GROUND MOTION MAPS

How To Obtain the Basic Values

FEMA Instructional Materials Complementing *FEMA 451, Design Examples* Ground Motion Maps *5b - 1*

This series of slides would <u>not</u> normally be used as is but rather to develop a Group Exercise that shows how to use the USGS website to retrieve certain ground motion data from the USGS website (see Slide 9 in this set).

Seismic Ground Motions

1 **Determine basic values from maps for bedrock conditions**

2, 3 Classify soil conditions at site and determine site coefficients

4 Determine site-adjusted values

4 Take two-thirds for use in design

5 Construct design response spectrum

7 Site-specific studies permitted/required

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Ground Motion Maps *5b - 2*

This lesson focuses on the first step: getting the basic values from the maps. Subsequent lessons will cover the other steps.

Mapped Acceleration Parameters

- Two sets of maps; acceleration parameter is in units of gravity
- S_S for spectral response acceleration at 0.2 sec
- S_1 for spectral response acceleration at 1.0 sec
- Shortcut to Seismic Design Category A:
  - $S_S < 0.15$ and $S_1 < 0.04$

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Ground Motion Parameters & Seismic Hazard

Mapped Contours of S_S

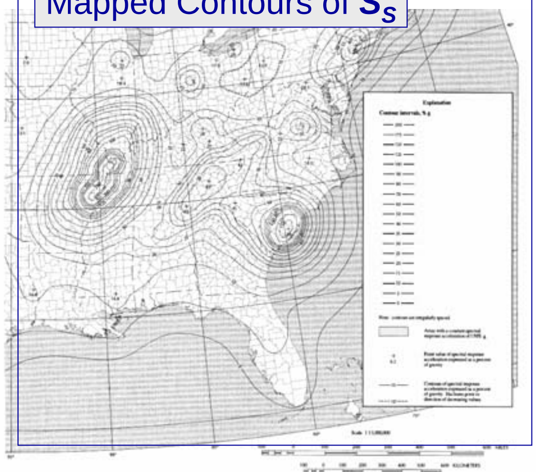

FIGURE 9.4.1.1(a) — continued
MAXIMUM CONSIDERED EARTHQUAKE GROUND MOTION FOR CONTERMINOUS UNITED STATES. OF 0.2 s SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING), SITE CLASS B

S_S and S_1 are the mapped 2% in 50 year spectral accelerations for firm rock

S_{DS} and S_{D1} are the design level spectral accelerations (modified for site and "expected good performance")

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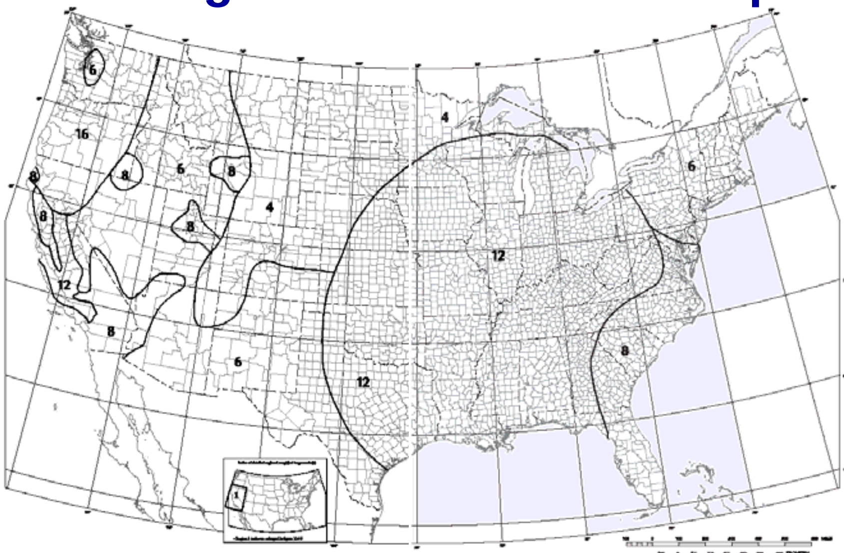
Long-Period Transition Maps



