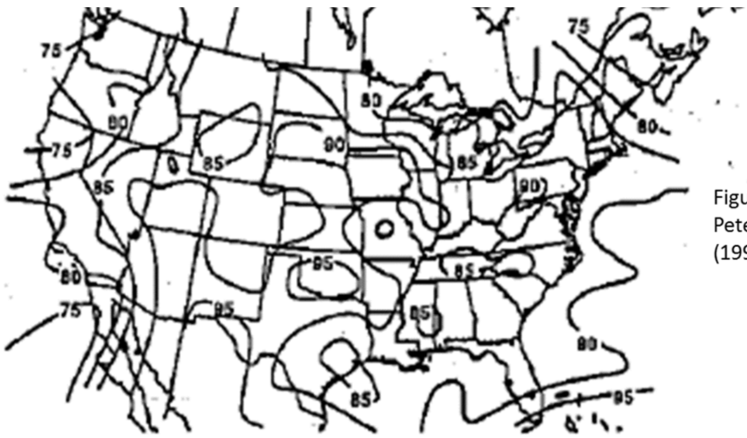

Figure 3 from Peterka and Shahid (1998)

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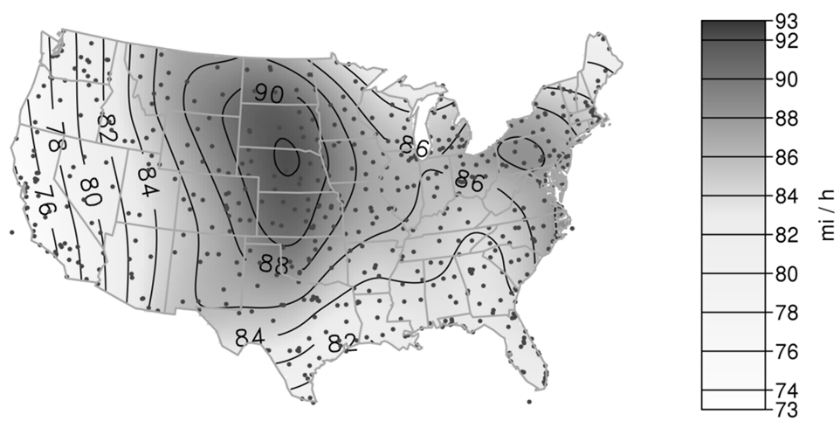
- Non-Hurricane 50 year MRI Map - Smoothed



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- Hurricane Model Updates
  - Implemented two changes to the model
    - Reduced translation speed effect for fast moving storms (published in USNRC NUREG/CR 7005)
    - Simple Extra-Tropical Transition model where the surface winds are reduced linearly by up to 10% over the latitude range 37 N to 45 N. This reduction approximates transitioning from a hurricane boundary layer to an ESDU extratropical storm boundary layer. The full ESDU reduction is around 15%.
    - Model has been validated using Hurricane Juan winds from Nova Scotia

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- Combined Map Winds
  - Non-hurricane winds provided to ARA by NIST
  - Winds given for return periods of 10 through 100,000 years computed using a Type I distribution
  - Hurricane and non-hurricane winds are combined as independent events using:
    - P = 1-(1-PNH)*(1-PH)
  - Computer generated contours were hand smoothed
  - Tornado winds are not considered

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- Back to the Future?

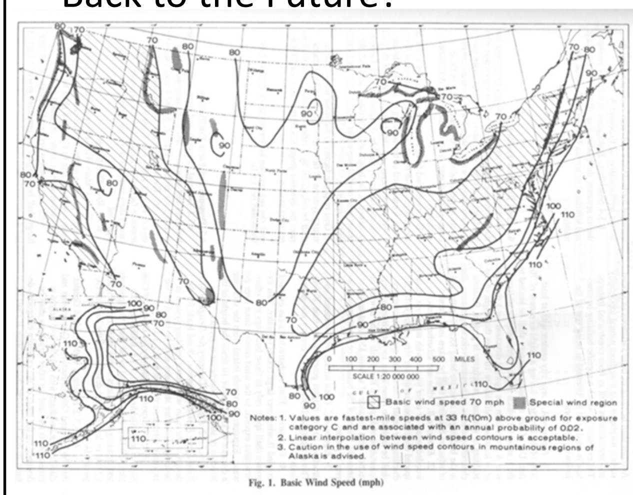

Fig. 1. Basic Wind Speed (mph)

The fastest mile map in ASCE 7-93 and earlier versions included regional variations outside hurricane prone regions

These regional variations were smoothed in ASCE 7-95 in a manner where the 90 mph was close to an upper bound for the region it covered

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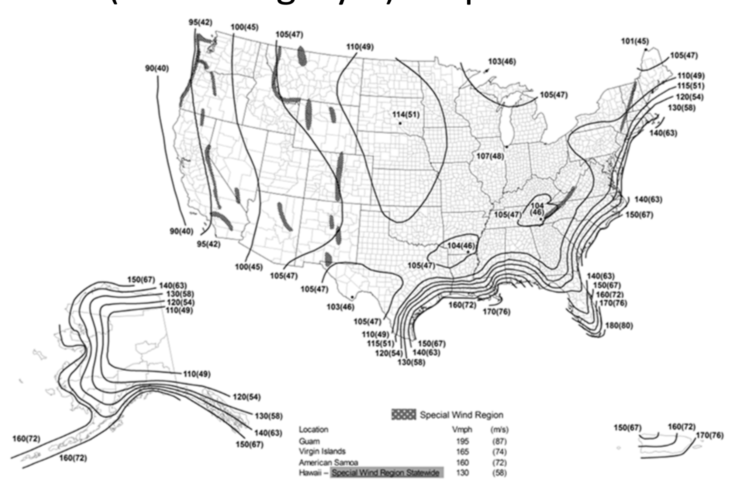
- 700 Year (Risk Category II) Map



