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INTERNATIONAL CODE COUNCIL 2018

Welcome to the

# 2018 Annual Conference Educational Sessions

**Session: Ever-Changing Structural Provisions of Our Building Codes**

Sponsored by ORACLE

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# Ever-Changing Structural Provisions of Our Building Codes

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# U.S. Codes and Standards

## Legal Codes

California Building Code

## Model Codes

IBC

## Standards

ASCE 7

ACI 318

AISC 360, 341

# IBC Structural Provisions

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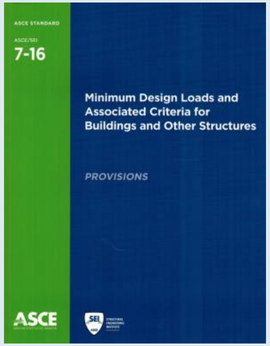
Largely by reference to

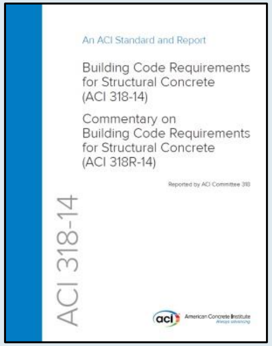
*Minimum Design Loads for Buildings and Other Structures* (ASCE 7)




and Material Standards:

Concrete – ACI 318

Masonry – TMS 402, TMS 602



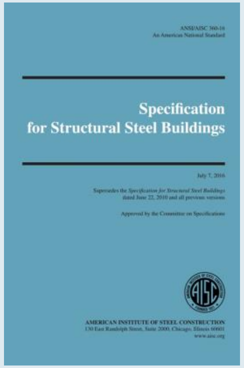
# IBC Structural Provisions

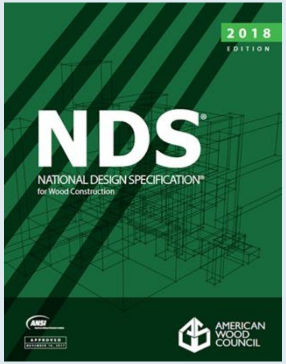
Largely by reference to ASCE 7 and Material Standards:

Structural Steel – AISC 360, AISC 341

Cold-Formed Steel – AISI S100, AISI S400, etc.

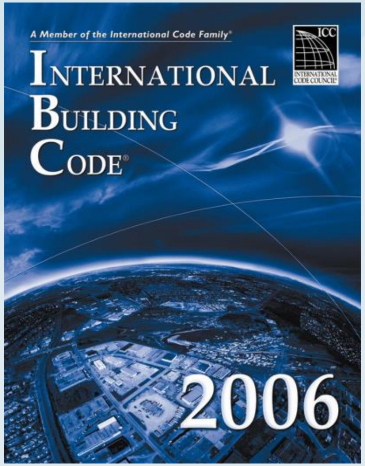
Wood – NDS, SDPWS

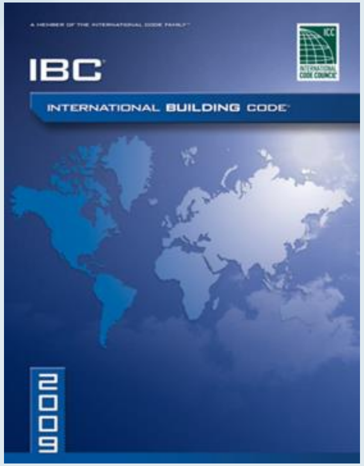


# IBC Structural Provisions

Big changes in IBC structural provisions occur when a new edition of ASCE 7 is adopted by the IBC




# IBC Structural Provisions

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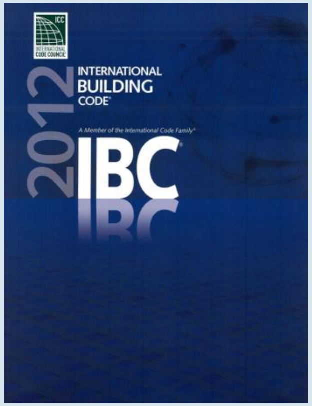


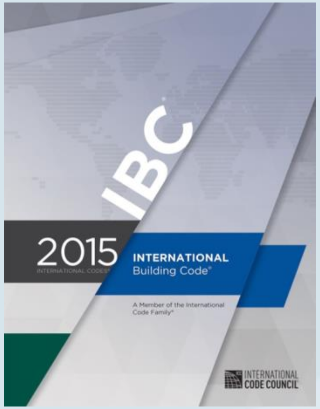



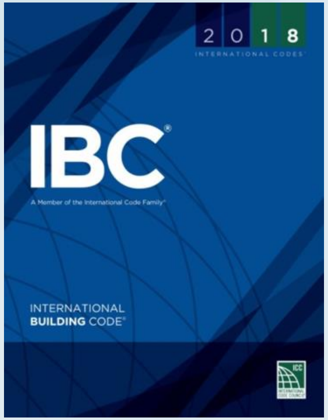


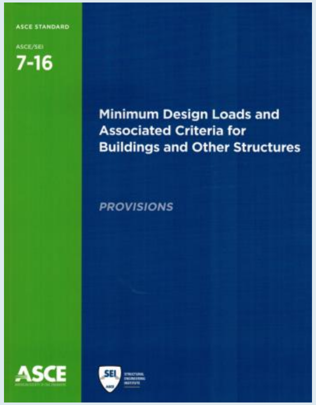


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# WIND

# ASCE 7 Wind

**ANSI A58.1-72, ANSI A 58.1-82, ASCE 7-88:**

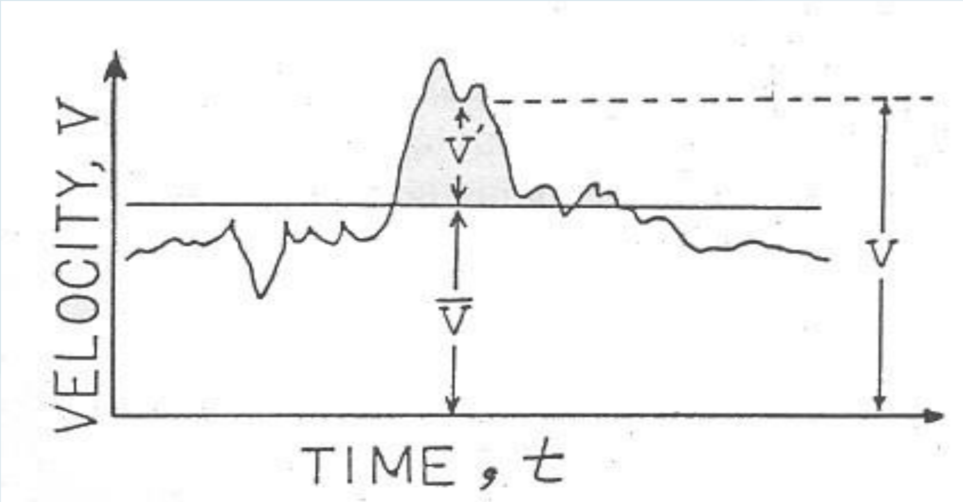
Fastest-Mile Wind Speed, *V*

Wind speed contours for the entire country

Basic wind speed in most of the country: 70 mph

# Fastest-Mile Wind

Instantaneous velocity of wind at a point as a function of time:

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# Fastest-Mile Wind

- Max. wind speed averaged over one mile of wind passing through anemometer.

- Averaging time of fastest-mile wind: T(sec.) 3600/$V_f$

  $V_f$ – fastest-mile wind speed in mph

  For $V_f$ = 60 mph – T = 3600/60 = 60 sec

  For $V_f$ = 120 mph – T = 3600/120 = 30 sec

# Return Period

- Also known as mean recurrence interval (MRI).
- In most U.S. inland locations, MRI of 50 years was used for normal-use structures.
- Return period greater than 50 years was used on the hurricane coast to provide consistent risk of failure.
- MRI for critical facilities such as hospitals was 100 years.
- MRI for low-risk buildings such as barns was 25 years.

# Importance Factor

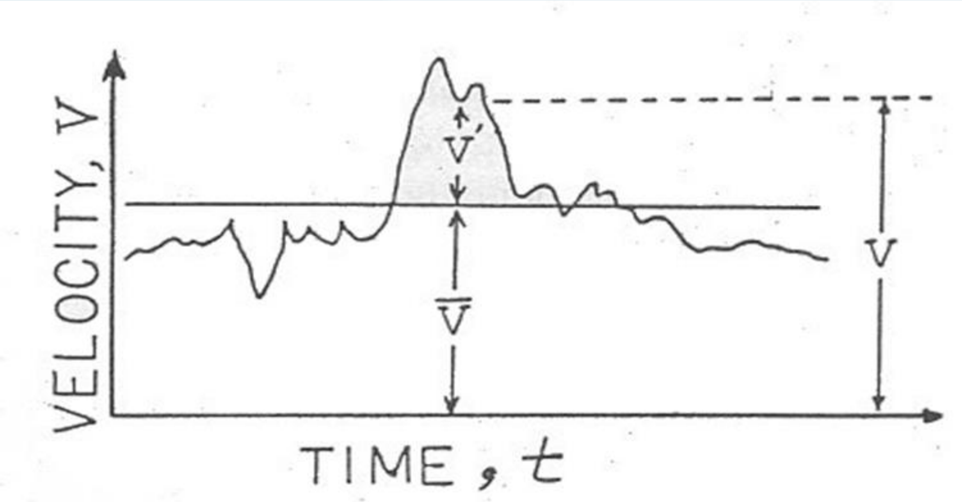
- For MRI of 25, 50 , and 100 years -

  3 Maps???? - No!
- MRI was adjusted by using importance factor, *I*.
- Ratio of difference in velocity pressure from one MRI to another is a fairly consistent ratio for non-hurricane locations.
- Inclusion of "*I*" in the wind pressure equation had the mathematical effect of adjusting the wind speed up or down.

# 3-second Gust Speed

**ASCE 7-95, ASCE 7-98, ASCE 7-02, ASCE 7-05:**

50-year MRI 3-second gust speed

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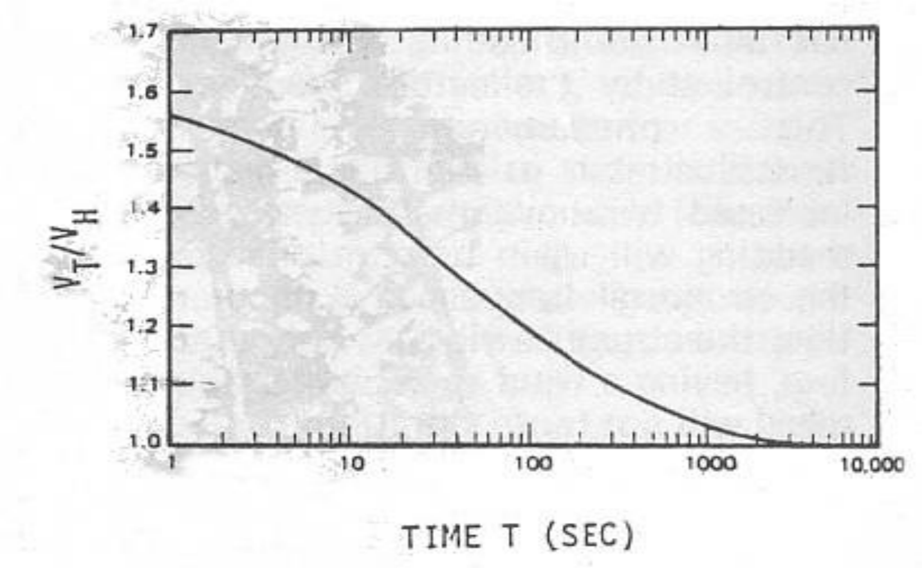
# 3-second Gust Speed




- $V_T$ = max. wind speed based on averaging time of T sec
- $V_H$ = max. wind speed based on averaging time of 1 hour

# 3-second Gust Speed

Basic wind speed

85 mph in California, Oregon, Washington

90 mph in rest of the country outside of hurricane-prone regions

Higher in hurricane-prone regions

# Importance Factor

## ASCE 7-05:

| Occupancy Category | **Importance Factor** (Non-Hurricane Prone Regions with *V* = 85-100 mph and Alaska) | **Importance Factor** (Hurricane Prone Regions with *V* > 100 mph) |
|---|---|---|
| I | 0.87 | 0.77 |
| II | 1.00 | 1.00 |
| III and IV | 1.15 | 1.15 |

# “Service-Level” Wind

**ASCE 7-05:**

Load factor on W =1.6 in Strength Design

Load factor on W =1.0 in ASD.

# “Strength-Level” Wind



## ASCE 7-10:

Load factor on W changed to1.0 for Strength Design and 1/1.6 or 0.6 for ASD.

Thus, the design wind speed maps in ASCE 7-10 produce strength-level design wind forces. The mapped design wind speeds are, therefore, higher than in ASCE 7-05.