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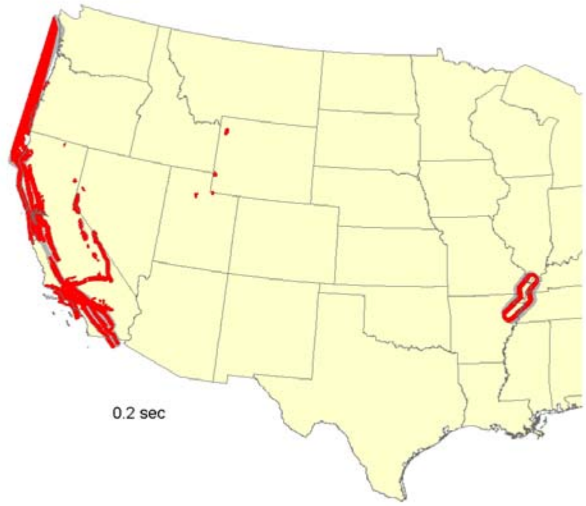
Ground Motion Maps *5b - 5*

Location of Deterministic Areas



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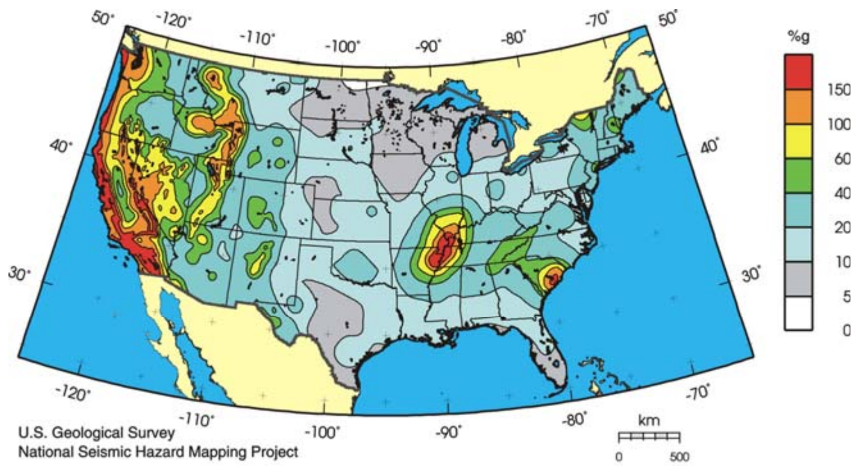
Ground Motion Maps *5b - 6*

Typical Probabilistic Map



S_S - 0.2 Spectral Response Acceleration

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The USGS probabilistic maps are generally rendered in color. But the MCE maps for use with codes are usually rendered in black and white.

CD vs Internet

- Internet
- CD
- Both sources give the same answers
- Both sources have a similar user interface
- The graphics are somewhat different

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Ground Motion Maps *5b - 8*

Internet Ground Motion Tool

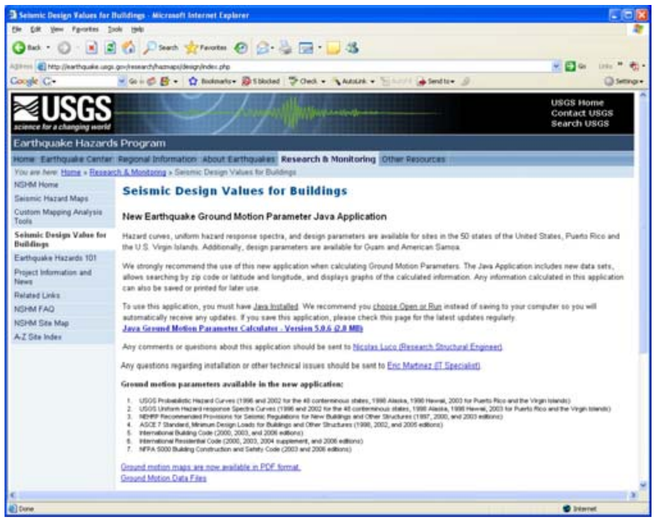
http://earthquake.usgs.gov/research/hazmaps/

SEISMIC DESIGN VALUES FOR BUILDINGS

S_s and S_1, Hazard Curves, Uniform Hazard Spectra, and Residential Design Category

Please note that the USGS is constantly changing its web-based tools, and the following slides may or may not reflect the current information on the web. Also, the web site shown above may not be current. Google "USGS Seismic Hazard Maps" to locate the latest information.