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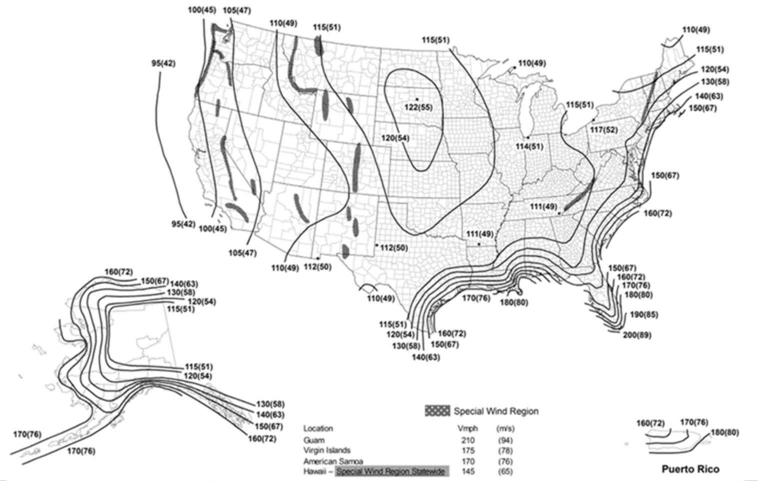
- 1,700 Year (Risk Category III) Map



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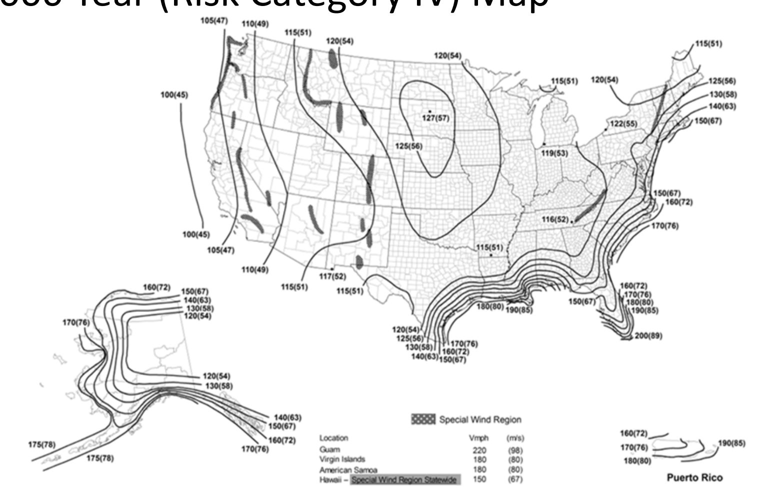
- 3,000 Year (Risk Category IV) Map



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- Net Effects of Map Changes
  - Hurricane Prone Regions
    - Decrease in hurricane wind speeds along northeast coast
    - No changes to hurricane contours from the Carolinas to Texas
      - Except interior contours where transitioning to non-tropical storms controlling
    - No changes to Hawaii, Puerto Rico, and other islands

ASCE 7-16 – Wind Provisions

- Net Effects of Map Changes
  - Locations not Controlled by Hurricanes (in Contiguous US)
    - Maps now better reflect regional variation in extreme wind climate
    - Wind speeds in Great Plains states nearly unchanged
    - Wind speeds decrease for the rest of the country

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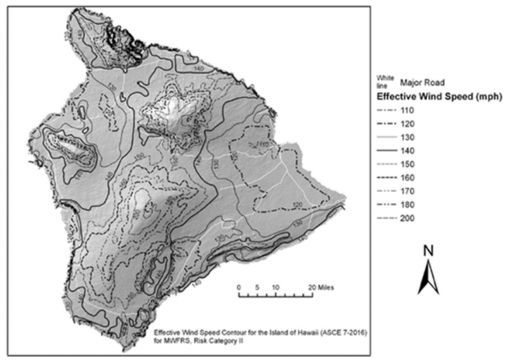
- Hawaii Wind Speed Maps
  - New micro zoned "effective" wind speed maps, including the effect of topography. Formatted to allow use of
    - K_{zt} of 1.0
    - K_d as given in Table 26.6-1

Local site conditions of finer toposcale, such as ocean promontories and local escarpments, should still be examined.



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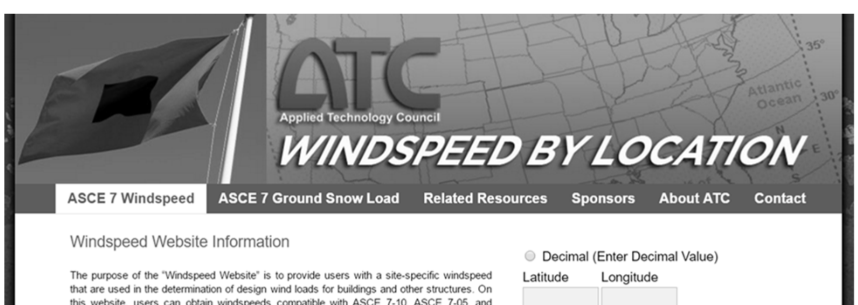
- Web-based Wind Speed Tools
  - Applied Technology Council's (ATC) *WINDSPEED BY LOCATION* web site is recognized as a permitted method to determine wind speed, in a footnote on each wind speed map
  - Location-specific basic wind speeds shall be permitted to be determined using www.atcouncil.org/windspeed.



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- Web-based Wind Speed Tools

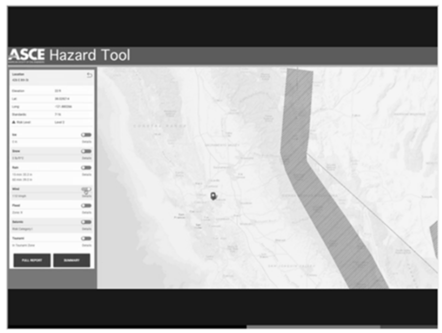
ASCE 7 Hazard Tool

ASCE 7 Hazard Tool is a web-based application that offers a better way to look up key design parameters specified by Standard ASCE 7. Its easy-to-use mapping features quickly retrieve your choice of hazard data, including:

- basic wind speed
- seismic accelerations
- flood zone and base flood elevation
- ground snow load
- rain load
- tsunami-load risk
- ice thickness with concurrent gust speed and temperature

Both individual and corporate subscriptions will be available.

Launches Summer 2017.



