LOAD & BEHOLD!

KEY UPDATES TO STRUCTURAL CODE REQUIREMENTS

$$C_s = \frac{S_{DS}}{\left(\frac{R}{I}\right)}$$

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NICK WELLING, PE

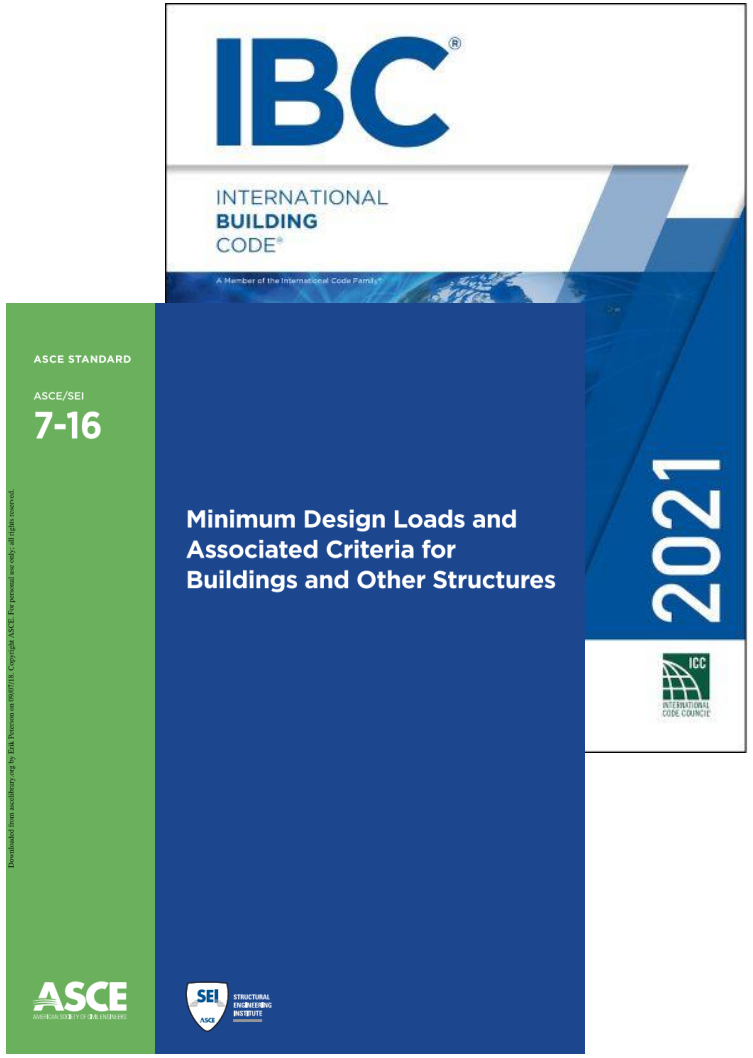
Project Manager

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NEW CODES!

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<u>Adoption & Enforcement:</u>
OR: 04/2026
WA: 05/2027
ID: ??/????



PRESENTATION OVERVIEW

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Topics

- Seismic Loads
- Snow Loads

Key Takeaways

- Code Updates
- Impacts to Design Process
- Impacts to Design Outcomes

WHY CODES (AND ENGINEERS) MATTER

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	2010 Haiti	2010 Chile
Magnitude	7.0	8.8
PGA	0.5g	0.65g
Duration	0.5min	3min
Deaths	200K-300K	<1K
Injured	~300K	12K
Economic Loss	~$14B	~$30B
Building Codes	No Code	Modern Seismic Philosophy