W → SD

0.6W → ASD

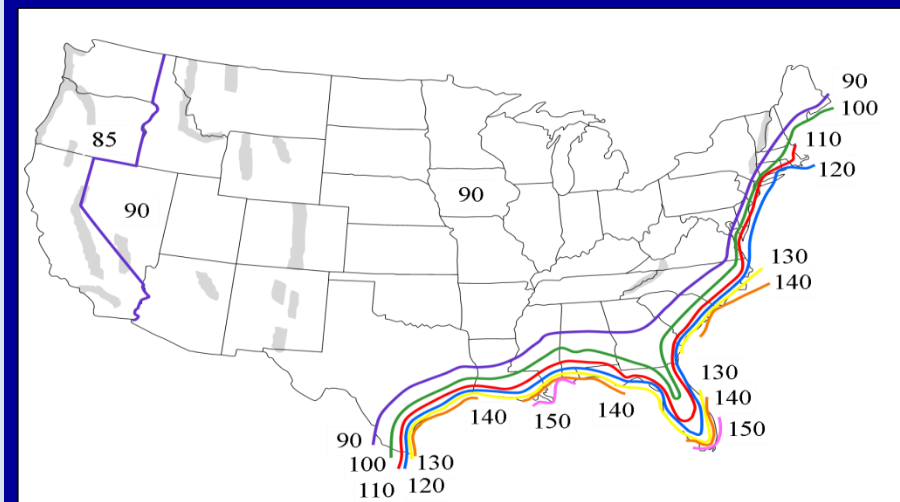
# ASCE 7-10 Wind

**No Importance Factor** is used in wind design any more.

Basic Wind Speeds: 3 Maps replace need for Importance Factor

# ASCE 7-10 Wind Speed Maps

## ASCE 7-05
## Chapter 6

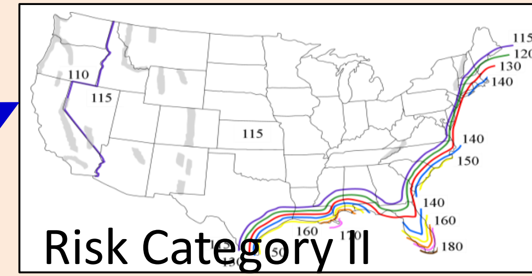


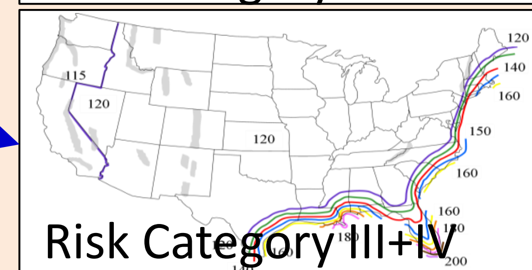

$\times\sqrt{1.6}$

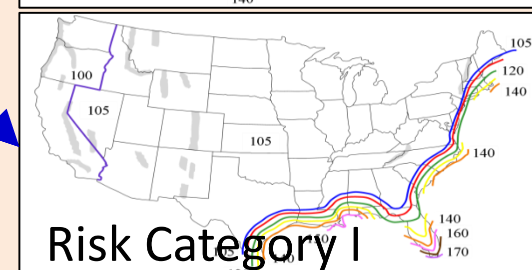
$\times\sqrt{1.6\times1.1}$

$\times\sqrt{1.6\times0.87}$

## ASCE 7-10
## Chapter 26



# ASCE 7-05 Figure 6-1

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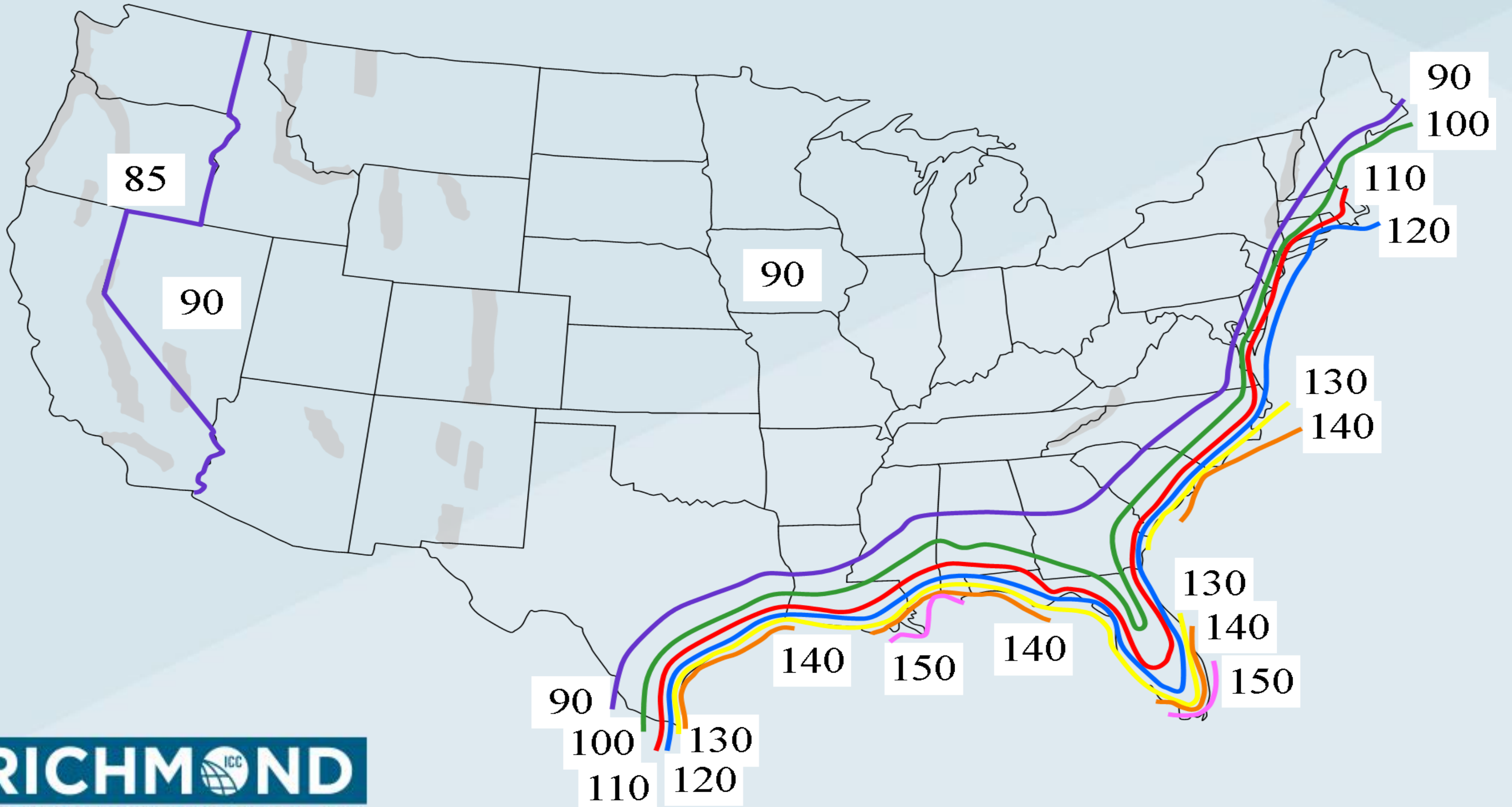


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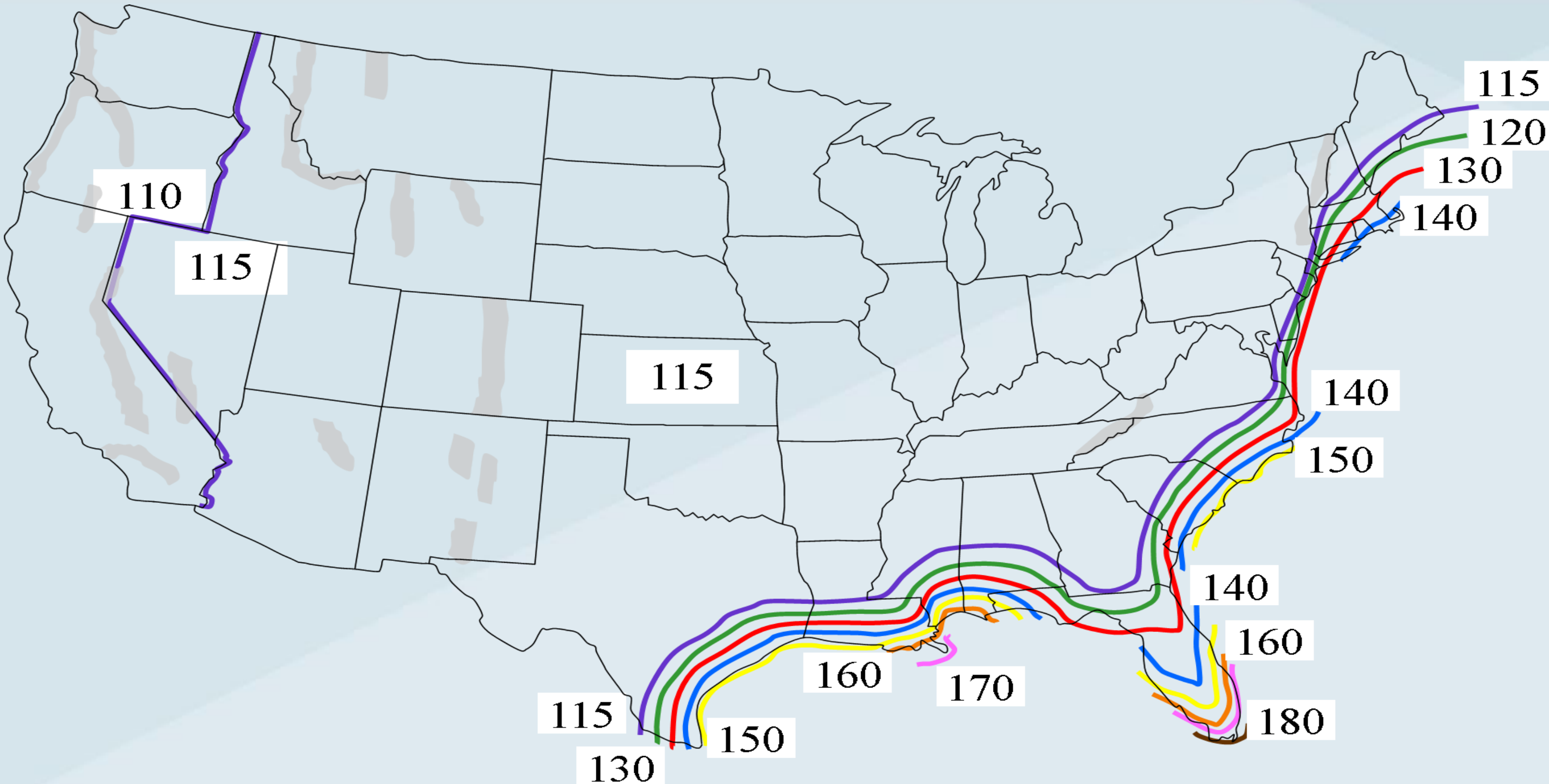
# ASCE 7-10 Figure 26.5-1A

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Risk Category II - 7% probability of exceedance in 50 years, MRI of 700 years

# ASCE 7-10: Figure 26.5-1B

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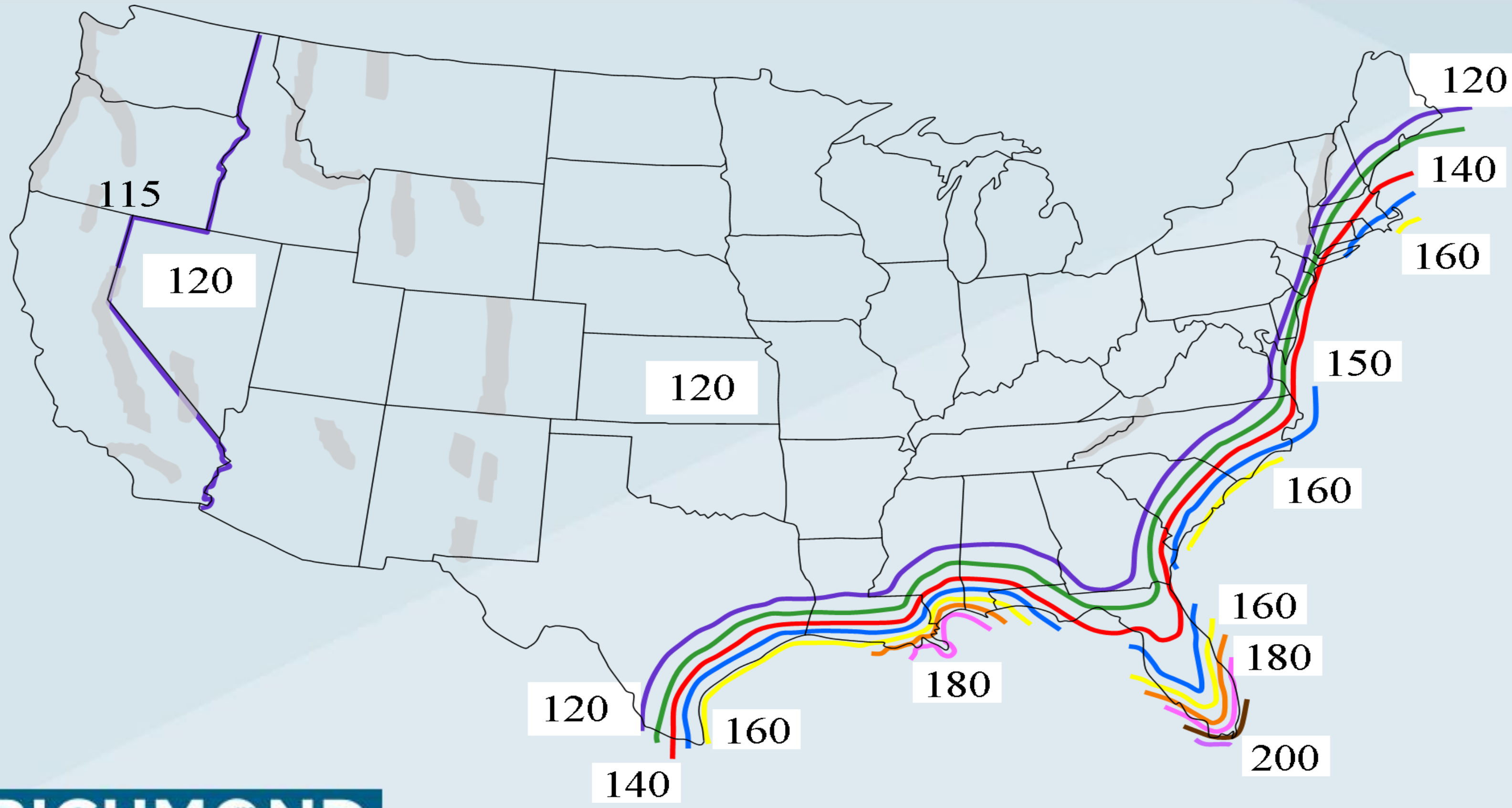