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- Component & Cladding Wind Loads on Roofs
  - The low-rise C&C provisions in ASCE 7-10 are largely based on ground-breaking wind tunnel studies conducted at UWO in the late 1970s
  - Since then there has been a significant increase in knowledge of the aerodynamics of low-rise buildings, and validation of wind tunnel studies from full-scale field experiments.
  - There are extensive, state-of-the-art, publically-accessible databases of wind tunnel data, which have been validated against full-scale and earlier model scale data

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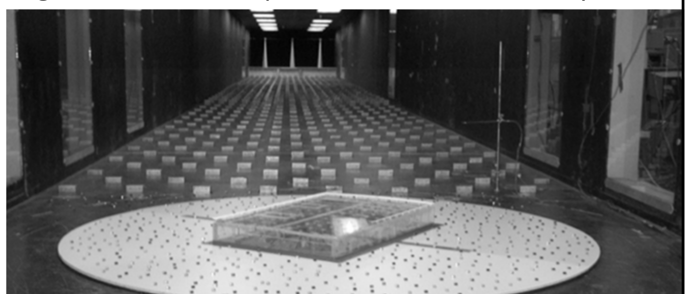
- Component & Cladding Wind Loads on Roofs
  - NIST Aerodynamic Database
    - The TTU field studies changed our understanding, indicating higher levels of turbulence in ABL.
    - This knowledge has been incorporated in the NIST study



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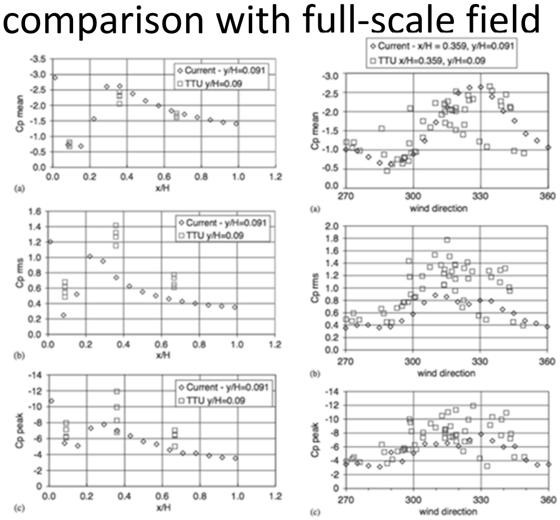
- Ho et al. (2005) comparison with full-scale field data from TTU



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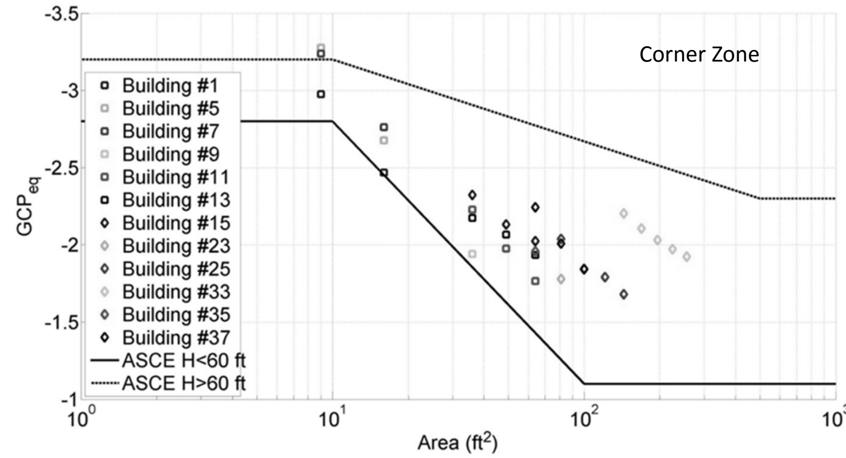
- Evaluation of ASCE 7-10, Flat Roof C&C



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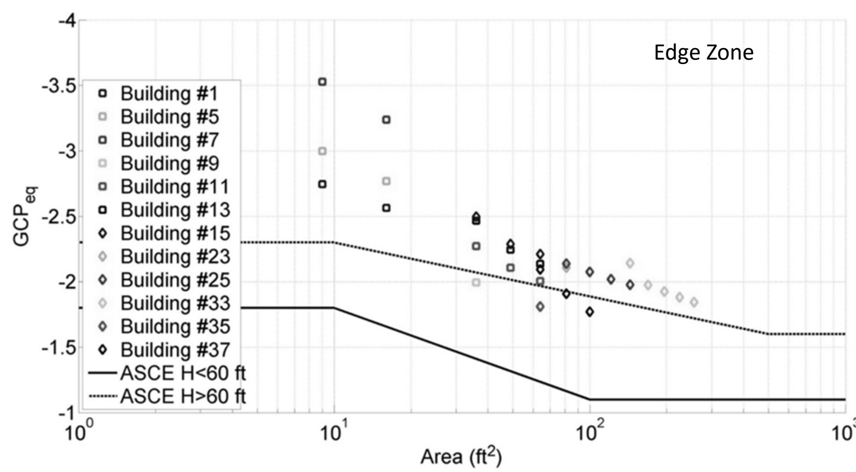

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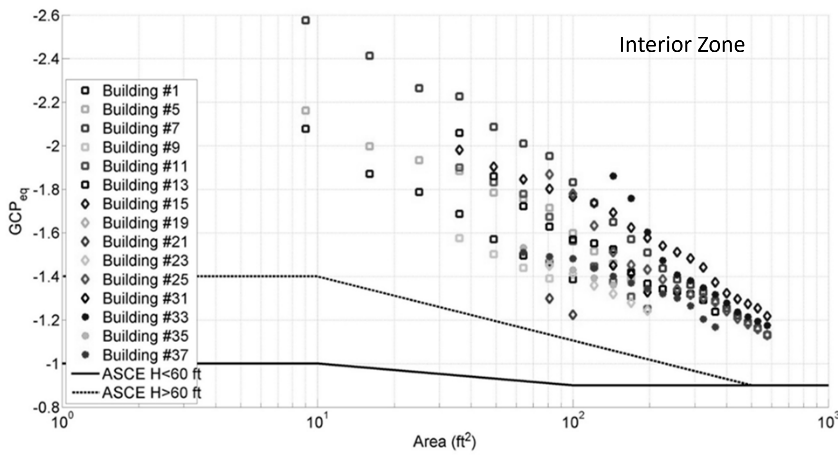

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- Evaluation of ASCE 7-10, Flat Roof C&C
  - There are problems with both magnitude of the area-averaged pressure coefficients and the zone sizes
  - Using the larger coefficients, and “L” shaped corner, for buildings with h > 60 ft does not solve this.
  - The main problems are with the edge and interior.

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- Evaluation of ASCE 7-10, Flat Roof C&C
  - The UWO data from the 1970s had limited pressure tap resolution, so C&C coefficients were obtained from limited data.
  - The zone sizes were based on point pressure distributions and an assumed 30% reduction from the maxima
  - The NIST data allows one to compute the spatial distribution of the enveloped area-averages. This was not available in the 1970s.
  - Thus, the current data allows one to assess both the magnitude of the area-averaged pressure coefficients, and their spatial distribution.