SEISMIC UPDATES

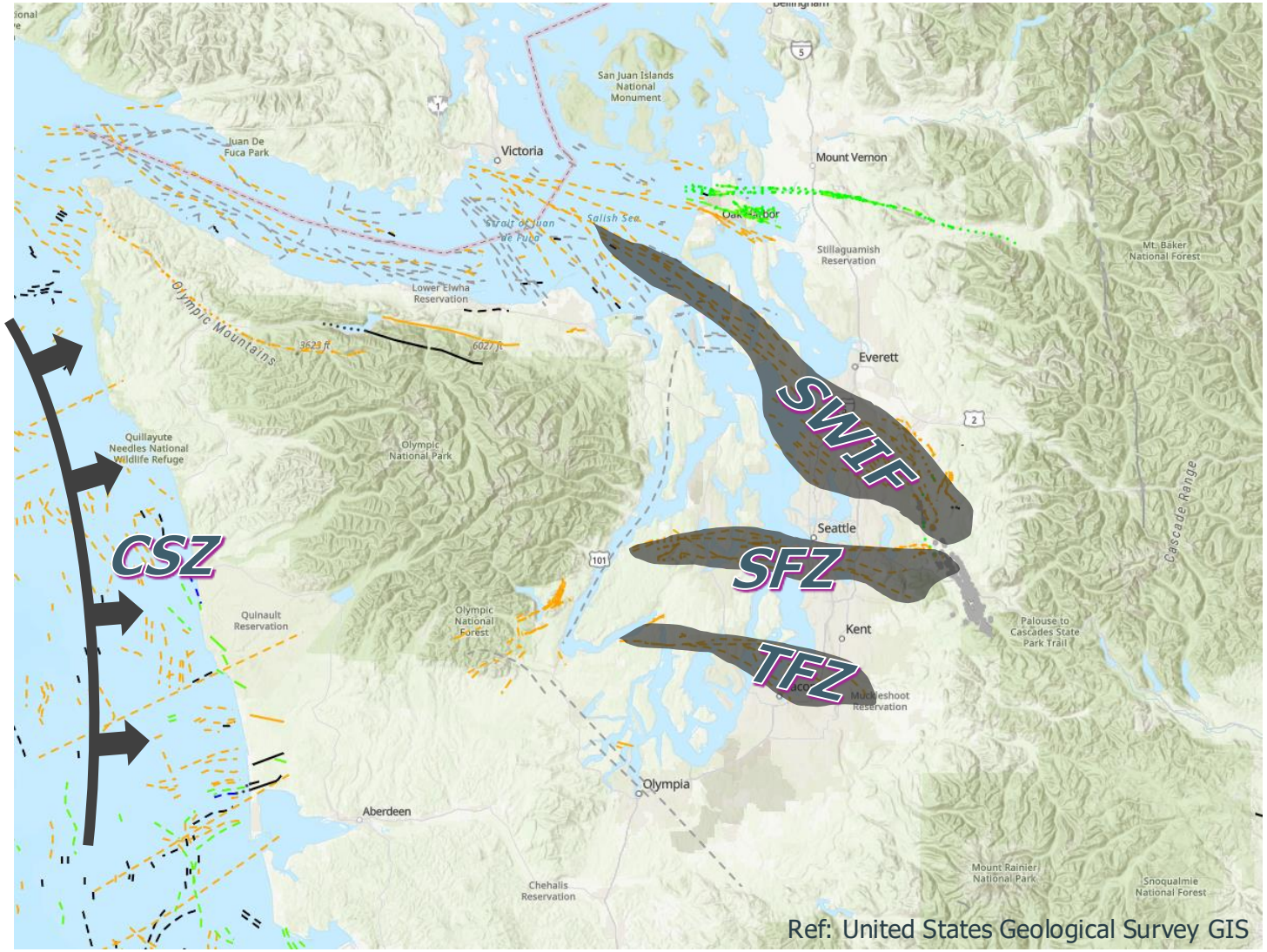


Malhotra, P. K. (2006). Earthquake induced sloshing in tanks with insufficient freeboard. Structural Engineering International, 16(3), 222–225. 1933 Long Beach California Earthquake (photo by: Harold M. Engle)