USGS Ground Motion Calculator



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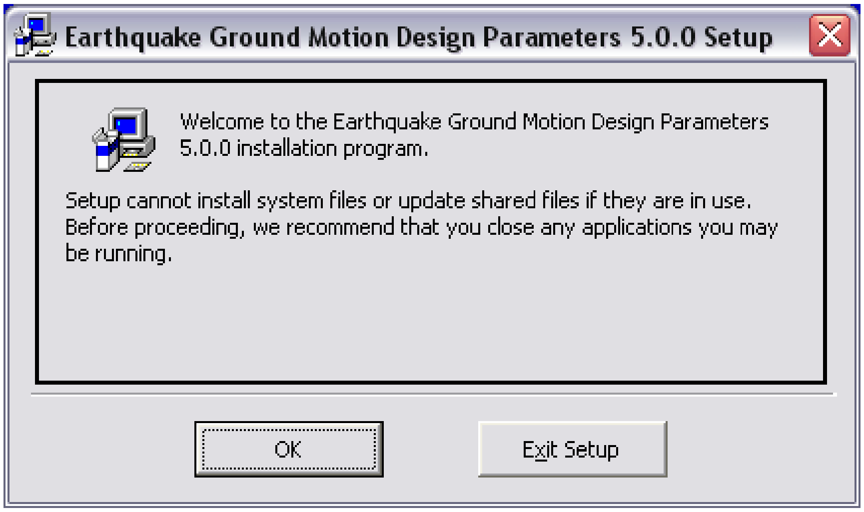
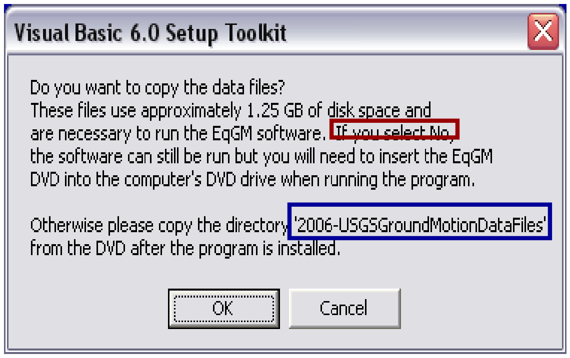
Ground Motion Maps *5b - 10*

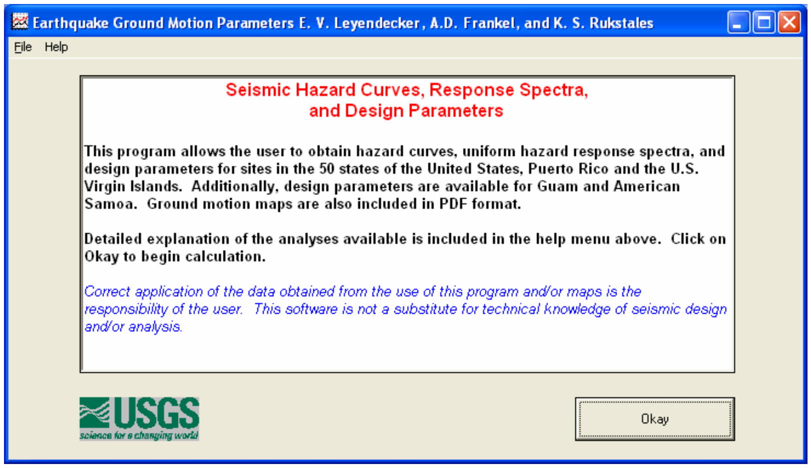
Installation



Installation Caution



Opening Screen



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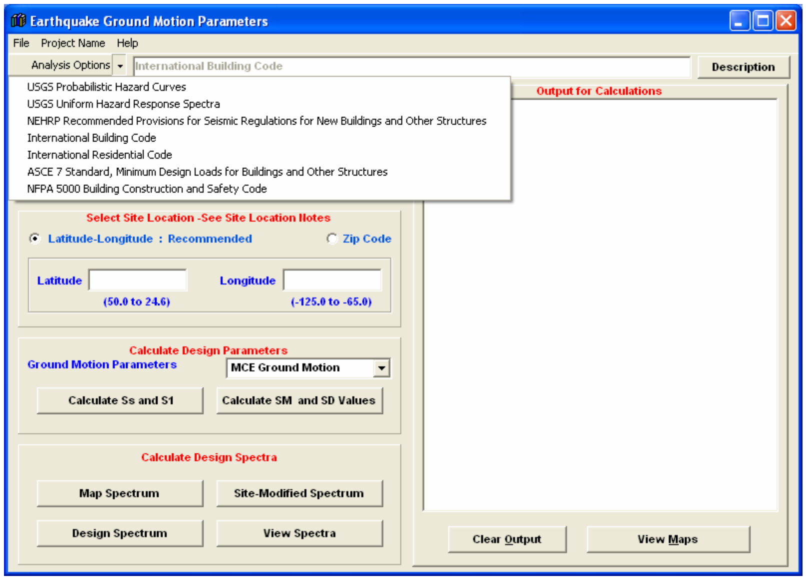
Ground Motion Maps *5b - 13*