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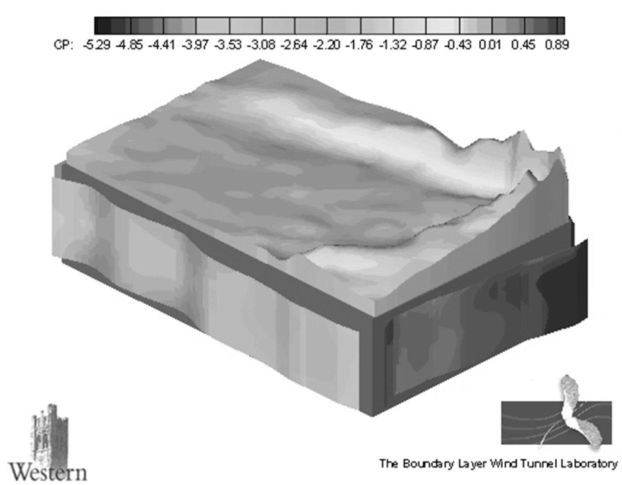

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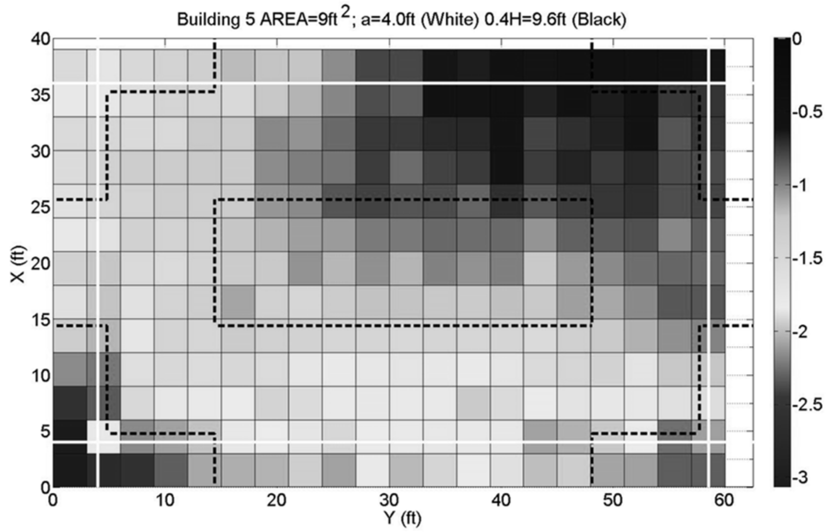

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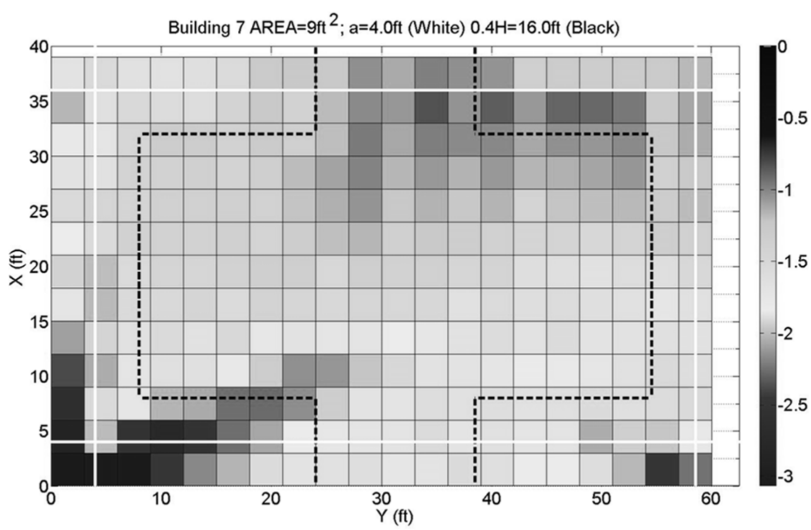

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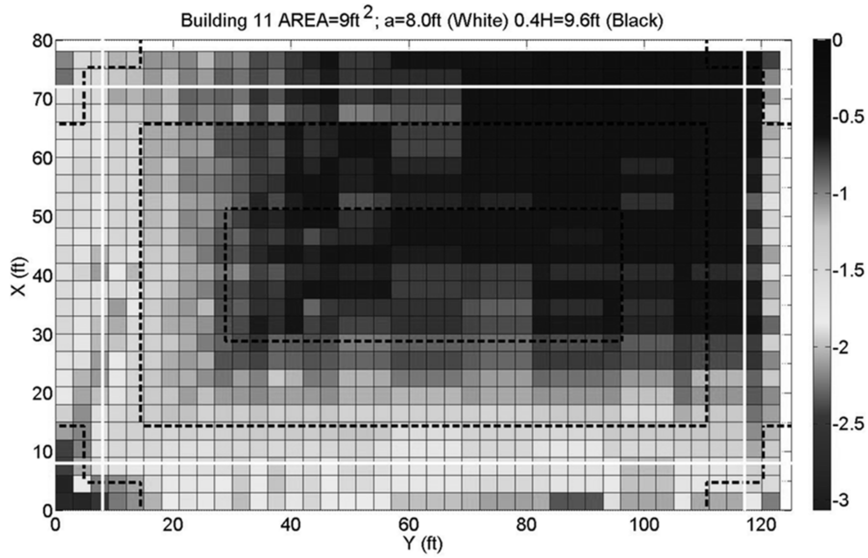

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- Spatial Distribution of Area-Averaged Pressure Coefficients
  - The worst of the peak coefficients are about the same for all of these buildings. (The color bars were in all plots were made the same.)
  - For two buildings of the same plan dimensions, the taller building has high magnitude pressures covering larger areas.
  - For buildings of the same height, but differing plan dimensions, the pressure distributions are very similar
  - Thus, the distribution of enveloped pressures is primarily dependent on roof height. Plan dimensions only play a secondary role.