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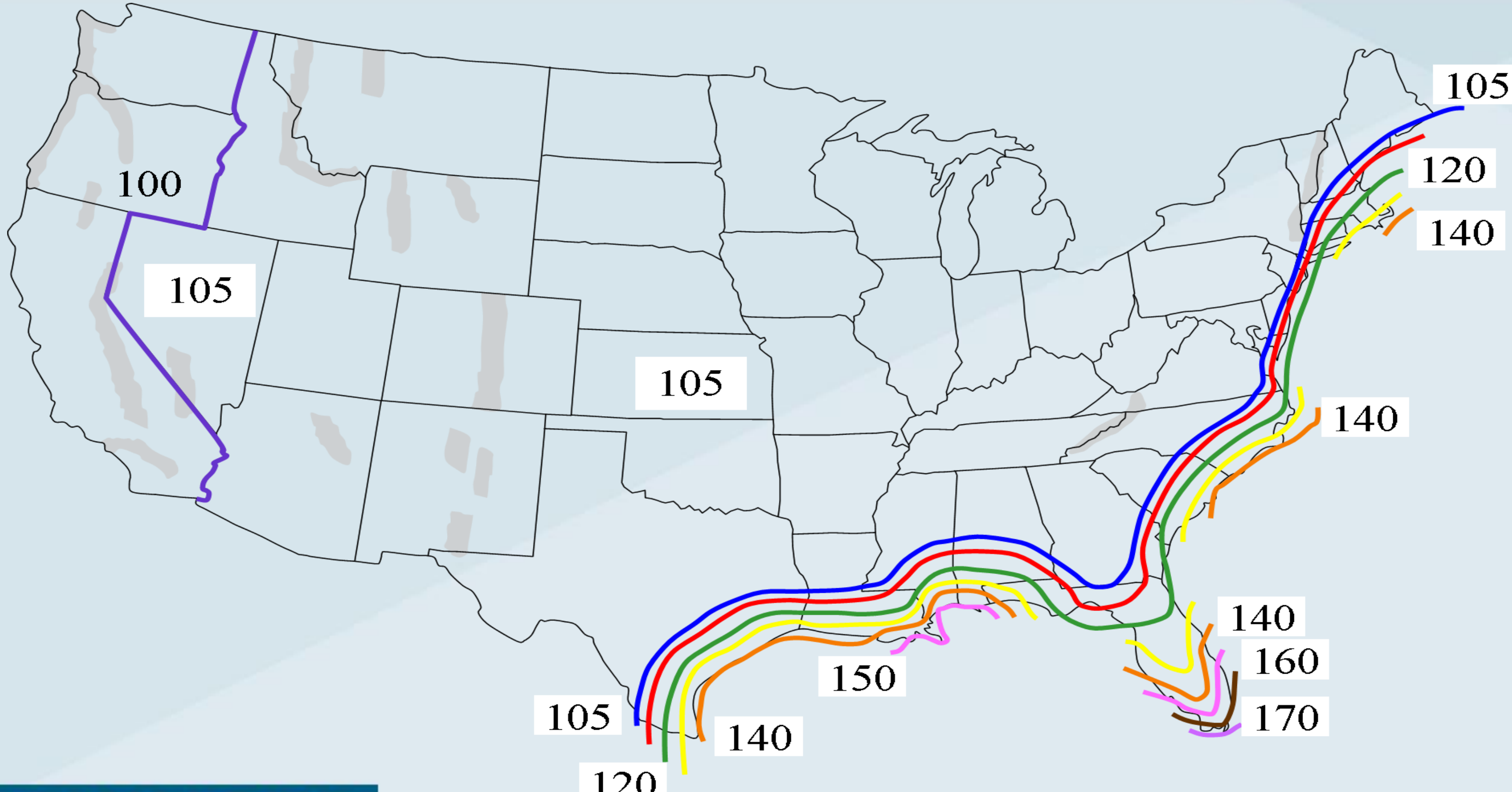
Risk Category III and IV - 3% probability of exceedance in 50 years, MRI of 1700 years

# ASCE 7-10: Figure 26.5-1C




Risk Category I - 15% probability of exceedance in 50 years, MRI of 300 years

# Risk Category II Comparison

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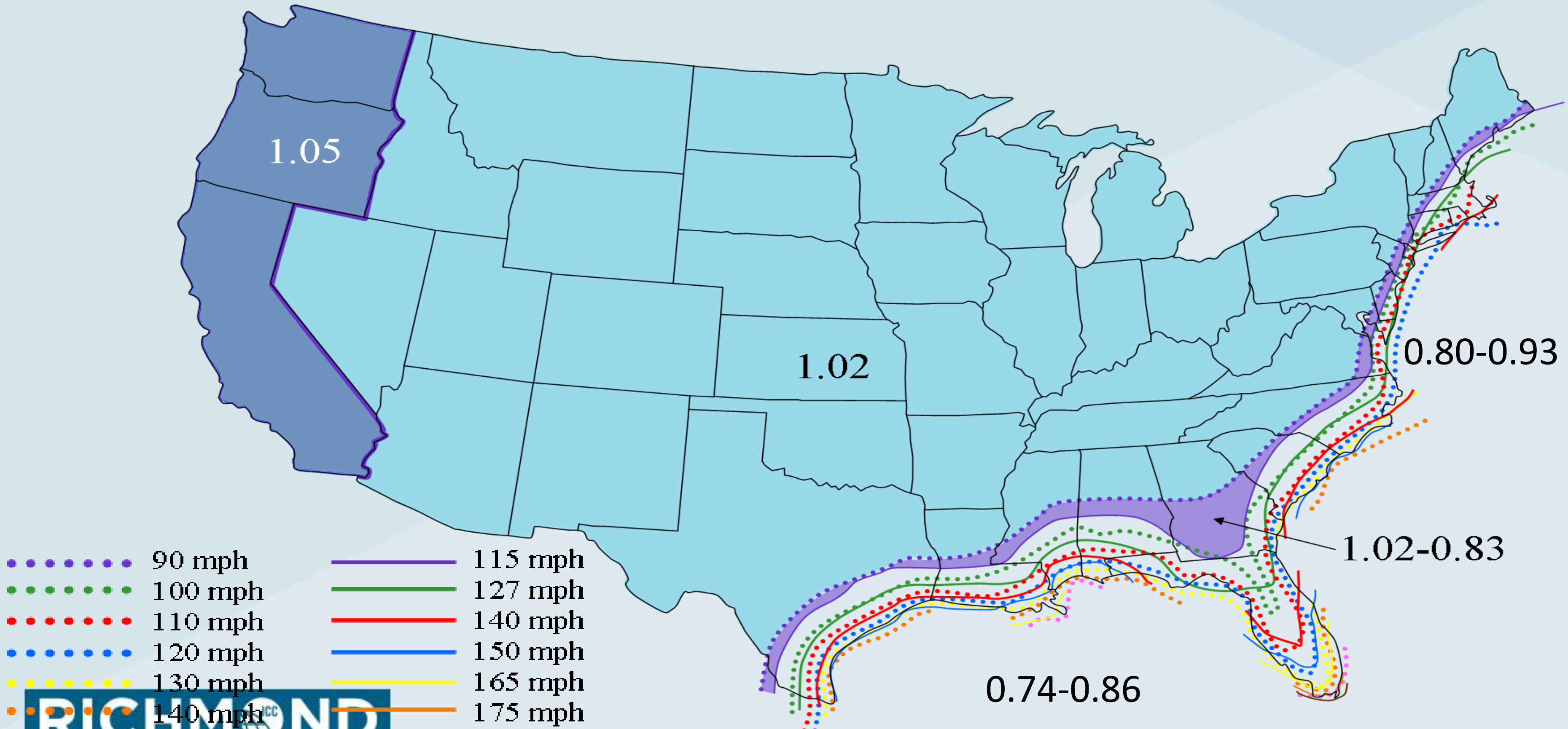


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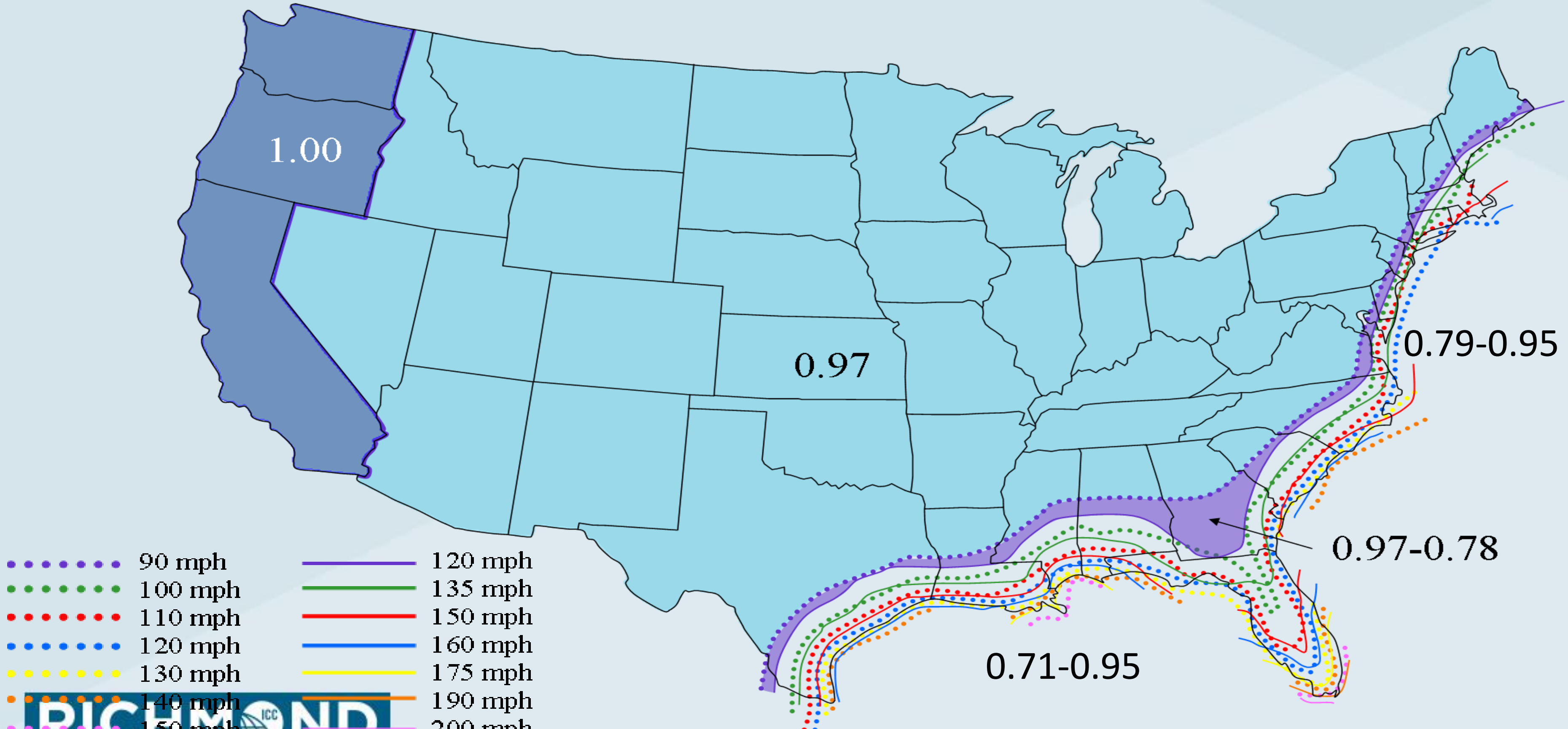
# RC III and IV Comparison