Analysis Options



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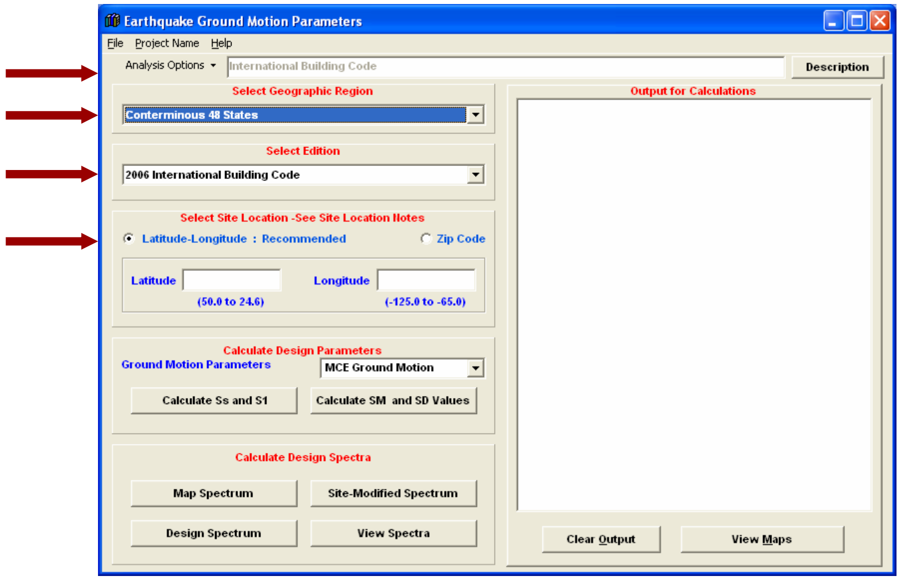
Ground Motion Maps *5b - 14*

IBC Option



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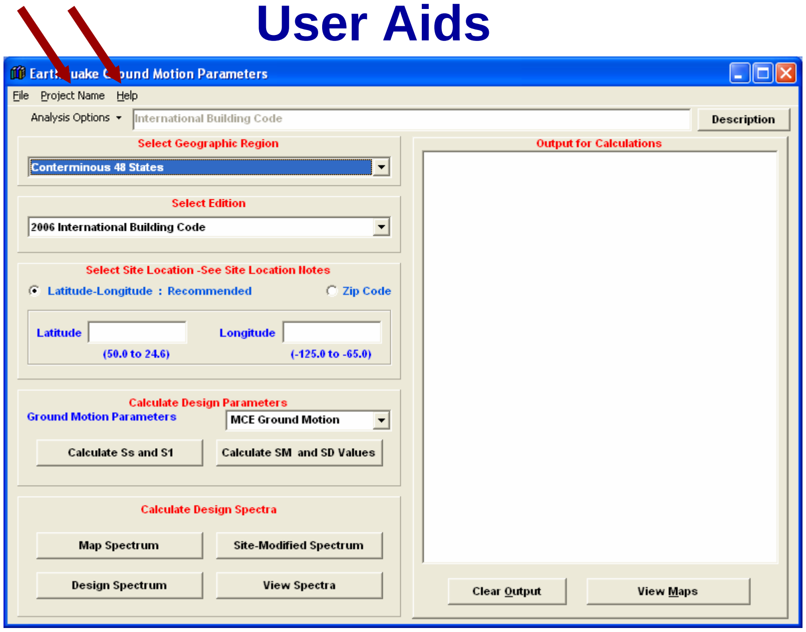
Ground Motion Maps *5b - 15*