REGIONAL FAULT EXAMPLE

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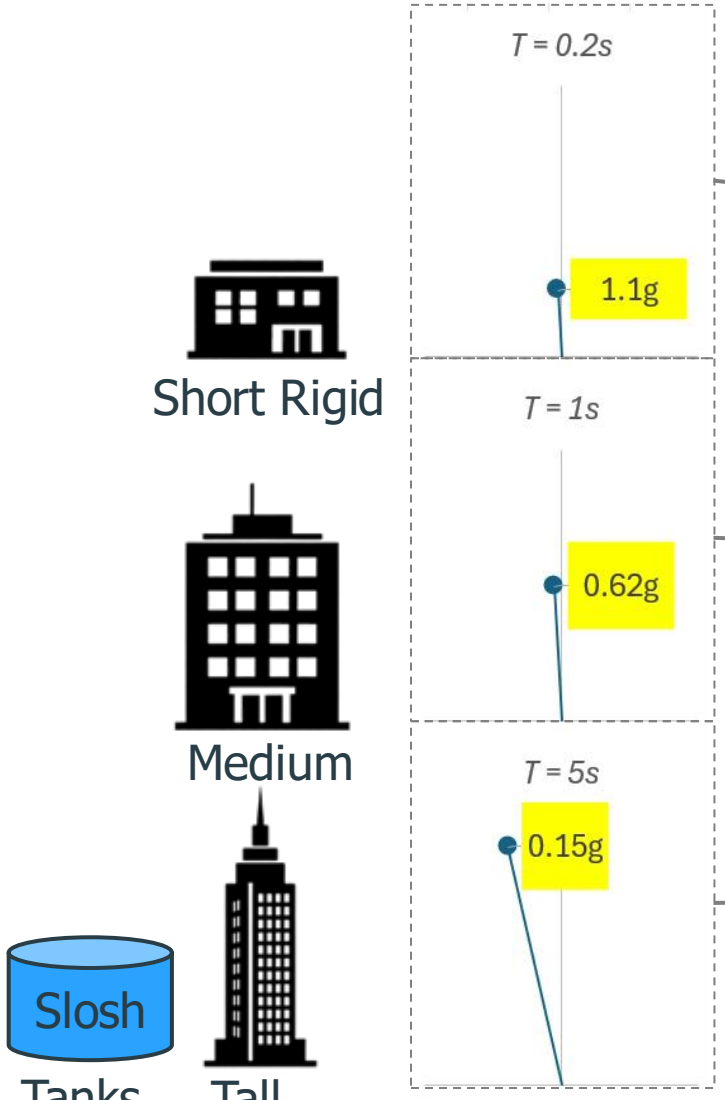
LABEL	FAULT	MAG.
SWIF	SOUTH WHIDBEY ISLAND FAULT	M6.5-7.5
SFZ	SEATTLE FAULT ZONE	M6.5-7.5
TFZ	TACOMA FAULT ZONE	M7.0
CSZ	CASCADIA SUBDUCTION ZONE	M9.0+