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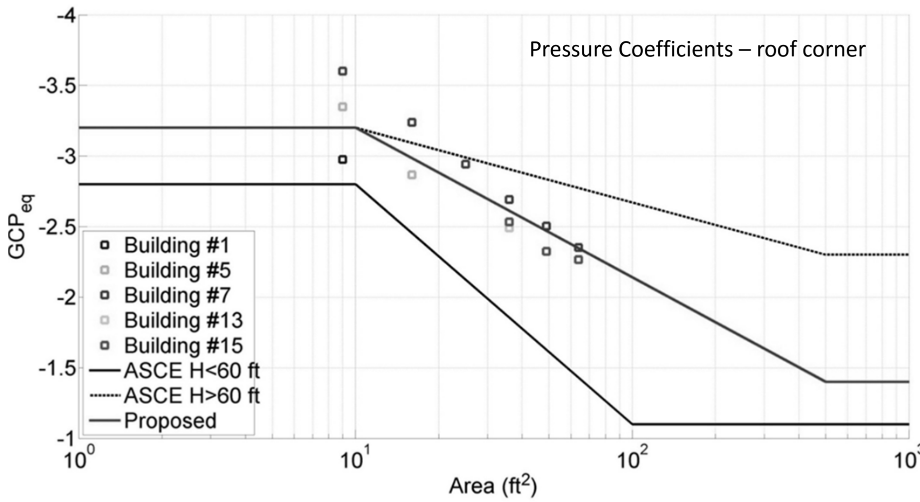

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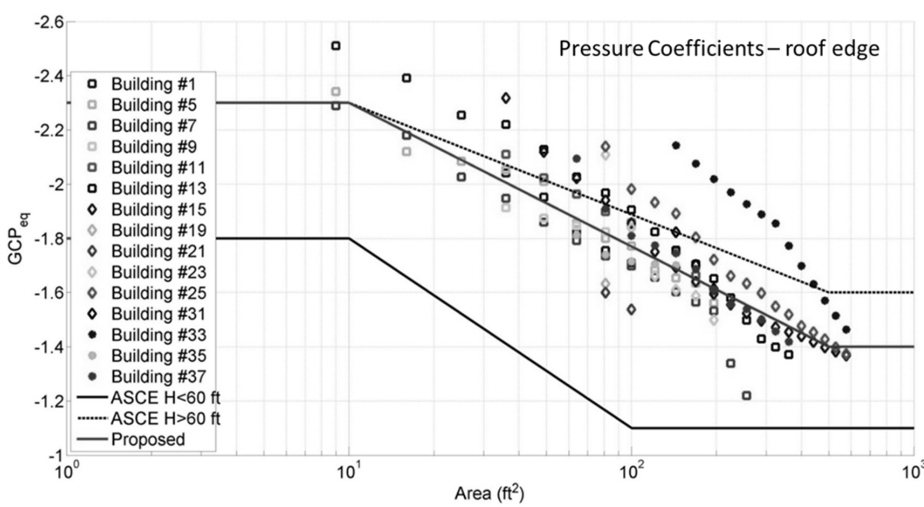

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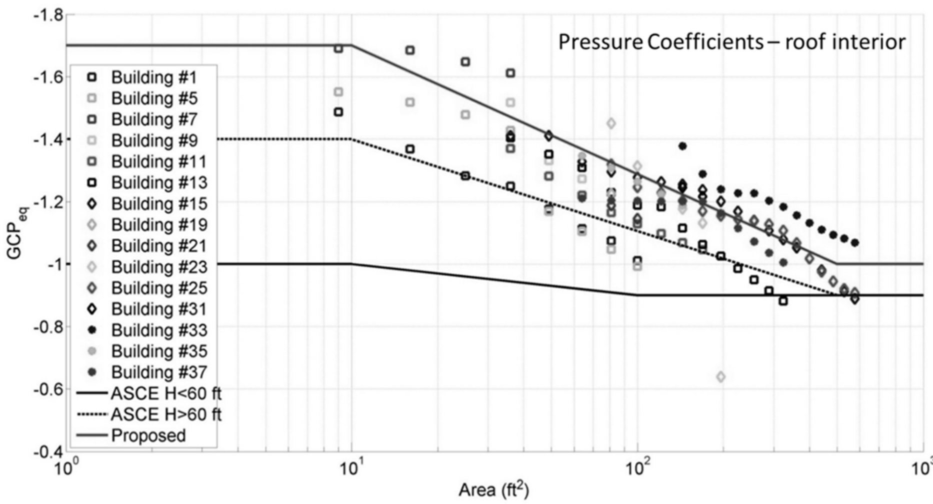

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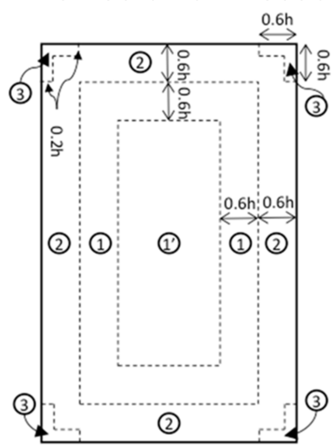
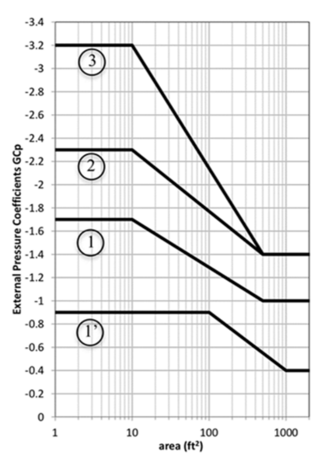
ASCE 7-16 – Wind Provisions

- Roof Zones and Pressure Coefficients





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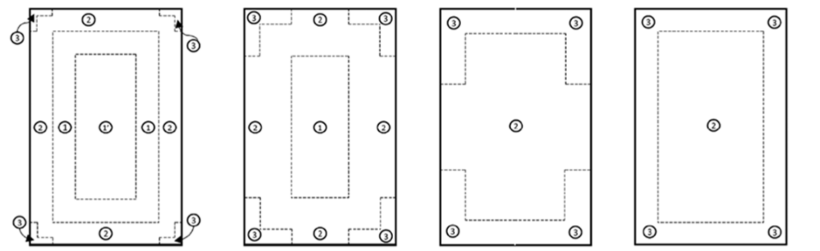
ASCE 7-16 – Wind Provisions

- Flat Roof Zoning



Buildings with least horizontal dimension greater than 2.4*h*

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

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

Buildings with largest horizontal dimension less than 1.2*h*

FIGURE C30-1 Four Possible Scenarios for Roof Zones, Which Depend on the Ratios of the Least and Largest Horizontal Plan Dimensions to the Mean Roof Height *h*