User Aids



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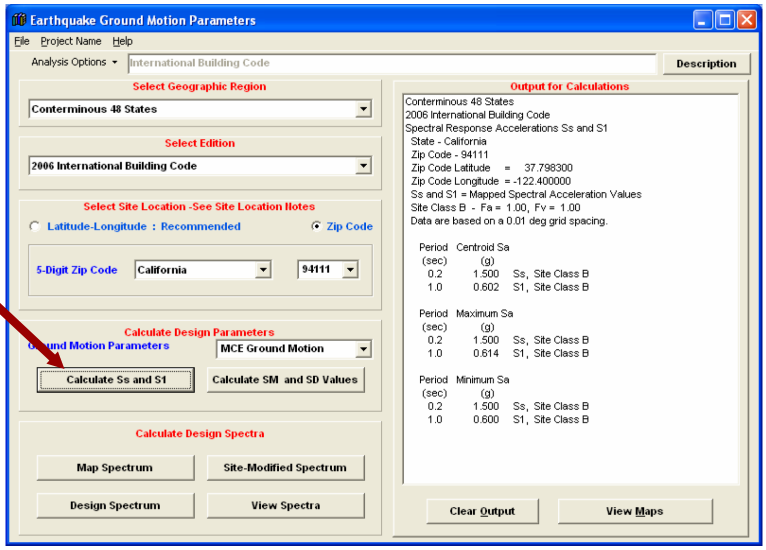
Ground Motion Maps *5b - 16*

Calculate S_S AND S_1



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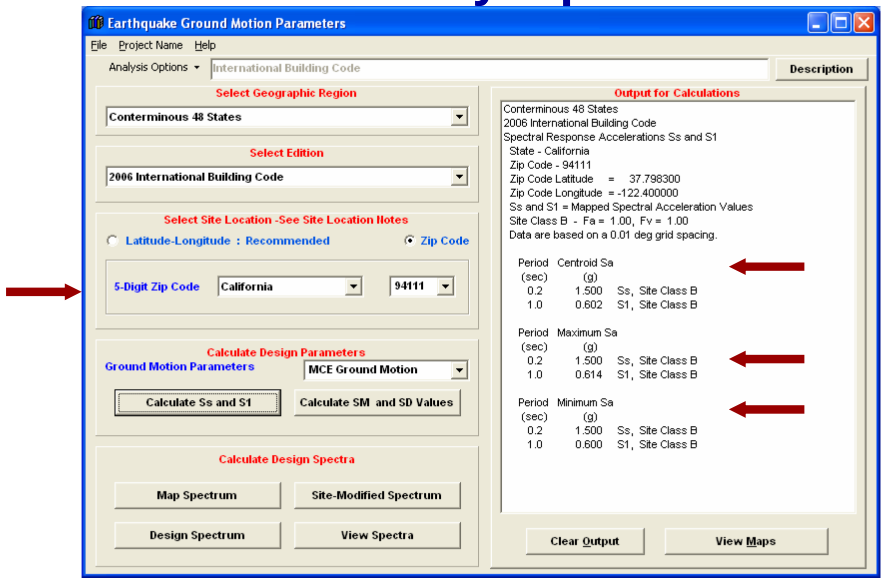
Ground Motion Maps *5b - 17*

Location By Zipcode



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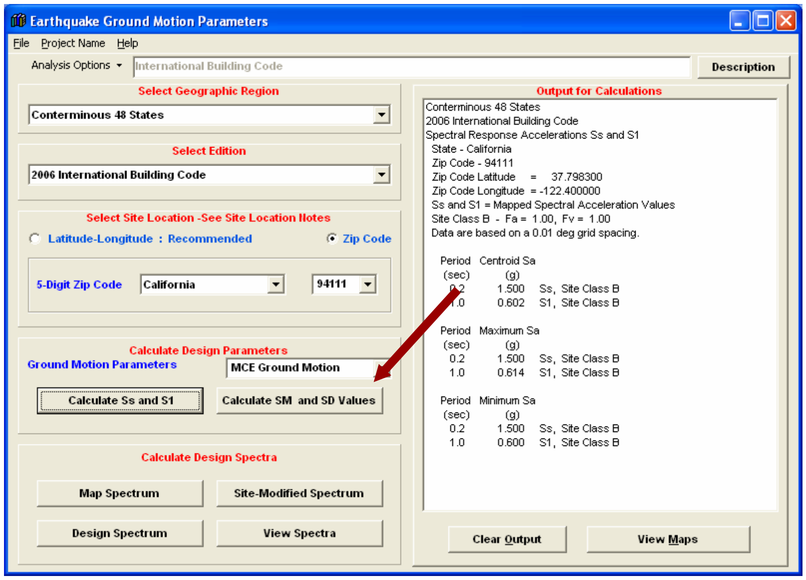
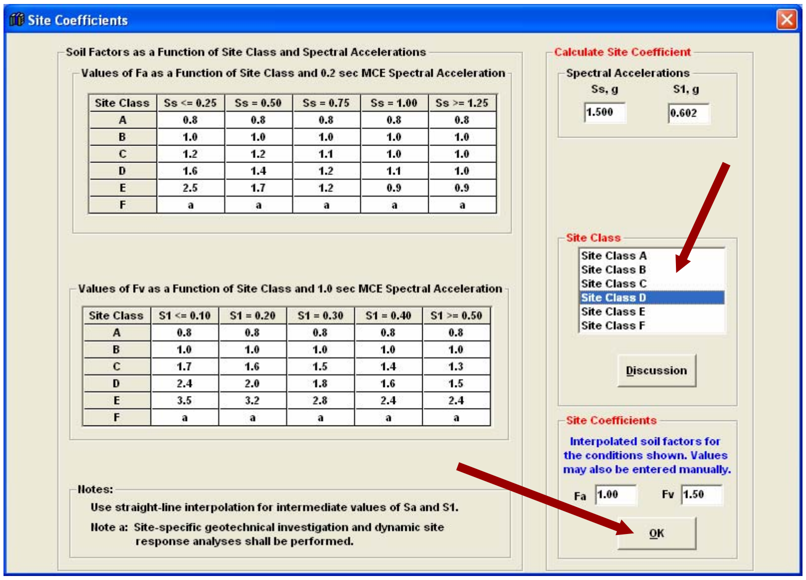
Ground Motion Maps *5b - 18*