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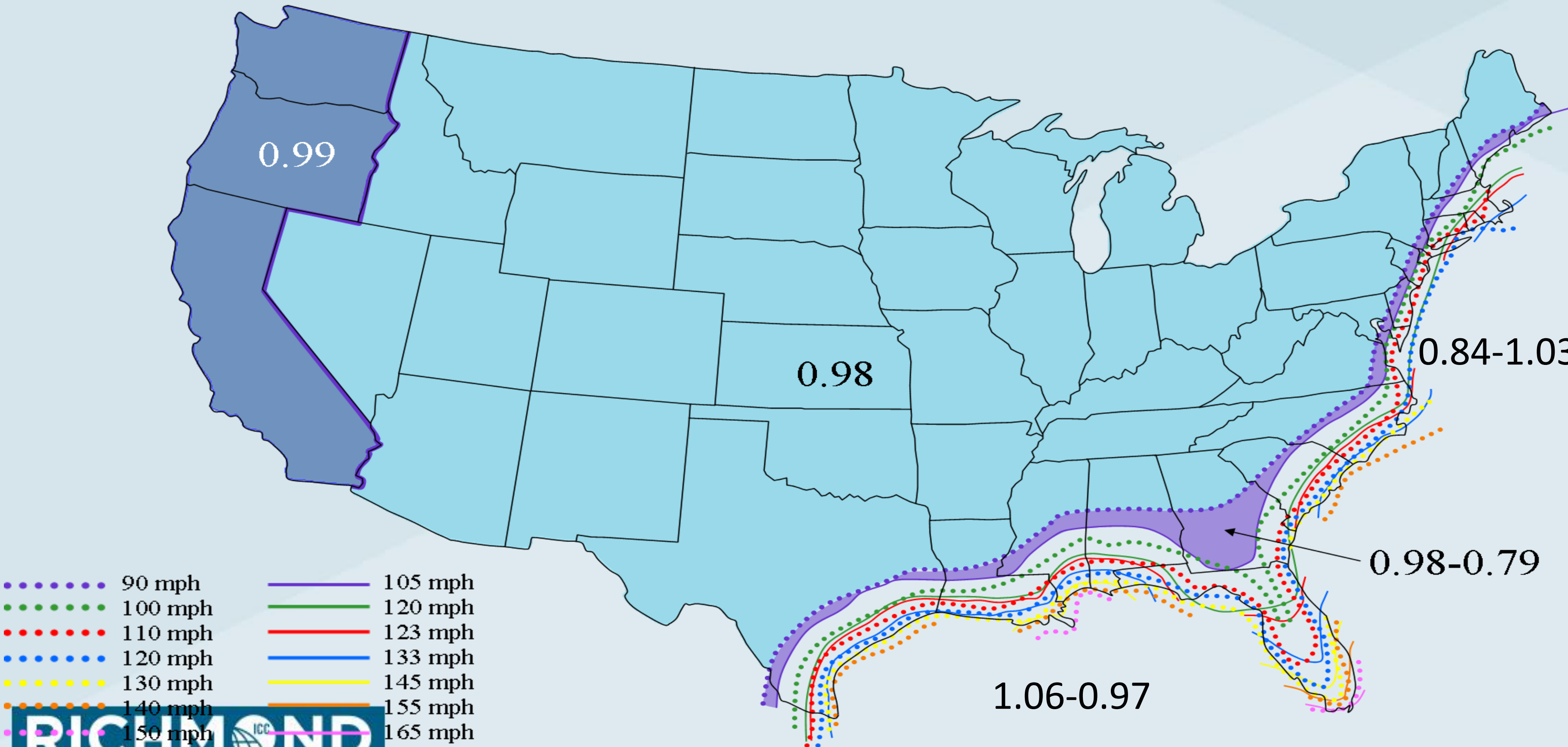
# Risk Category I Comparison

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# ASCE 7-16 Design Wind Speed Maps

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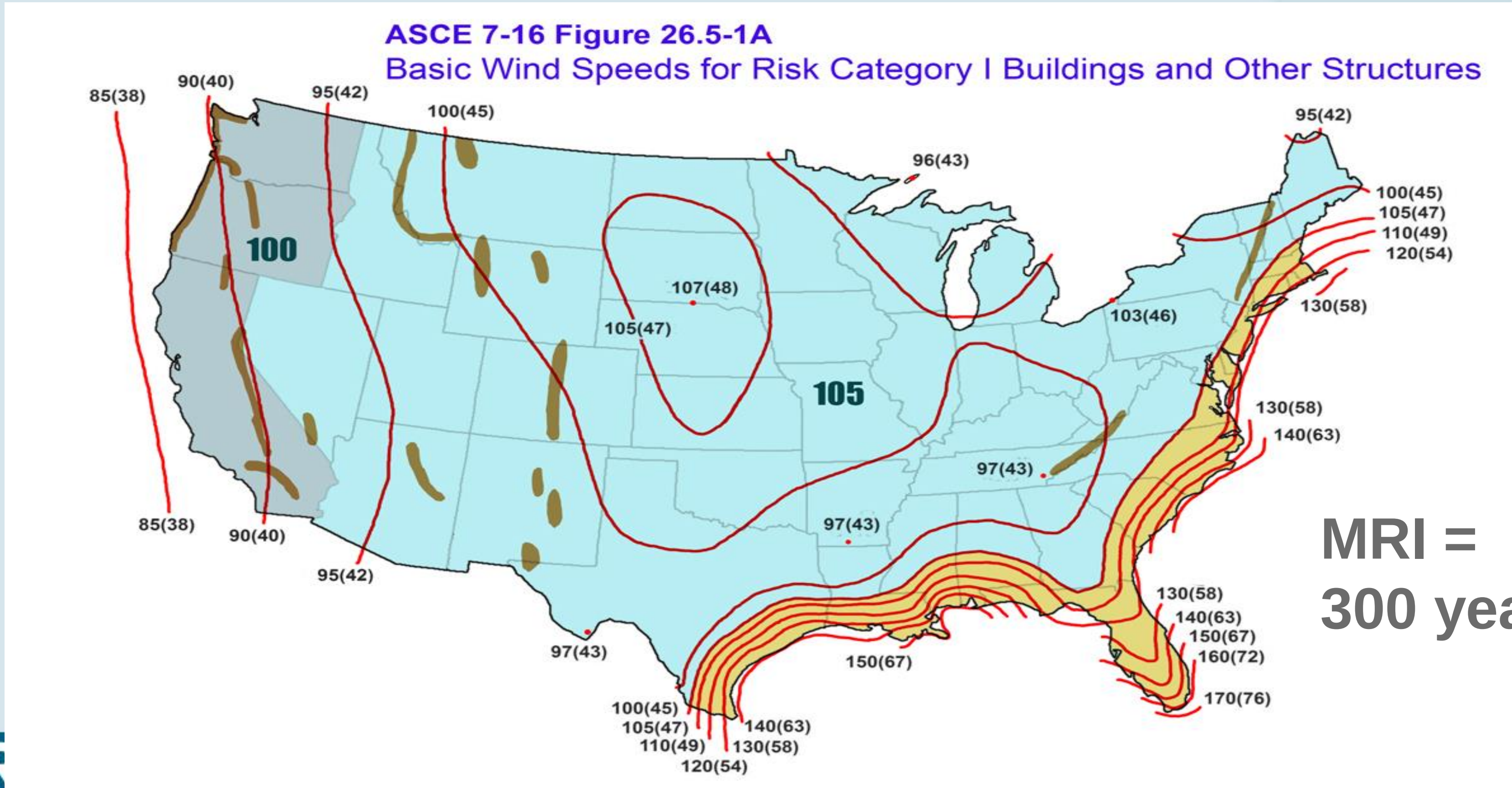
**ASCE 7-16:**

- Basic Wind Speed Maps, Figures 26.5-1 A, B, C Replaced
- New Figure D Introduced

# ASCE 7-16 Design Wind Speed Map RC I




**MRI = 300 years**

# ASCE 7-16 Design Wind Speed Map RC II

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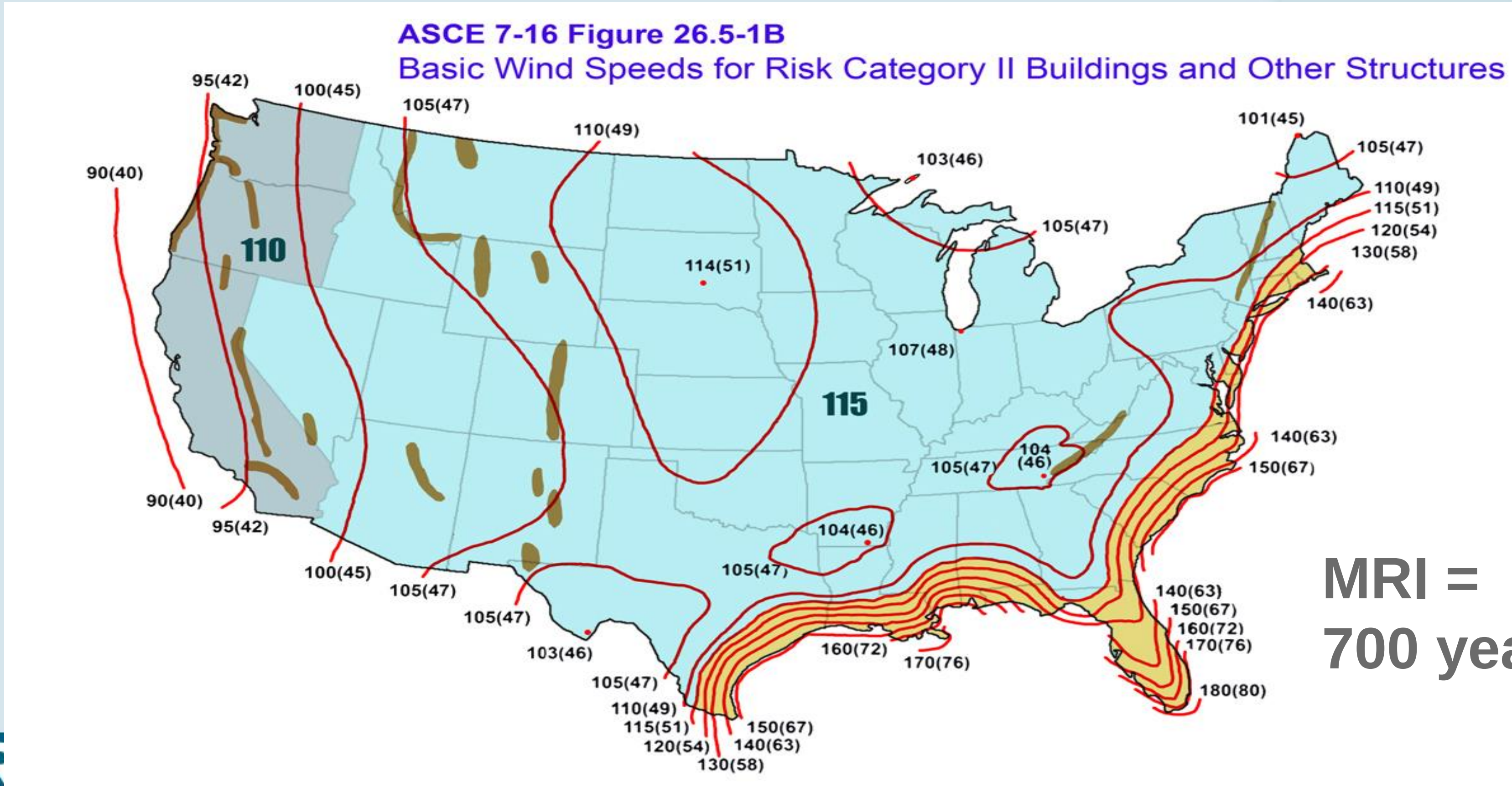