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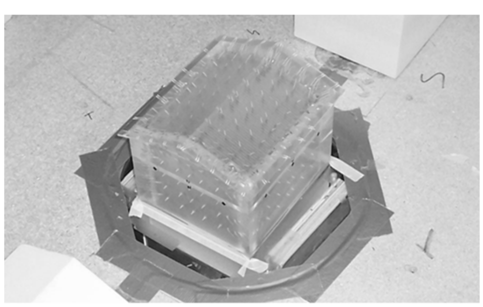
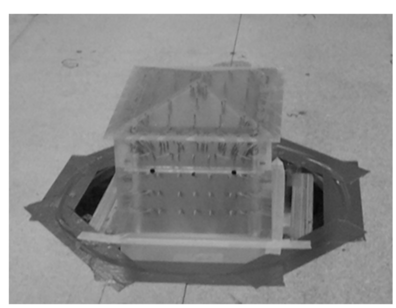
ASCE 7-16 – Wind Provisions

- Sloped Roof Pressure Coefficients





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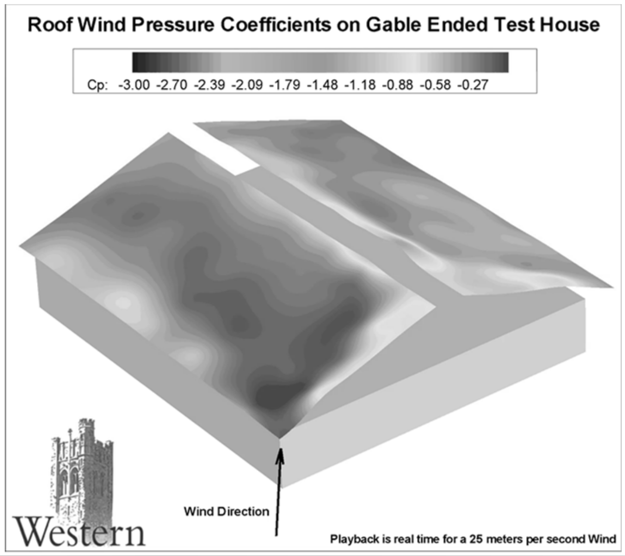
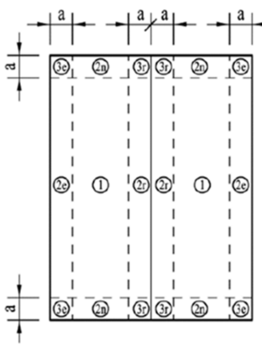


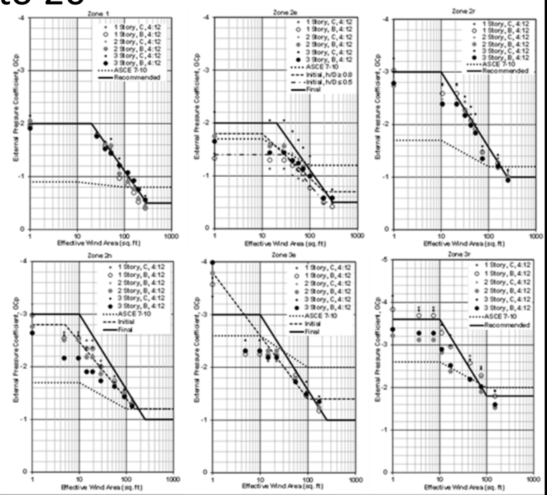
ASCE 7-16 – Wind Provisions

- Sloped Roof Pressure Coefficients
  - 4:12 tests on 1, 2 and 3 stories buildings
    - Performed at the BLWTL at UWO early December 2005 to examine the impact h/D on roof pressure coefficients.
    - Tests performed with & without surrounding buildings with two different spacing's.
  - 4:12 tests performed in January 2006
    - Effect of trees on wind loads & velocity profile was examined (hip/gable 1,2 & 3 story).
  - 7:12, 9:12 and 12:12 May 2007
    - With and without trees (hip/gable 1,2 & 3 story)
  - 5:12 and 6:12 tests performed April 2008
    - Hip/gable 1, 2 & 3 story plus an interference effects study.

ASCE 7-16 – Wind Provisions

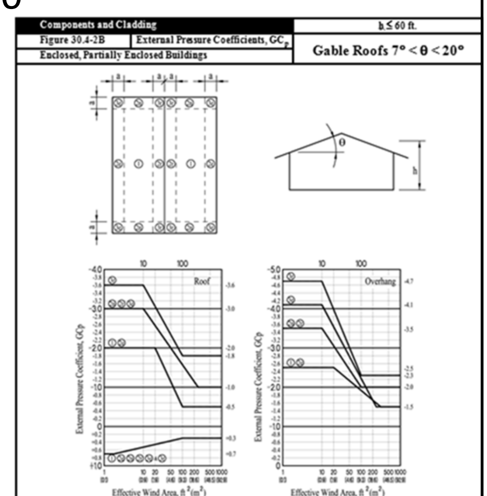
- Gable Roof Slope 7^o to 20^o





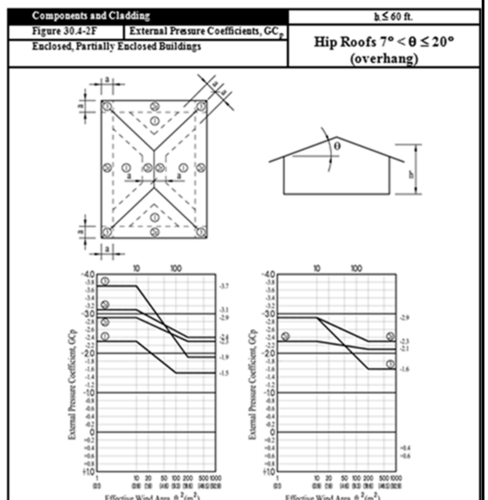
ASCE 7-16 – Wind Provisions

- Gable Roof Slope 7^o to 20^o



ASCE 7-16 – Wind Provisions

- Hip Roof Slope 7° to 20°



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ASCE 7-16 – Wind Provisions

- Equations for all GCp's given in Commentary

Table C30.3-5. Gable Roofs, 27° < θ ≤ 45° (Figure 30.3-2D)