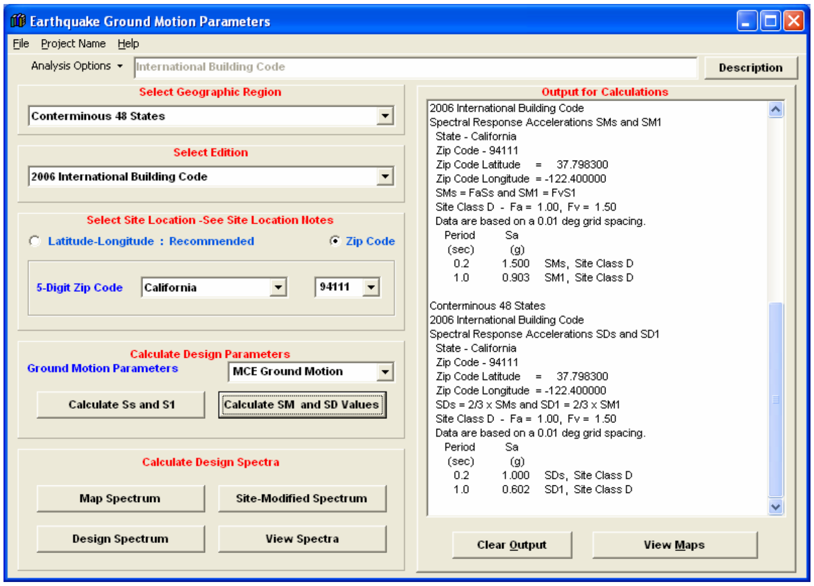
Calculate S_{MS}, S_{M1}, S_{DS}, S_{D1}