MRI = 700 years

# ASCE 7-16 Design Wind Speed Map RC III

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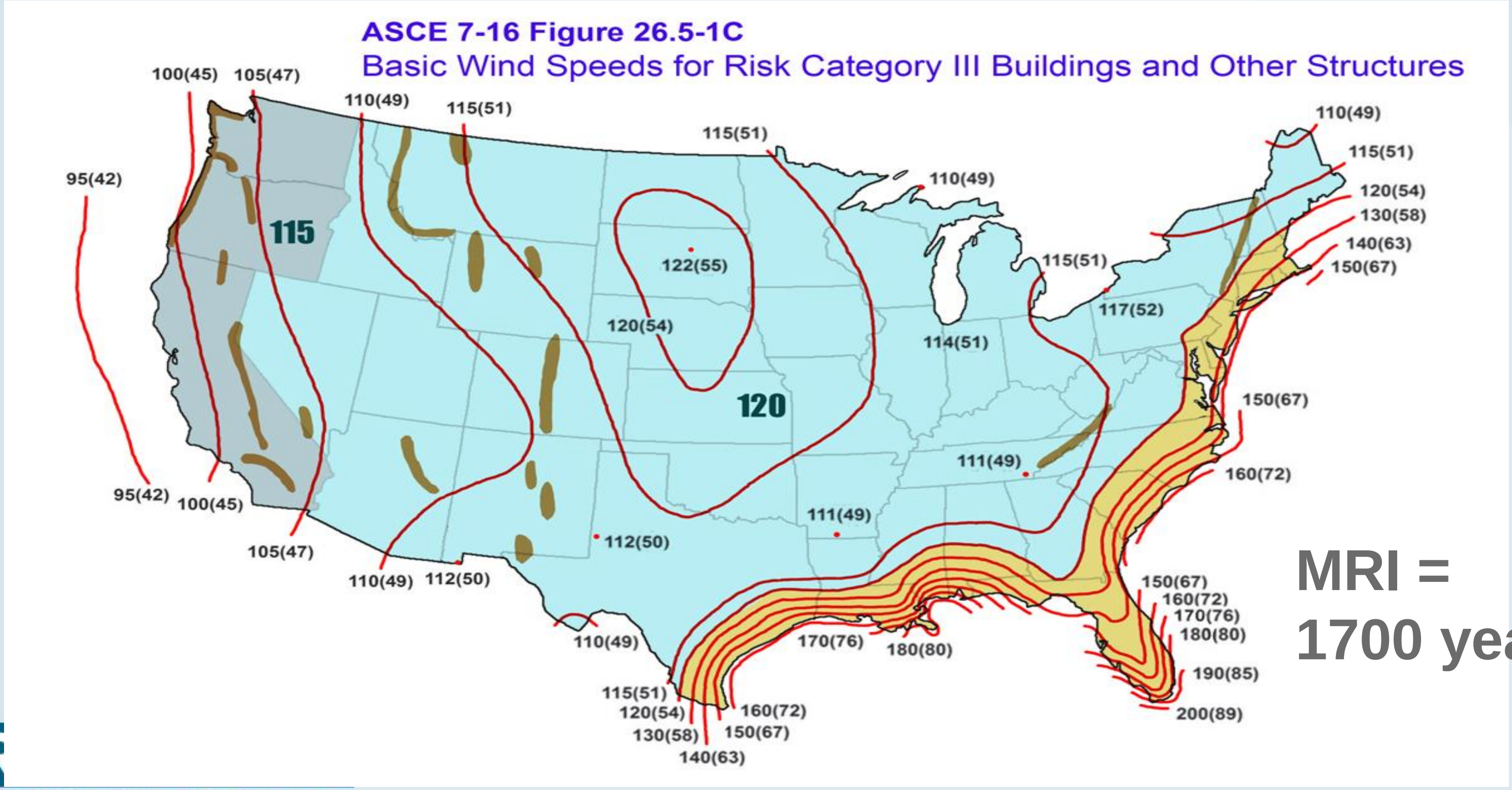
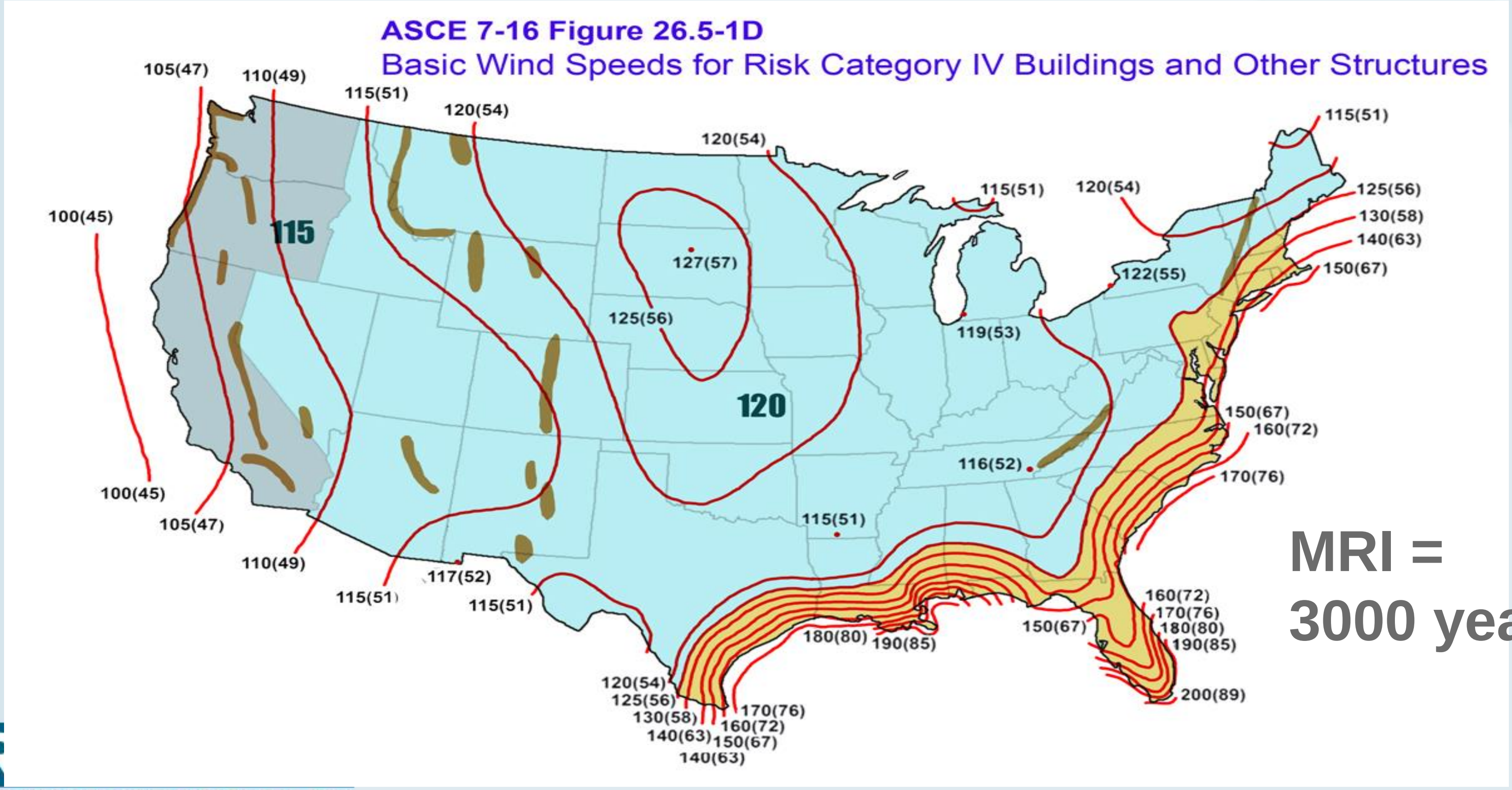



MRI = 1700 years

# ASCE 7-16 Design Wind Speed Map RC IV




**MRI = 3000 years**

# SNOW

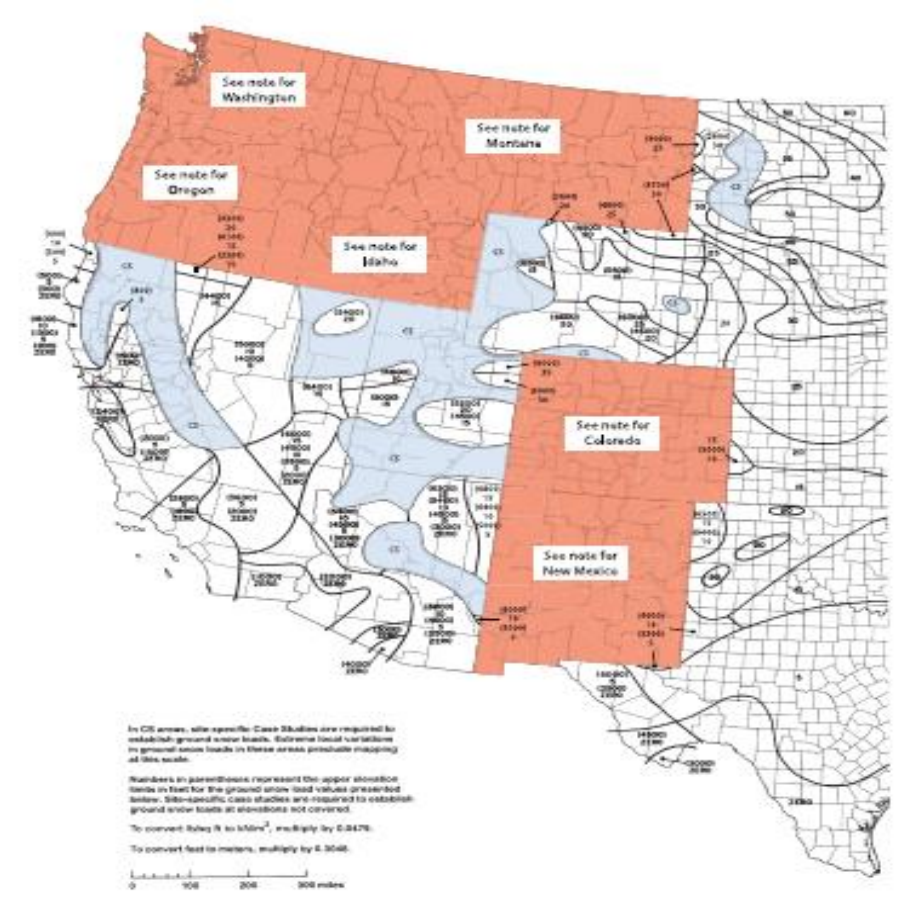
# ASCE 7-16 Ground Snow Load

Maps replaced by tables for:

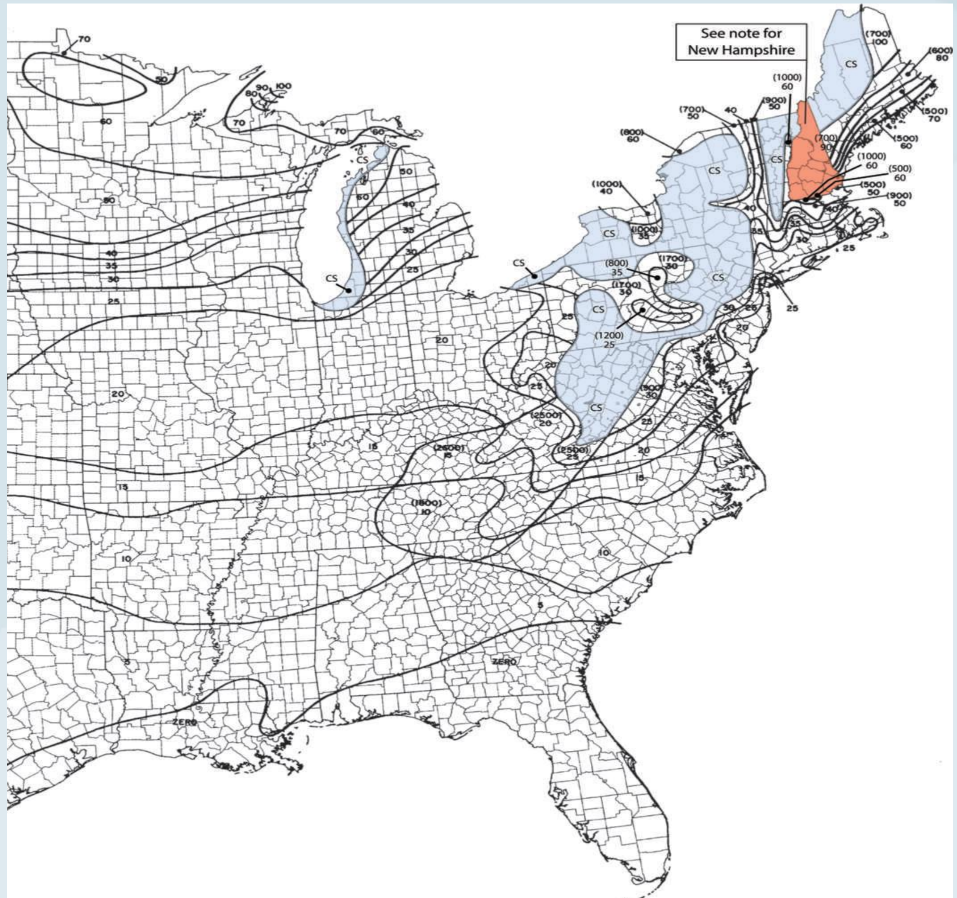
- Colorado (Table 7.2-2)
- Idaho (Table 7.2-3)
- Montana (Table 7.2-4)
- New Hampshire (Table 7.2-8)
- New Mexico (Table 7.2-6)
- Oregon (Table 7.2-7)
- Washington (Table 7.2-5)

# ASCE 7-16 Ground Snow Load





# ASCE 7-16 Ground Snow Load



# EARTHQUAKE

# ASCE 7-10 Seismic Design Map Updates

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## CHANGE 1:

USGS has updated some source zone models, have used Next Generation Attenuation (NGA) relationships, to the exclusion of old relationships, in the western U.S., and have used new attenuation relationships in addition to old ones in the central and eastern U.S.

UPDATED SOURCE ZONES, NEW ATTENUATION RELATIONSHIPS

# Seismic Design Map Updates

Ground motion – particularly long-period ground motion decreased by 50% or more in many parts of the U.S as a result of Change 1.

# Seismic Design Map Updates

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**CHANGE 2:**

Uniform-hazard ground motion has now been replaced by risk-targeted ground motion.

This switch from a 2% in 50-year hazard level to a 1% in 50-year collapse risk target has resulted in up to 30% decreases in ground motion in high-hazard areas of the central and eastern U.S. and in coastal Oregon and in some increases in other areas.

UNIFORM HAZARD ➡ RISK TARGETED

# Seismic Design Map Updates

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## CHANGE 3:

A switch has been made from “geo-mean” ground motions (square root of the product of ground motions in any two orthogonal directions) to maximum direction ground motions. This has resulted in increases in short-period ground motion by a factor of 1.1 and in long-period ground motion by a factor of 1.3 (these are scalar multipliers, based on work by Andrew Whittaker).