Positive with and without overhang		
All Zones	$(GC_p) = 0.9$	for $A \le 10$ ft²
	$(GC_p) = 1.3000 - 0.4000 \log A$	for $10 \le A \le 100$ ft²
	$(GC_p) = 0.5$	for $A \ge 100$ ft²
Negative without overhang		
Zones 1, 2e, and 2r	$(GC_p) = -1.8$	for $A \le 10$ ft²
	$(GC_p) = -2.8000 + 1.0000 \log A$	for $10 \le A \le 100$ ft²
	$(GC_p) = -0.8$	for $A \ge 100$ ft²
Zones 2n and 3r	$(GC_p) = -2.0$	for $A \le 10$ ft²
	$(GC_p) = -2.7686 + 0.7686 \log A$	for $10 \le A \le 200$ ft²
	$(GC_p) = -1.0$	for $A \ge 200$ ft²
Zone 3e	$(GC_p) = -3.2$	for $A \le 2$ ft²
	$(GC_p) = -3.5043 + 1.0110 \log A$	for $2 \le A \le 300$ ft²
	$(GC_p) = -1.0$	for $A \ge 300$ ft²
Negative with overhang		
Zones 1, 2e, and 2r	$(GC_p) = -2.6$	for $A \le 10$ ft²
	$(GC_p) = -3.6000 + 1.0000 \log A$	for $10 \le A \le 100$ ft²
	$(GC_p) = -1.6$	for $A \ge 100$ ft²
Zones 2n and 3r	$(GC_p) = -2.8$	for $A \le 10$ ft²
	$(GC_p) = -3.5686 + 0.7686 \log A$	for $10 \le A \le 200$ ft²
	$(GC_p) = -1.8$	for $A \ge 200$ ft²
Zone 3e	$(GC_p) = -4.0$	for $A \le 2$ ft²
	$(GC_p) = -4.3043 + 1.0110 \log A$	for $2 \le A \le 300$ ft²
	$(GC_p) = -1.8$	for $A \ge 300$ ft²

Table C30.3-7. Hip Roofs, Overhang, 7° < θ ≤ 20° (Figure 30.3-2F)

Negative $h/D \ge 0.8$		
Zone 1	$(GC_p) = -2.3$	for $A \le 20$ ft²
	$(GC_p) = -2.8584 + 0.4292 \log A$	for $20 \le A \le 100$ ft²
	$(GC_p) = -2.0$	for $A \ge 100$ ft²
Zone 2r	$(GC_p) = -2.9$	for $A \le 10$ ft²
	$(GC_p) = -3.3612 + 0.4612 \log A$	for $10 \le A \le 200$ ft²
	$(GC_p) = -2.3$	for $A \ge 200$ ft²
Zones 2e	$(GC_p) = -3.1$	for $A \le 10$ ft²
	$(GC_p) = -3.6380 + 0.5380 \log A$	for $10 \le A \le 200$ ft²
	$(GC_p) = -2.4$	for $A \ge 200$ ft²
Zones 3	$(GC_p) = -3.7$	for $A \le 10$ ft²
	$(GC_p) = -5.0835 + 1.3835 \log A$	for $10 \le A \le 200$ ft²
	$(GC_p) = -1.9$	for $A \ge 200$ ft²
Negative $h/D \le 0.5$		
Zone 1	$(GC_p) = -1.8$	for $A \le 20$ ft²
	$(GC_p) = -1.4277 - 0.2861 \log A$	for $20 \le A \le 100$ ft²
	$(GC_p) = -2.0$	for $A \ge 100$ ft²
Zones 2r	$(GC_p) = -2.9$	for $A \le 10$ ft²
	$(GC_p) = -3.3612 + 0.4612 \log A$	for $10 \le A \le 200$ ft²
	$(GC_p) = -2.3$	for $A \ge 200$ ft²
Zones 2e	$(GC_p) = -2.3$	for $A \le 10$ ft²
	$(GC_p) = -2.4537 + 0.1537 \log A$	for $10 \le A \le 200$ ft²
	$(GC_p) = -2.1$	for $A \ge 200$ ft²
Zone 3	$(GC_p) = -2.9$	for $A \le 10$ ft²
	$(GC_p) = -3.8992 + 0.9992 \log A$	for $10 \le A \le 200$ ft²
	$(GC_p) = -1.6$	for $A \ge 200$ ft²

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ASCE 7-16 – Wind Provisions

- Equations for all GCp's given in Commentary

Table C30.3-9. Hip Roofs, 27° < θ ≤ 45°, No Overhang (Figure 30.3-2H)

	Positive	
All Zones	$(GC_p) = 0.9$	for $A \le 2$ ft^2
	$(GC_p) = 1.0063 - 0.3532 \log A$	for $2 \le A \le 100$ ft^2
	$(GC_p) = 0.3$	for $A \ge 100$ ft^2
	Negative	
Zone 1	$(GC_p) = -0.6175 - 0.0200\theta$	for $A \le 10$ ft^2
	$(GC_p) = -1.0191 - 0.0250\theta + [0.4016 + 0.0050\theta] \log A$	for $10 \le A \le 200$ ft^2
	$(GC_p) = -0.0950 - 0.0135\theta$	for $A \ge 200$ ft^2
Zone 2e	$(GC_p) = 0.2000 - 0.0670\theta$	for $A \le 2$ ft^2
	$(GC_p) = -0.8000 + \left[\frac{\log(280 - 5\theta)(0.0670\theta - 1)}{0.301 - \log(280 - 5\theta)}\right] + \left[\frac{1 - 0.0670\theta}{0.3010 - \log(280 - 5\theta)}\right] \log A$	for $2 \le A \le [280 - 5\theta]$ ft^2
	$(GC_p) = -0.8$	for $A \ge [280 - 5\theta]$ ft^2
Zones 2r	$(GC_p) = 1.0000 - 0.0820\theta$	for $A \le 5$ ft^2
	$(GC_p) = 2.0746 - 0.1261\theta + [0.0630\theta - 1.5373] \log A$	for $5 \le A \le 100$ ft^2
	$(GC_p) = -1.0000$	for $A \ge 100$ ft^2
Zones 3	$(GC_p) = 1.2500 - 0.1080\theta$	for $A \le [9 - 0.1350\theta]$ ft^2
	$(GC_p) = \left[\frac{0.1835\theta - 3.8230}{\log(9 - 0.1350\theta) - 1.6990}\right] - 1.0 + \left[\frac{2.25 - 0.1080\theta}{\log(9 - 0.1350\theta) - 1.6990}\right] \log A$	for $[9 - 0.1350\theta] \le A \le 50$ ft^2
	$(GC_p) = -1.0000$	for $A \ge 50$ ft^2

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ASCE 7-16 – Wind Provisions

- Effects vary across the US based on new roof pressure coefficients, new design wind speeds, new elevation factor.
  - Review (4) locations across the US and compare to ASCE 7-10
    1. Miami, FL
    2. Nashville, TN
    3. Casper, WY
    4. San Francisco, CA