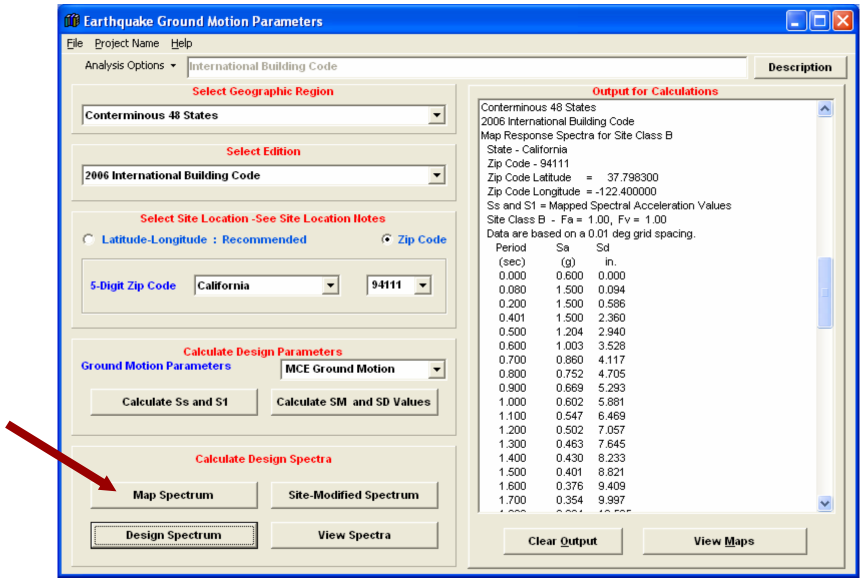
Calculate Site Coefficients



S_{MS}, S_{M1}, S_{DS}, S_{D1} Values



Calculate MCE Spectrum



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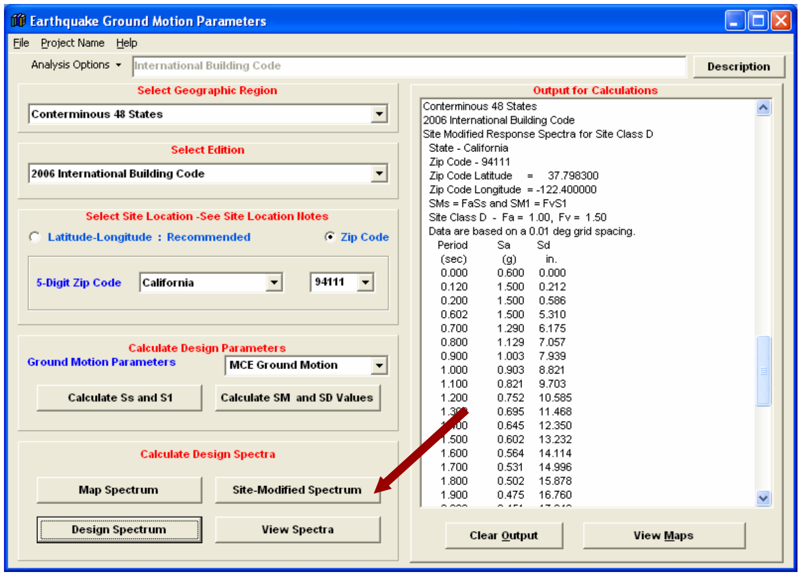
Ground Motion Maps *5b - 22*

Calculate S_M Spectrum



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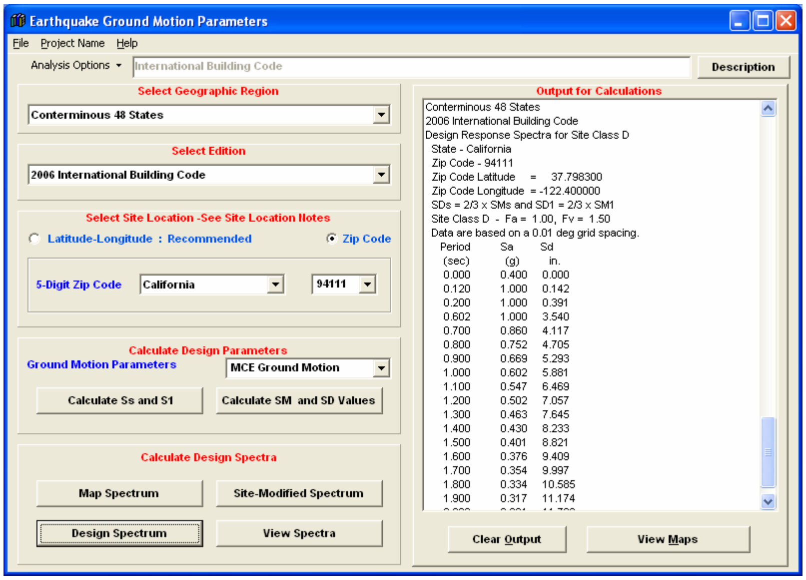
Ground Motion Maps *5b - 23*

Calculate S_D Spectrum



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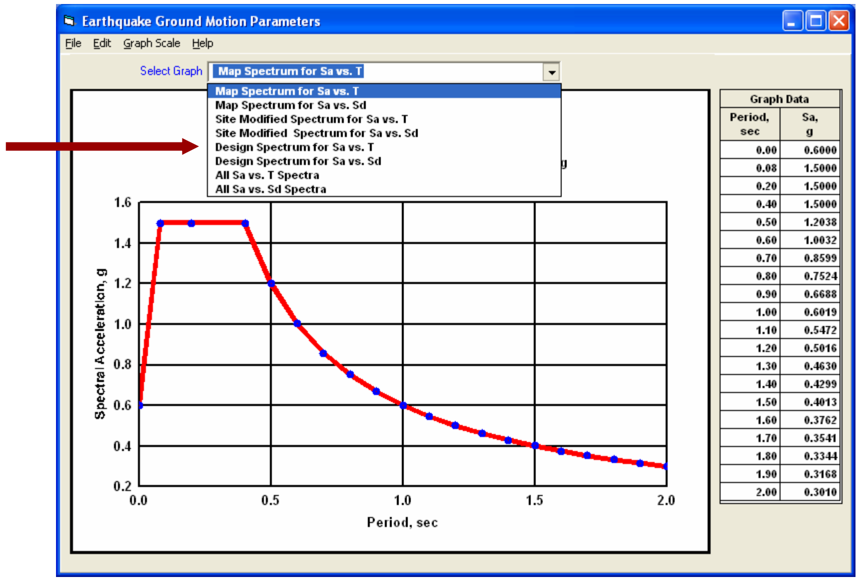
Instructional Materials Complementing *FEMA 451, Design Examples*