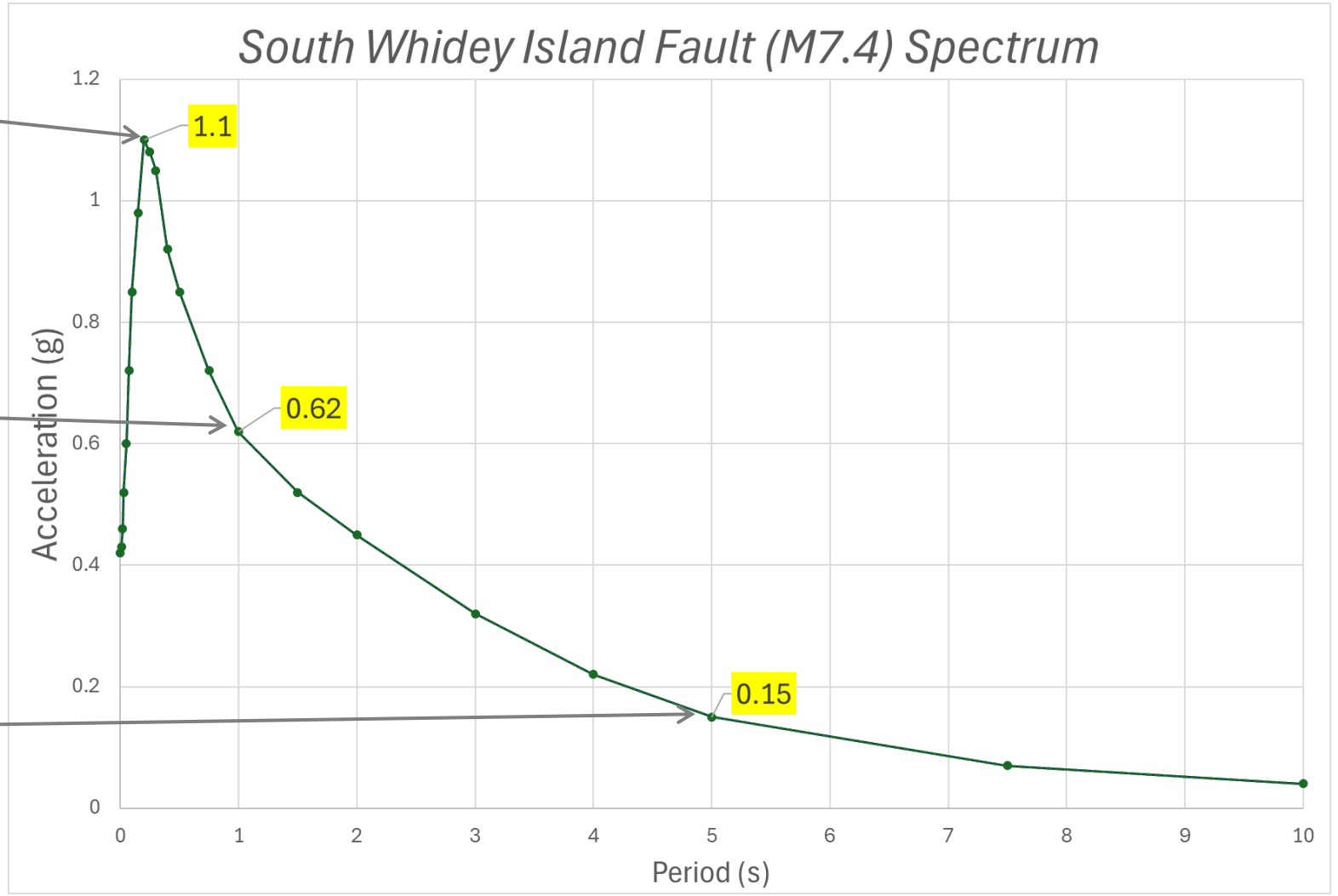


Ref: United States Geological Survey GIS

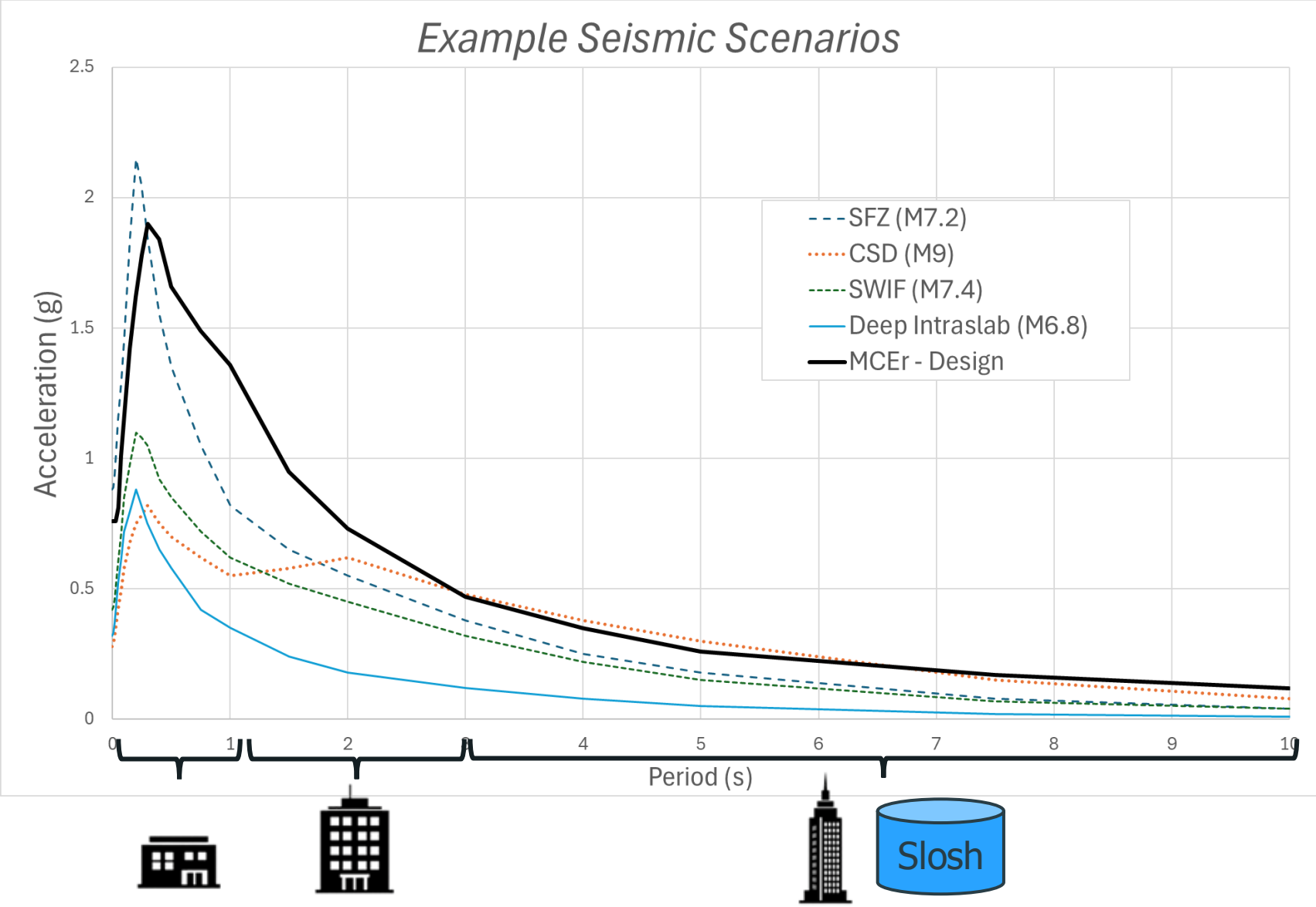