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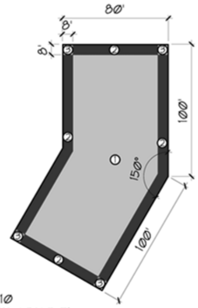
ASCE 7-16 – Wind Provisions

1. Miami, FL
   - Basic Wind Speed = 171 mph
   - Exposure D
   - Elevation = 3’

ASCE 7-16 – Wind Provisions

1. Miami, FL

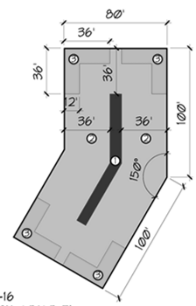


ASCE 7-10
LOCATION: MIAMI, FL
EXPOSURE: D

PLAN

USE 10FT²

	-	+
ZONE ①	-97.2 PSF	39.5 PSF
ZONE ②	-163.1 PSF	39.5 PSF
ZONE ③	-245.5 PSF	39.5 PSF



ASCE 7-16
LOCATION: MIAMI, FL
EXPOSURE: D
ELEVATION: 3 FT
WINDSPEED: 171 MPH

PLAN

USE 10FT²

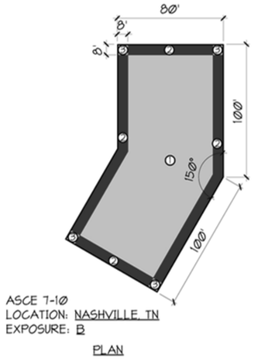
	-	+
ZONE ①	-155.3 PSF	39.6 PSF
ZONE ②	-204.8 PSF	39.6 PSF
ZONE ③	-279.2 PSF	39.6 PSF

ASCE 7-16 – Wind Provisions

2. Nashville, TN
   - Basic Wind Speed = 105 mph
   - Exposure B
   - Elevation = 500’

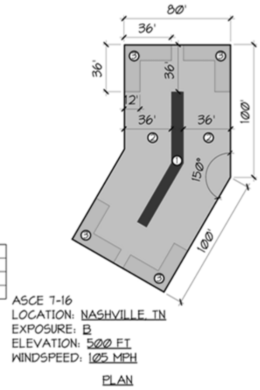
ASCE 7-16 – Wind Provisions

2. Nashville, TN



USE 10FT²

	-	+
ZONE 1	-29.0 PSF	16 PSF
ZONE 2	-48.7 PSF	16 PSF
ZONE 3	-73.3 PSF	16 PSF



USE 10FT²

	-	+
ZONE 1	-37.5 PSF	16 PSF
ZONE 2	-49.6 PSF	16 PSF
ZONE 3	-67.5 PSF	16 PSF

ASCE 7-16 – Wind Provisions

3. Casper, WY
   - Basic Wind Speed = 108 mph
   - Exposure B
   - Elevation = 5150’

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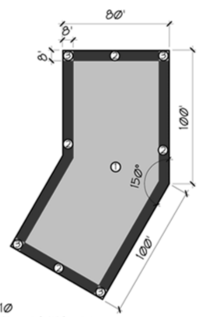
ASCE 7-16 – Wind Provisions

3. Casper, WY

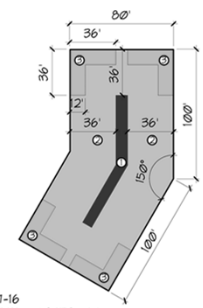


ASCE 7-10
LOCATION: CASPER, WY
EXPOSURE: B

PLAN

USE 10FT^2

	-	+
ZONE 1	-29.0 PSF	17 PSF
ZONE 2	-48.7 PSF	17 PSF
ZONE 3	-73.3 PSF	17 PSF



ASCE 7-16
LOCATION: CASPER, WY
EXPOSURE: B
ELEVATION: 5150 FT
WINDSPEED: 108 MPH

PLAN

USE 10FT^2

	-	+
ZONE 1	-33.3 PSF	16 PSF
ZONE 2	-43.9 PSF	16 PSF
ZONE 3	-59.8 PSF	16 PSF

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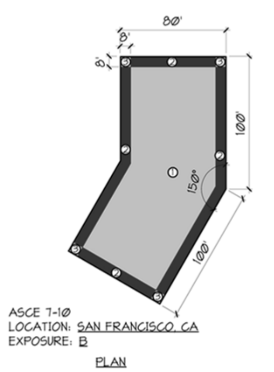
ASCE 7-16 – Wind Provisions

4. San Francisco, CA
   - Basic Wind Speed = 92 mph
   - Exposure B
   - Elevation = 34'

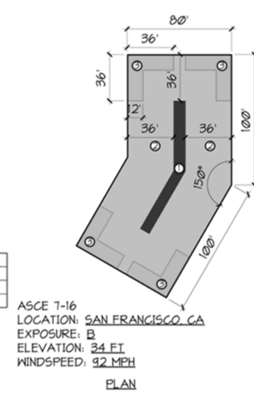
ASCE 7-16 – Wind Provisions

4. San Francisco, CA



USE 10FT²

	-	+
ZONE ①	-26.4 PSF	16 PSF
ZONE ②	-44.4 PSF	16 PSF
ZONE ③	-66.8 PSF	16 PSF



USE 10FT²

	-	+
ZONE ①	-29.5 PSF	16 PSF
ZONE ②	-38.9 PSF	16 PSF
ZONE ③	-53.1 PSF	16 PSF

ASCE 7-16 – Wind Provisions

- Roof Pressure Summary
  - New Roof Pressure Coefficients increase cladding pressures on roof along the hurricane coast line.
  - New Wind Speed Maps & Elevation Factors offset the increase in the Roof Pressure Coefficient increases for the remaining portion of the US.
  - New Roof Zones are larger than previous zones, but better reflect the actual roof loading.
  - The interior zone pressures have the largest increase on a percentage basis.

ASCE 7-16 – Wind Provisions

- ASCE 7-16 Summary
  - New Wind Maps give lower MWFRS loads in the majority of the non-hurricane portions of the country.
  - New Roof Pressure Coefficients increase cladding pressures on roof in the hurricane-prone regions.
  - New provisions for Building Canopies and Rooftop Solar have been provided.
  - Tornado Guidelines for design provided in Commentary

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ASCE 7-16 Wind Provisions:

"How they affect the Practicing Engineer"

Questions?

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Chair, NCSEA Wind Engineering Committee