GEO-MEAN → MAXIMUM DIRECTION

# Seismic Design Map Updates

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## CHANGE 4:

Deterministic ground motions have been changed from 150% of median ground motions to 84th percentile ground motions, which are 180% of median ground motions.

150% OF MEDIAN → 180% OF MEDIAN

# Seismic Design Map Updates

The net result of these four major changes has been that short-period ground motions have gone down rather substantially in the central and eastern U.S.; elsewhere, status quo has by and large been maintained.

# $S_S$-values after Changes 1- 4 Compared to ASCE 7-05 $S_S$-values

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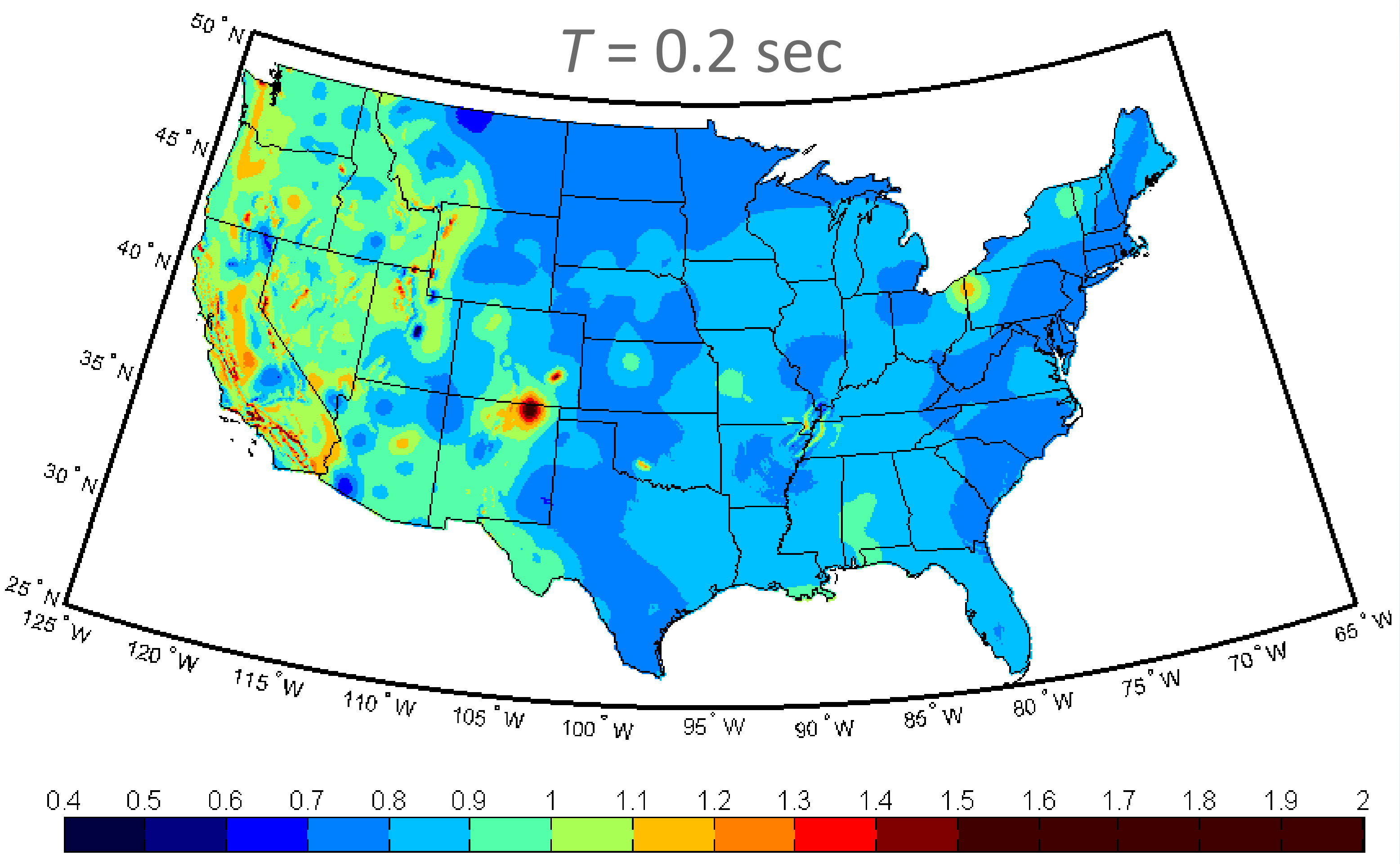


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# $S_1$-values after Changes 1- 4 Compared to ASCE 7-05 $S_1$-values

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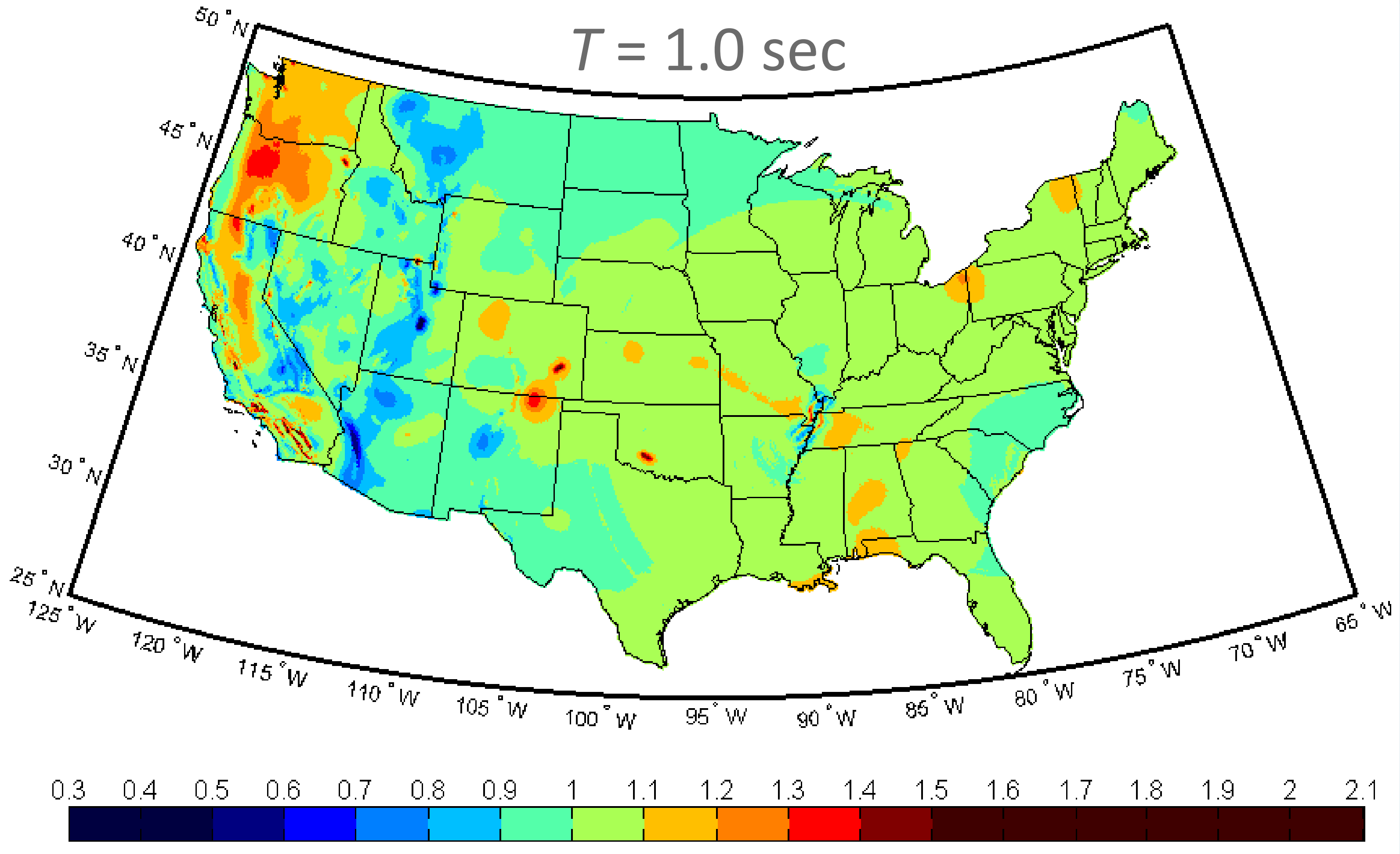


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# Comparison of $S_{DS}$-Values and Corresponding SDC for Twelve (12) City Sites, Assuming Default Site Class D



| City | ASCE 7-05 | | ASCE 7-10 | |
|---|---|---|---|---|
| | SDC | $S_{DS}$ (g) | SDC | $S_{DS}$ (g) |
| Los Angeles | D | 1.44 | E | 1.60 |
| Irvine | D | 1.00 | D | 1.03 |
| San Diego | D | 1.07 | D | 0.84 |
| Sacramento | D | 0.52 | D | 0.57 |
| San Francisco | D | 1.00 | D | 1.00 |
| Seattle | D | 0.97 | D | 0.91 |
| Portland | D | 0.73 | D | 0.72 |
| Boise | B | 0.32 | B | 0.32 |
| Las Vegas | D | 0.51 | C | 0.46 |
| St. Louis | D | 0.52 | C | 0.42 |
| Chicago | B | 0.18 | A | 0.14 |
| New York | C | 0.37 | B | 0.29 |

# Comparison of $S_{D1}$-Values and Corresponding SDC for Twelve (12) City Sites, Assuming Default Site Class D

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| City | ASCE 7-05 | | ASCE 7-10 | |
|---|---|---|---|---|
| | SDC | $S_{D1}$ (g) | SDC | $S_{D1}$ (g) |
| Los Angeles | D | 0.72 | E | 0.84 |
| Irvine | D | 0.53 | D | 0.57 |
| San Diego | D | 0.64 | D | 0.49 |
| Sacramento | D | 0.31 | D | 0.35 |
| San Francisco | D | 0.68 | D | 0.64 |
| Seattle | D | 0.49 | D | 0.53 |
| Portland | D | 0.39 | D | 0.44 |
| Boise | C | 0.17 | C | 0.17 |
| Las Vegas | D | 0.25 | D | 0.24 |
| St. Louis | D | 0.24 | D | 0.24 |
| Chicago | B | 0.10 | B | 0.10 |
| New York | B | 0.11 | B | 0.11 |

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# Comparison of SDC of ASCE 7-10 with SDC for Twelve (12) City Sites, Assuming Default Site Class D

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| City | ASCE 7-05 | ASCE 7-10 |
|---|---|---|
| | SDC | SDC |
| Los Angeles | D | E |
| Irvine | D | D |
| San Diego | D | D |
| Sacramento | D | D |
| San Francisco | D | D |
| Seattle | D | D |
| Portland | D | D |
| Boise | C | C |
| Las Vegas | D | D |
| St. Louis | D | D |
| Chicago | B | B |
| New York | C | B |

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# Changes in Ground Motion Parameters

| Site Location | $S_s$ | | | $S_1$ | | |
|---|---|---|---|---|---|---|
| | ASCE 7-05 | ASCE 7-10 | Change (%) | ASCE 7-05 | ASCE 7-10 | Change (%) |
| San Diego | 1.572g | 1.223g | -22 | 0.616g | 0.471g | -32 |
| San Bernardino | 1.698g | 2.367g | +39 | 0.622g | 1.083g | +74 |
| San Ramon | 1.988g | 2.385g | +20 | 0.746g | 0.906g | +21 |