EXAMPLE SEISMIC SCENARIO

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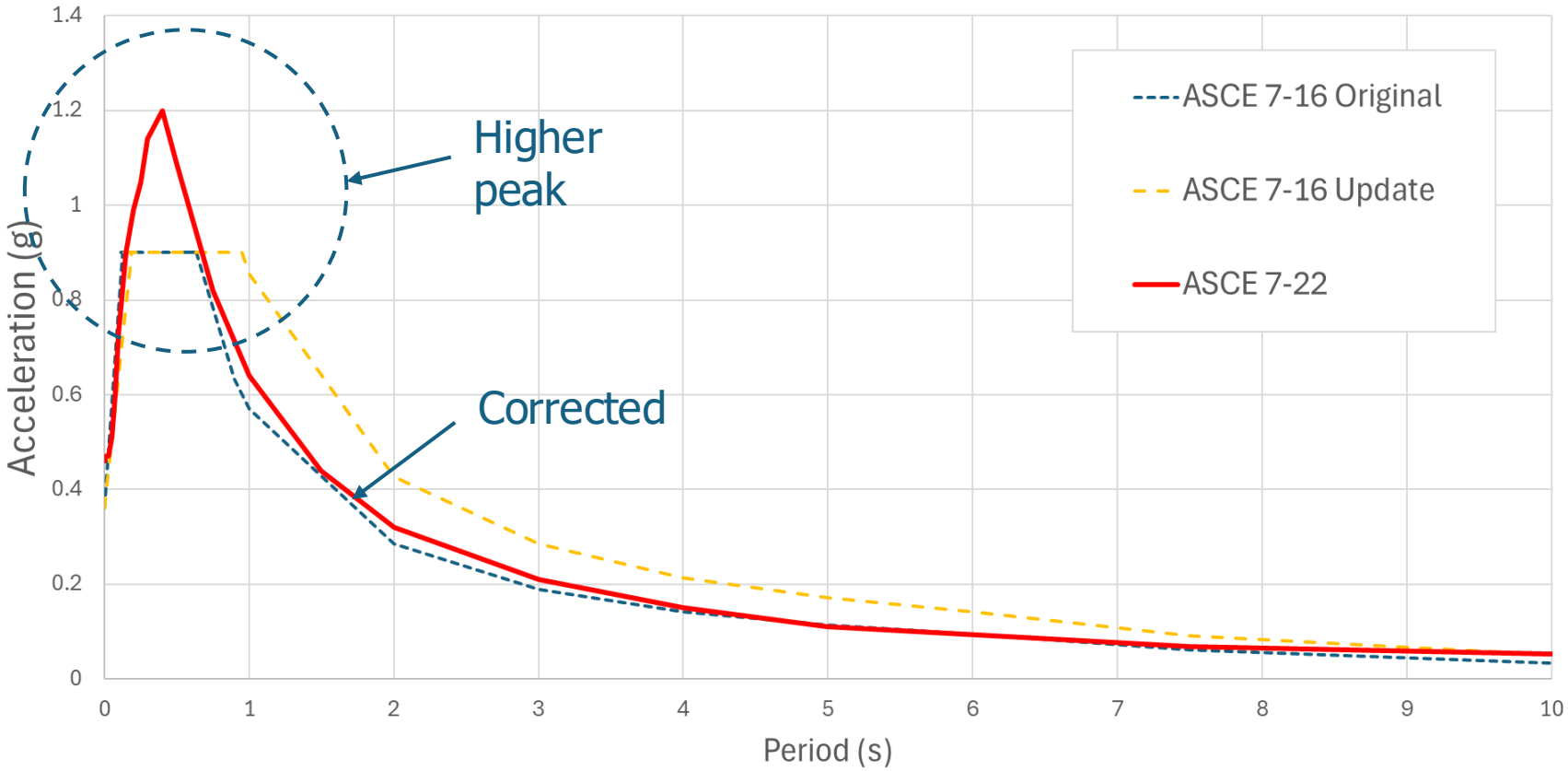
MULTIPLE SCENARIOS



1. Regions include multiple seismic scenarios
2. Each scenario has spectral bias (i.e. "favors" some structure types)
3. Code design parameters consider an envelope

UPDATE 1: RESPONSE SPECTRUMS

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1. Previous unconservative errors corrected*
2. Improved accuracy
3. Higher peak for rigid structures

*Applicable to Site Class D

UPDATE 2: DETERMINING SITE CLASS

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- 7-16: (3) methods
  - Shear Wave Velocity
  - SPT (Blow Counts)
  - Undrained Shear Strength
- 7-22: (1) method
  - Shear wave velocity

1. Site class changes design parameters
2. Fewer options for determining site class
3. Geotech scope changes

UPDATE 3: SITE CLASSIFICATION



1. More granular
2. Reclassify if Geotech report is from prior code.
3. Changes design loads

SNOW UPDATES

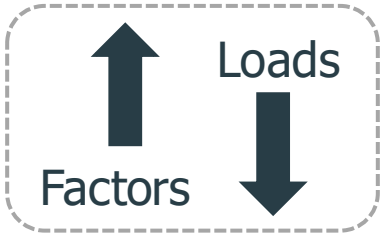


UPDATE 1: LOAD FACTORS

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ASCE 7-16 (Service)

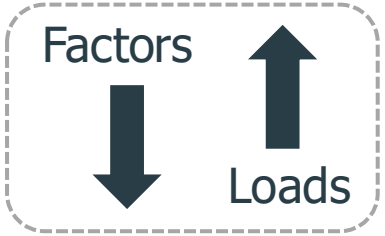
1. $1.4D$
2. $1.2D + 1.6L + 0.5(L_r \text{ or } S \text{ or } R)$
3. $1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (L \text{ or } 0.5W)$
4. $1.2D + 1.0W + L + 0.5(L_r \text{ or } S \text{ or } R)$
5. $0.9D + 1.0W$



1. D
2. $D + L$
3. $D + (L_r \text{ or } S \text{ or } R)$
4. $D + 0.75L + 0.75(L_r \text{ or } S \text{ or } R)$
5. $D + (0.6W)$
6. $D + 0.75L + 0.75(0.6W) + 0.75(L_r \text{ or } S \text{ or } R)$
7. $0.6D + 0.6W$

ASCE 7-22 (Ultimate)

1a. $1.4D$
2a. $1.2D + 1.6L + (0.5L_r \text{ or } 0.3S \text{ or } 0.5R)$
3a. $1.2D + (1.6L_r \text{ or } 1.0S \text{ or } 1.6R) + (L \text{ or } 0.5W)$
4a. $1.2D + 1.0(W \text{ or } W_T) + L + (0.5L_r \text{ or } 0.3S \text{ or } 0.5R)$
5a. $0.9D + 1.0(W \text{ or } W_T)$



1a. D
2a. $D + L$
3a. $D + (L_r \text{ or } 0.7S \text{ or } R)$
4a. $D + 0.75L + 0.75(L_r \text{ or } 0.7S \text{ or } R)$
5a. $D + 0.6(W \text{ or } W_T)$
6a. $D + 0.75L + 0.75(0.6(W \text{ or } W_T)) + 0.75(L_r \text{ or } 0.7\text{S or } R)$
7a. $0.6D + 0.6(W \text{ or } W_T)$