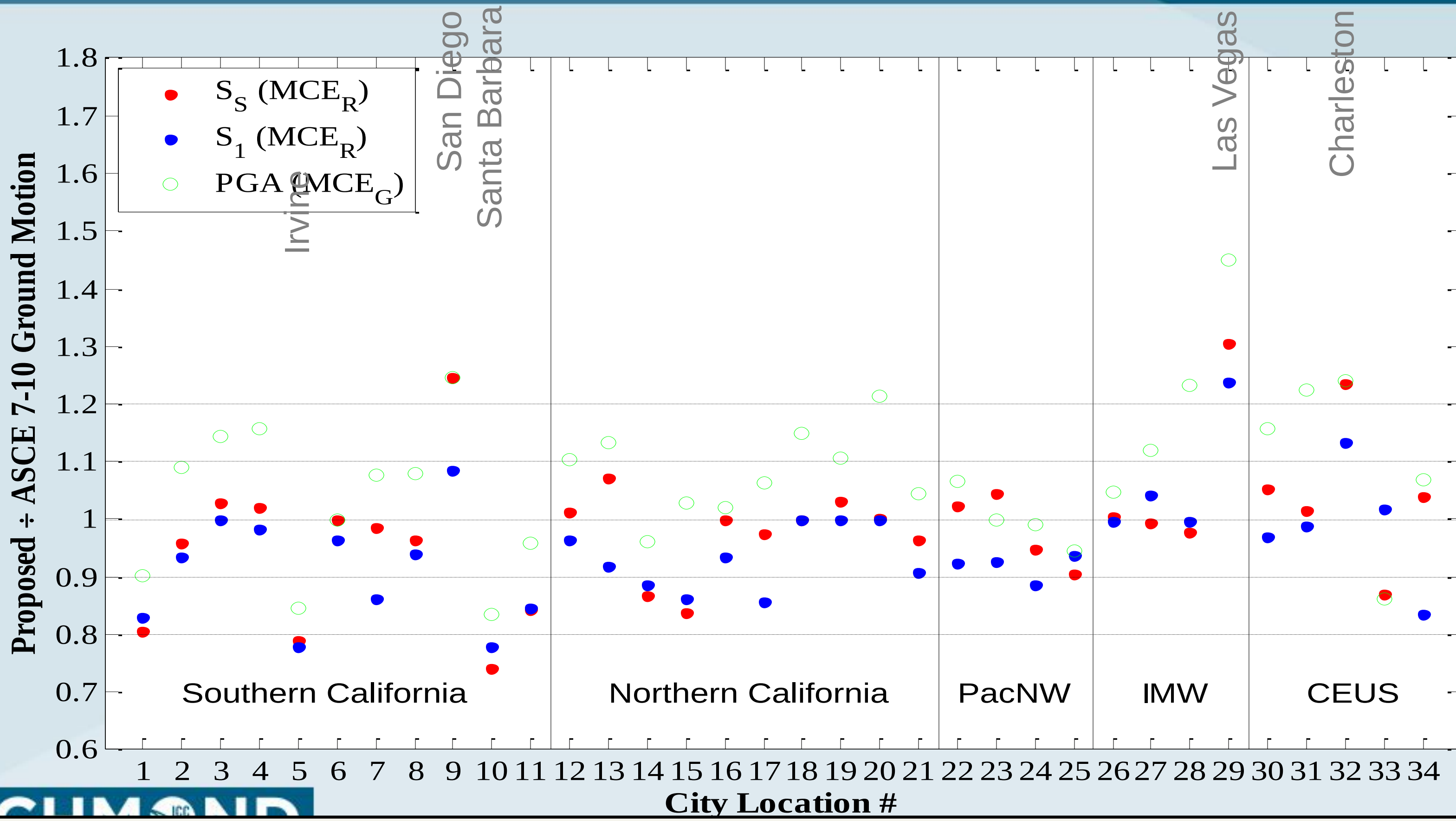
# ASCE 7-16 Seismic Ground Motion Maps

The following Chapter 22 figures (maps) updated:

FIGURE 22-1 $S_S$ Risk-Targeted Maximum Considered Earthquake ($MCE_R$) Ground Motion Parameter for the Conterminous United States for 0.2 s Spectral Response Acceleration (5% of Critical Damping), Site Class B.

FIGURE 22-2 $S_1$ Risk-Targeted Maximum Considered Earthquake ($MCE_R$) Ground Motion Parameter for the Conterminous United States for 1.0 s Spectral Response Acceleration (5% of Critical Damping), Site Class B.

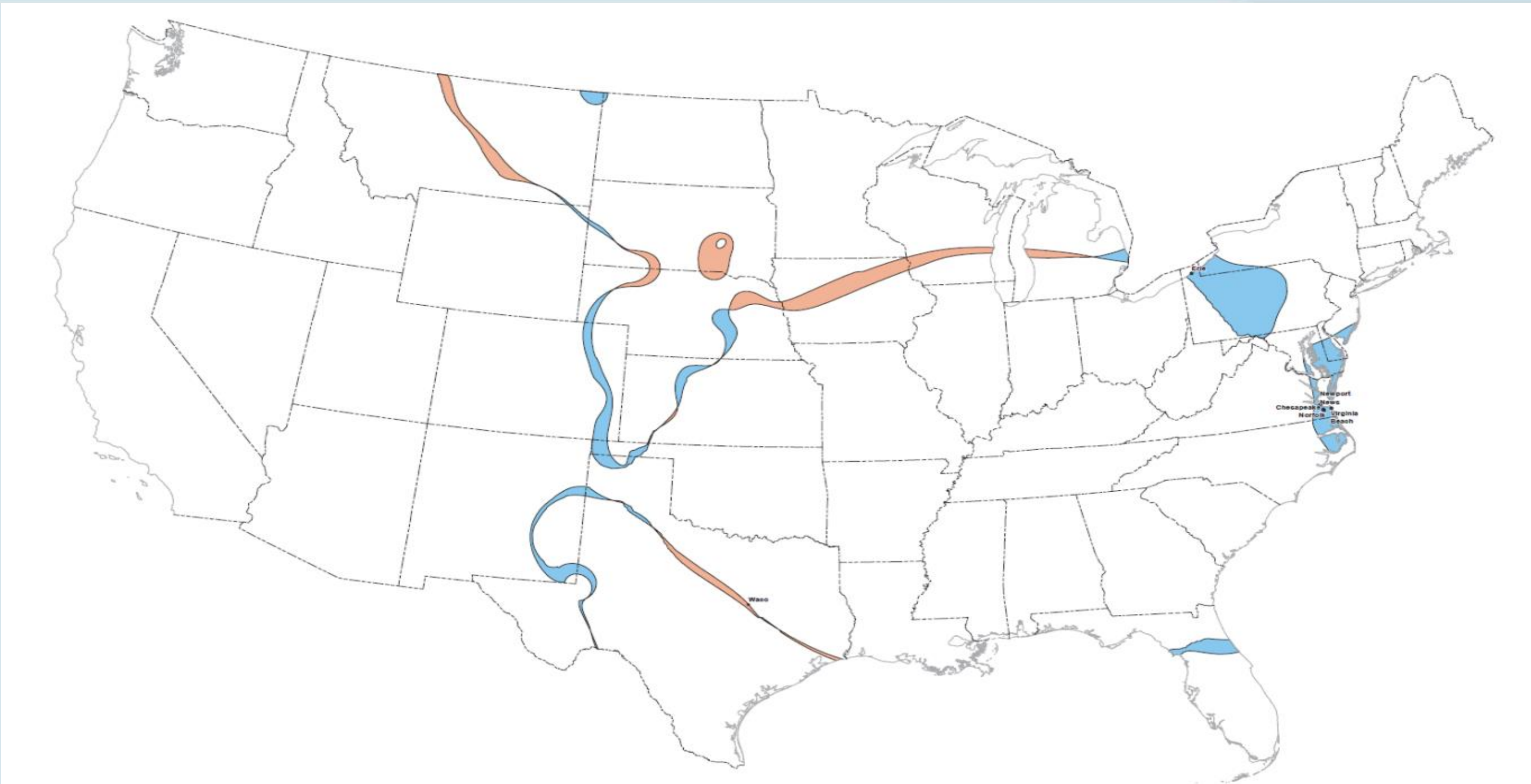
# Changes in $MCE_R$ & $MCE_G$ Values




*American Society of Civil Engineers 7-16 Standard (ASCE 7-16) Seismic Subcommittee (SSC) Meeting*

*"Resolution of Main-Committee Comments on Proposal to Update Conterminous U.S. Maps," N. Luco, USGS et al* *May 7, 2015*

# Changes in SDC (A→B & B→A)

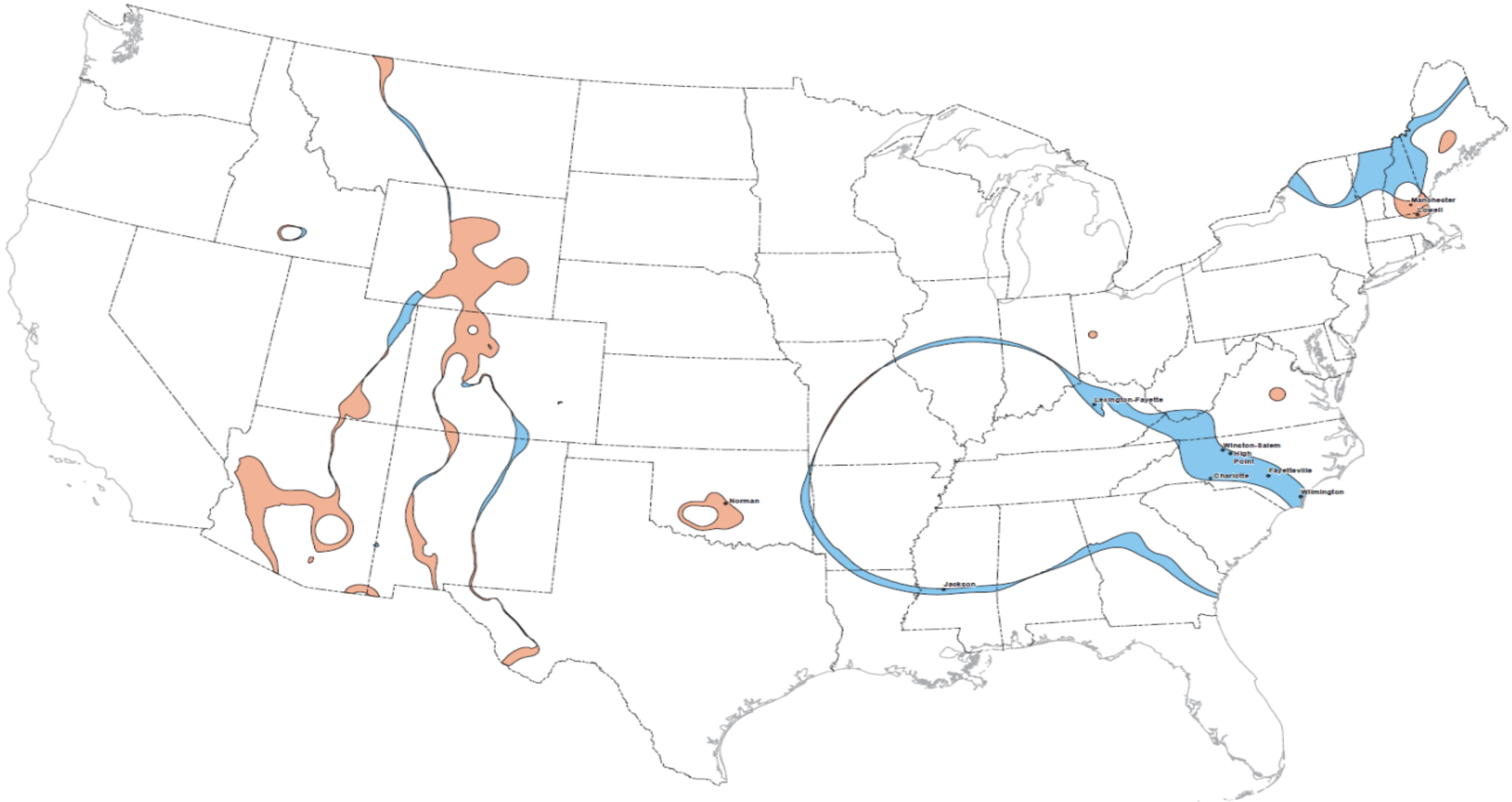



*American Society of Civil Engineers 7-16 Standard (ASCE 7-16) Seismic Subcommittee (SSC) Meeting*



*"Resolution of Main-Committee Comments on Proposal to Update Conterminous U.S. Maps," N. Luco, USGS et al* *May 7, 2015*

# Changes in SDC (B→C & C→B)

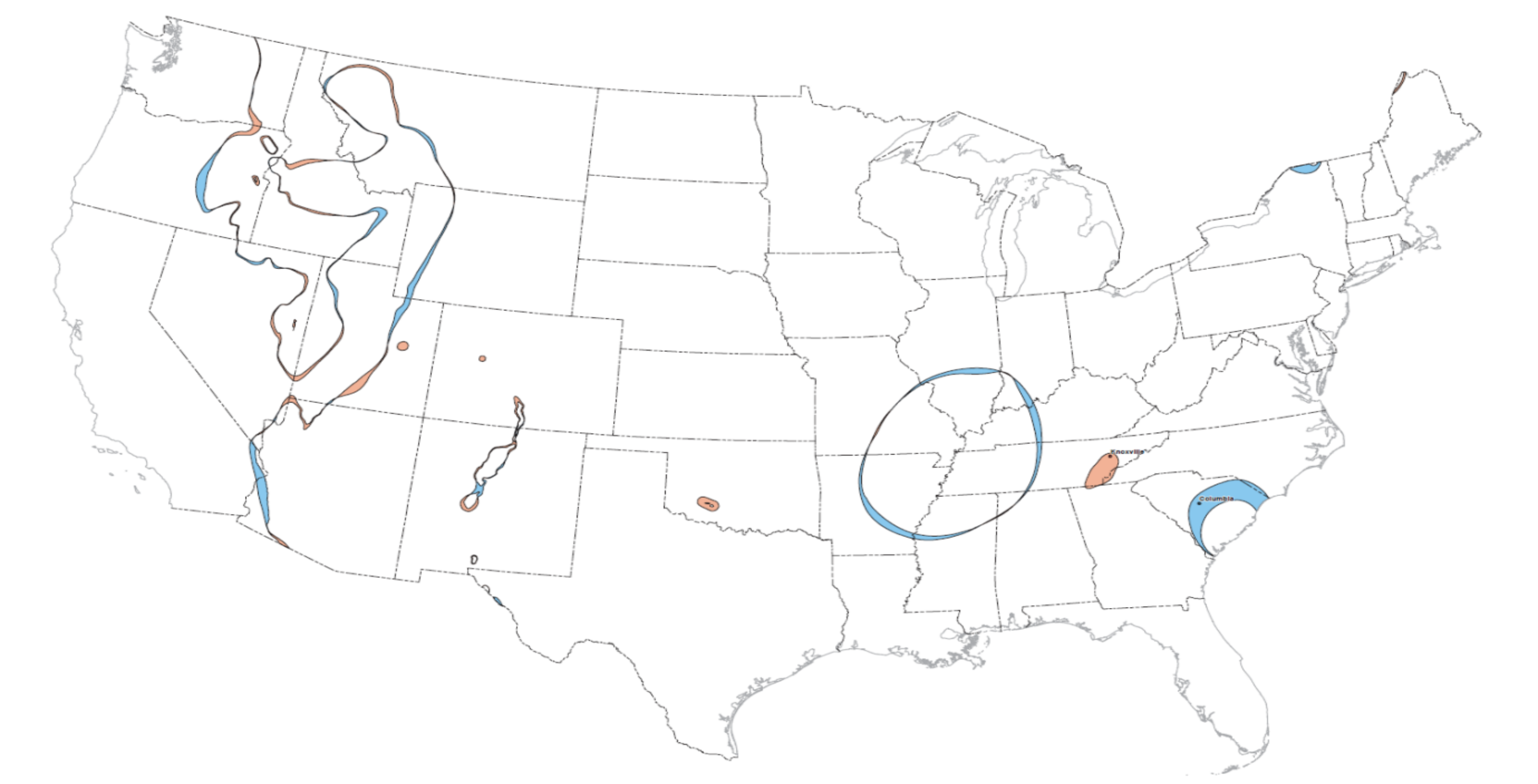



*American Society of Civil Engineers 7-16 Standard (ASCE 7-16) Seismic Subcommittee (SSC) Meeting*