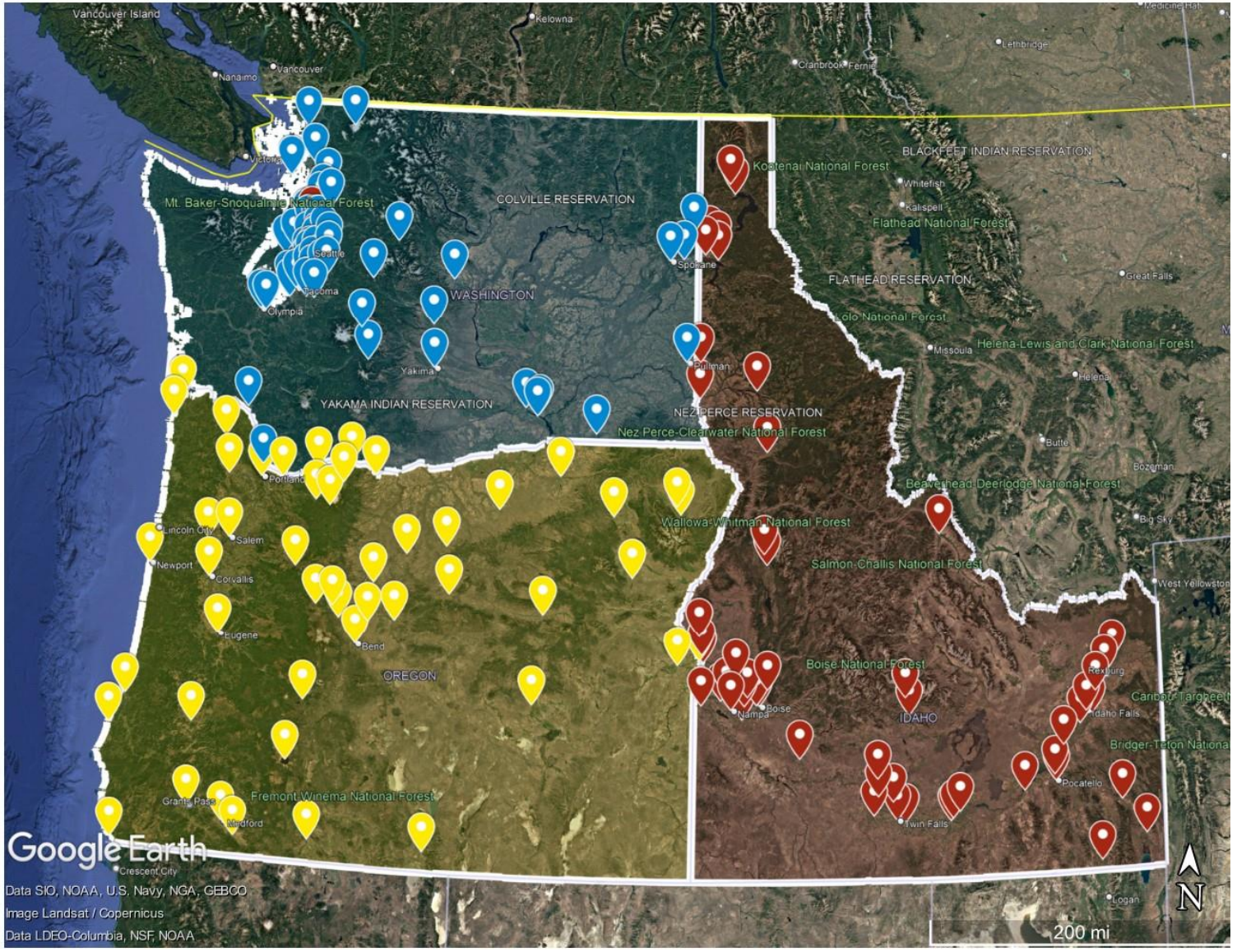
UPDATE 2: GROUND SNOW MAPS

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Feature	ASCE 7-16	ASCE 7-22
Basis	Unified Hazard	Uniform Reliability
Metric	50-year Mean Recurrence	Target Probability of Failure
Philosophy	Predicts *event* frequency	Predicts *structural risk*
Data Set	Up to 1995	30 yrs of new weather data

COMPARING EFFECTIVE SNOW LOADS IN PNW

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ASCE 7-16 Tabulated REgions

Table 7.2-5 Ground Snow Loads for Selected Locations in Washington

City/Town	County	Ground Snow Load (lb/ft²)	Elevation (ft)
Arlington	Snohomish	17	120
Auburn	King	20	85
Bainbridge Island	Kitsap	15	100
Bellevue	King	20	100
Bellingham	Watcom	15	

Table 7.2-7 Ground Snow Loads for Selected Locations in Oregon

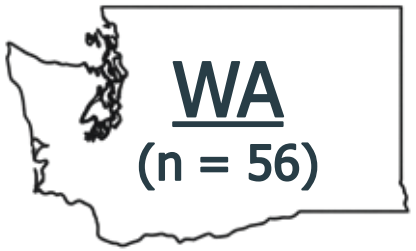
City/Town	County	Ground Snow Load (lb/ft²)	Elevation (ft)
Antelope	Wasco	17	2,840
Ashland	Jackson	13	1,990
Astoria	Clatsop	11	10
Baker City	Baker	17	3,450
Bandon	Coos	0	20
Bend	Deschutes	20	3,660
Black Butte	Deschutes	19	970
Bonneville Dam	Hood River	44	60
Brookings	Curry		

Table 7.2-3 Ground Snow Loads for Selected Locations in Idaho

City/Town	County	Ground Snow Load (lb/ft²)	Elevation (ft)
American Falls	Power	24	4,406
Ammon	Bonneville	24	4,718
Blackfoot	Bingham	28	4,498
Bogus Basin Lodge	Ada	137	6,176
Boise	Ada	15	2,681
Brundage Mtn. Lodge	Valley	207	6,038
Buhl	Twin Falls	28	3,769
Burley	Cassia	19	4,159
Caldwell	Canyon	18	2,37
Chubbuck			

SNOW INCREASES IN PNW!

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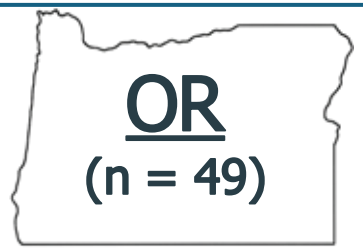
WA
(n = 56)

77%

Cases Increased

Median Value
40psf → 74psf

+85%



OR
(n = 49)

90%

Cases Increased

Median Value
34psf → 64psf

+88%



ID
(n = 53)

77%

Cases Increased

Median Value
46psf → 74psf

+61%



Rest of US

Average Increase

+5%

Maguire, M. (2022, February 1). Ground Snow Loads for ASCE 7-22. Ground snow loads for ASCE 7-22.



Updated codes result in significantly higher effective design loads across most PNWS sites.

*Data considers Risk Category IV structures

UPDATE 3: SNOW + SEISMIC COMBINED

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Winter Earthquake Scenarios

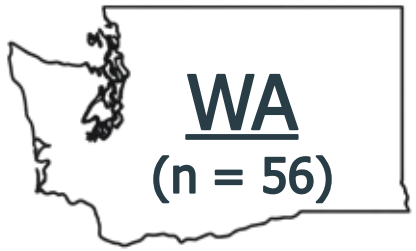
ASCE 7-16	vs	ASCE 7-22
Threshold: Flat Roof Snow **> 30psf**		Threshold: Flat Roof Snow **> 45psf**
+20% to "Effective Seismic Mass"		**+15%** to "Effective Seismic Mass"

Less Stringent? → **NO** (regionally)

- Higher threshold
- Higher snow loads in new maps offset
- Net effect depends on site

NET EFFECT SNOW + SEISMIC

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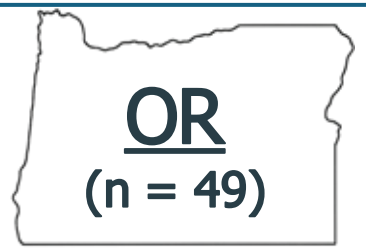
WA
(n = 56)

Cases Changed

54% → 86%

Median Increased Seismic
6.6psf → 9.5psf

+43%



OR
(n = 49)

Cases Changed

43% → 63%

Median Increased Seismic
13.2psf → 10.3psf

-22%

ID
(n = 53)



Cases Changed

53% → 68%

Median Increased Seismic
13.6psf → 10.4psf

-24%



1. More common to consider snow + seismic effects moving forward.
2. Net increase in demands depends on site.

*Data considers Risk Category IV structures

KEY TAKEAWAYS

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DESIGN PROCESS

- Updated design parameters
- Early geotechnical involvement
- Snow changes disproportionally affect PNW
- Snow contributes to seismic loads more frequently

DESIGN OUTCOMES

- Improved reliability & resilience
- Upfront engineering investment
- Construction cost increases aligned with regional risks

QUESTIONS?

NICK WELLING, PE
nick.welling@psengineers.com



PSE