*"Resolution of Main-Committee Comments on Proposal to Update Conterminous U.S. Maps," N. Luco, USGS et al* *May 7, 2015*

# Changes in SDC (C→D & D→C)




American Society of Civil Engineers 7-16 Standard (ASCE 7-16) Seismic Subcommittee (SSC) Meeting



*"Resolution of Main-Committee Comments on Proposal to Update Conterminous U.S. Maps," N. Luco, USGS et al* *May 7, 2015*

# Changes in SDC (D→E & E→D)


*American Society of Civil Engineers 7-16 Standard (ASCE 7-16) Seismic Subcommittee (SSC) Meeting*



*"Resolution of Main-Committee Comments on Proposal to Update Conterminous U.S. Maps," N. Luco, USGS et al* *May 7, 2015*

# SDC Changes

| Latitude | Longitude | City | State | SDC Change | $S_S$ Change | $S_1$ Change |
|---|---|---|---|---|---|---|
| 31.55 | -97.15 | Waco | TX | A to B | -8% | +1% |
| *42.13* | *-80.09* | *Erie* | *PA* | *B to A* | *-31%* | *-26%* |
| 37.03 | -76.35 | Hampton | VA | B to A | -6% | -16% |
| 36.98 | -76.43 | Newport News | VA | B to A | -6% | -17% |
| 36.85 | -75.98 | Virginia Beach | VA | B to A | -9% | -17% |
| 36.85 | -76.28 | Norfolk | VA | B to A | -8% | -17% |
| 36.82 | -76.27 | Chesapeake | VA | B to A | -9% | -17% |
| *43* | *-71.45* | *Manchester* | *NH* | *B to C* | *+62%* | *+6%* |
| *42.63* | *-71.32* | *Lowell* | *MA* | *B to C* | *+51%* | *+2%* |
| *35.22* | *-97.44* | *Norman* | *OK* | *B to C* | *+25%* | *+8%* |
| 38.05 | -84.46 | Lexington-Fayette | KY | C to B | -8% | -10% |
| 36.1 | -80.24 | Winston-Salem | NC | C to B | -11% | -18% |
| 35.96 | -80.01 | High Point | NC | C to B | -16% | -20% |
| *35.05* | *-78.88* | *Fayetteville* | *NC* | *C to B* | *-30%* | *-26%* |
| 35.23 | -80.84 | Charlotte | NC | C to B | -17% | -20% |
| *34.23* | *-77.94* | *Wilmington* | *NC* | *C to B* | *-29%* | *-26%* |
| 32.3 | -90.18 | Jackson | MS | C to B | -12% | -5% |

*American Society of Civil Engineers 7-16 Standard (ASCE 7-16) Seismic Subcommittee (SSC) Meeting*



*"Resolution of Main-Committee Comments on Proposal to Update Conterminous U.S. Maps," N. Luco, USGS et al* May 7, 2015

# SDC Changes

| Latitude | Longitude | City | State | SDC Change | $S_S$ Change | $S_1$ Change |
|---|---|---|---|---|---|---|
| *35.96* | *-83.92* | *Knoxville* | *TN* | *C to D* | *+51%* | *+8%* |
| 34 | -81.03 | Columbia | SC | D to C | -17% | -20% |
| *37.98* | *-122.03* | *Concord* | *CA* | *E to D* | *-15%* | *-22%* |
| 34.28 | -119.29 | Ventura | CA | E to D | -18% | -18% |
| *34.2* | *-119.18* | *Oxnard* | *CA* | *E to D* | *-31%* | *-29%* |
| *34.27* | *-118.78* | *Simi Valley* | *CA* | *E to D* | *-23%* | *-23%* |
| 34.18 | -118.31 | Burbank | CA | E to D | -7% | -19% |
| *34.14* | *-118.26* | *Glendale* | *CA* | *E to D* | *-24%* | *-23%* |
| 34.05 | -118.24 | Los Angeles | CA | E to D | -19% | -17% |
| *34.07* | *-118.03* | *El Monte* | *CA* | *E to D* | *-22%* | *-19%* |
| *34.07* | *-117.94* | *West Covina* | *CA* | *E to D* | *-21%* | *-19%* |
| 34.02 | -118.17 | East Los Angeles | CA | E to D | -18% | -16% |
| 34.06 | -117.75 | Pomona | CA | E to D | -16% | -18% |
| 33.94 | -117.23 | Moreno Valley | CA | E to D | +3% | -8% |
| *33.49* | *-117.15* | *Temecula* | *CA* | *E to D* | *-17%* | *-25%* |

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*"Resolution of Main-Committee Comments on Proposal to Update Conterminous U.S. Maps," N. Luco, USGS et al* May 7, 2015

# HELP AVAILABLE from SKGA

# Web Seminars

- SKGA offers on average two live web seminars a week.

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# Web Seminars

- Many of the web seminars are on code changes.
- Address changes in the IBC, ASCE 7 as well as material standards for concrete, structural steel, cold-formed steel, masonry and wood.

# Web Seminars

- Altogether, SKGA web seminars provide a comprehensive coverage of all code changes in structural provisions.

# Web Seminar Recordings

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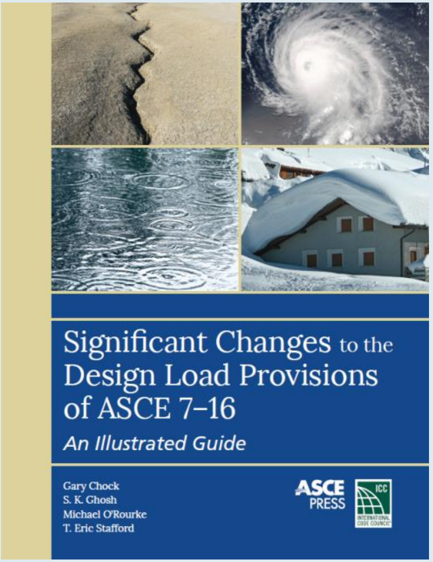
- Almost all SKGA web seminars are recorded, and the recordings are offered as DVDs and On-Demand videos.
- Offers convenience, cost-savings as well as CEUs to those who could not attend the live seminar.

# Publications

- SKGA produced the seismic portion of the recent ASCE publication - *Significant Changes to the Design Load Provisions of ASCE 7-16 - An Illustrated Guide.*
- Detailed explanation of every significant change in ASCE 7-16 is provided with illustrations.

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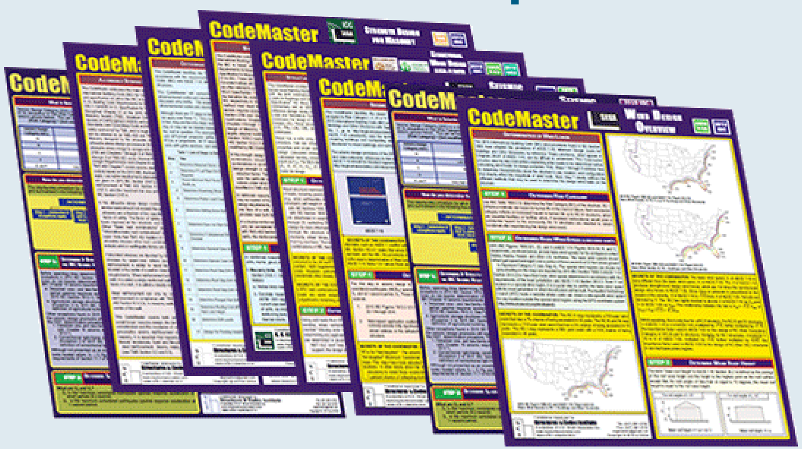
# CodeMasters



- CodeMasters are multi-page laminated reference tools that provide condensed clear explanations of difficult code requirements on various structural topics for everyday use and for taking to P.E. and S.E. exams.



# CodeMasters

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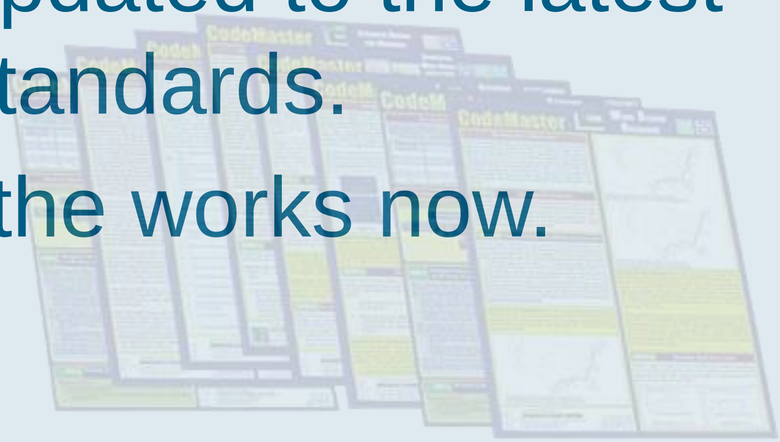
- SKGA offers a set of seven CodeMasters on seismic, wind, snow, flood, masonry and wood design.
- The whole set is kept updated to the latest IBC and its reference standards.
- The 2018 IBC set is in the works now.



# Blog

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## ACI 318 Requirements - General and Member-Specific

*Posted on 2017-04-21*
*Topics: ACI 318*
Return to Blog Index

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Image Courtesy: National Institute of Standards and Technology (NIST)

In the past, we have blogged about how ACI 318-14 has been completely reorganized to be a member-based document. The idea is that within each chapter devoted to a particular member type such as beam or column, the user will find all the requirements necessary to design that particular member type. Through its 2011 edition, certain chapters of ACI 318 contained provisions that applied to all member types, while there were other chapters that contained requirements specific to a particular member type. The advantage of moving to the new member-based format of ACI 318-14 becomes evident from the following question we recently responded to.

**Q.** I have a question about Table 10.7.6.5.2 in the new ACI 318-14. The table shows the maximum spacing of shear reinforcement in columns. I do not recall this table in ACI 318-11. When a column requires shear reinforcement ($V_u > \varphi V_c/2$), has the requirement always been that maximum spacing must be less than $d/2$ per 11.4.5.1 (ACI 318-11) or does this requirement not apply to columns (compression members)? I always thought this limitation applied to all members subjected to shear but many engineers in my office do not agree with that statement. It is pretty clear in this new code but was somewhat vague in the old. Thanks for any help.

**A.** The provisions of ACI 318-11 Sections 11.1 through 11.4 have always applied to beams as well as columns. If ACI 318 did not mean them to be applicable to columns, that would have been specifically stated. If different provisions were meant to apply to beams and columns, a clear distinction would have been made between the requirements for beams and those for columns. ACI 318-11 Sections 11.1-11.4 in fact apply to all structural members for which specific provisions are not included in Chapter 11. Such structural members are: Deep beams (11.7), Brackets and corbels (11.8), Walls (11.9), and Slabs and footings (11.11). Please note that 318-11 Section 11.10 gives you provisions for beam-column joints.

There's no change in the above regard from ACI 318-11 to ACI 318-14. The tabular format used as often as possible in ACI 318-14 just makes certain things clearer, as you yourself have noted.

# Blog

- SKGA website hosts a blog page that addresses many interesting, thought-provoking and important issues related to structural engineering and code applications that have come up over the years.

# Technical Inquiries

- SKGA has a long standing tradition of helping members of the structural engineering community with their technical inquiries, often free of charge.

# Technical Inquiries

- Inquiries could be simple enough for a quick email response
- Or complex enough necessitating considerable research
- And everything in between.

# Journal Articles

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- Dr. S. K. Ghosh continues with his long history of writing journal and magazine articles on critical structural issues including changes in the IBC, ASCE 7 and ACI 318.

# Computer Programs

- SKGA offers a number of computer programs to simplify the application of complicated code requirements.
- The programs are constantly kept up-to-date when the relevant provisions of the code changes.

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