Ground Motion Maps *5b - 24*

Graphic Options



Graph Data

Period, sec	Sa, g
0.00	0.6000
0.08	1.5000
0.20	1.5000
0.40	1.5000
0.50	1.2038
0.60	1.0032
0.70	0.8599
0.80	0.7524
0.90	0.6688
1.00	0.6019
1.10	0.5472
1.20	0.5016
1.30	0.4630
1.40	0.4299
1.50	0.4013
1.60	0.3762
1.70	0.3541
1.80	0.3344
1.90	0.3168
2.00	0.3010

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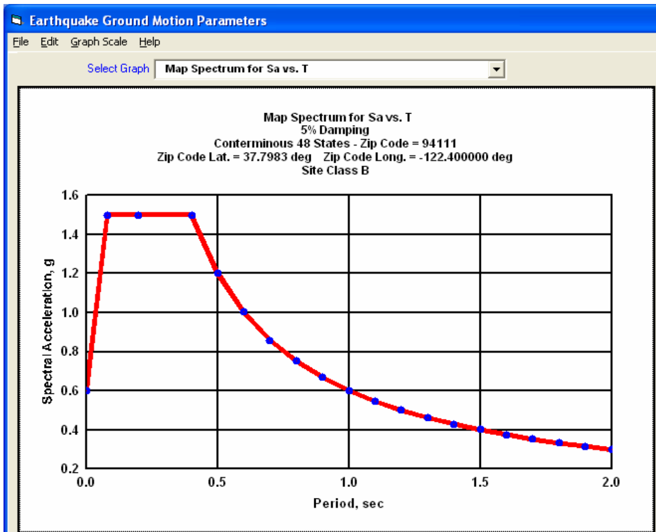
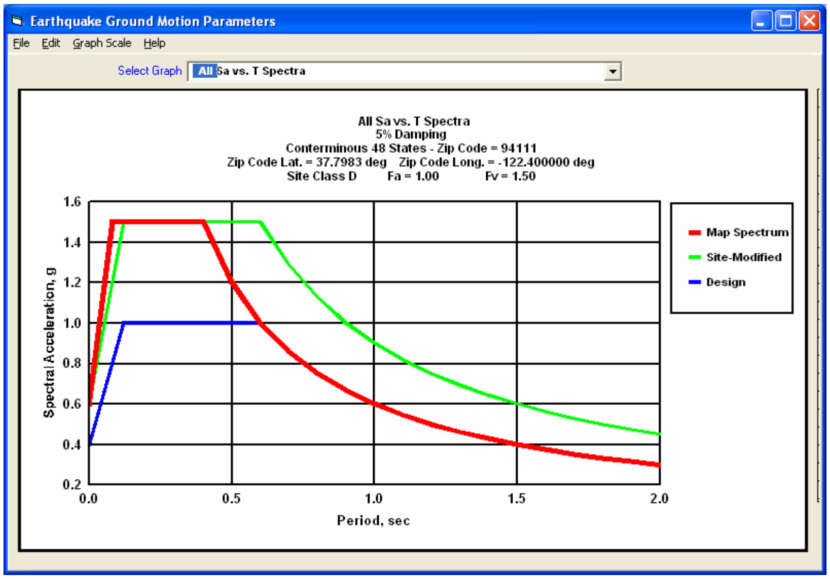
Ground Motion Maps *5b - 25*

Map Spectrum: S_a - T



Graph Data	
Period, sec	Sa, g
0.00	0.6000
0.08	1.5000
0.20	1.5000
0.40	1.5000
0.50	1.2038
0.60	1.0032
0.70	0.8599
0.80	0.7524
0.90	0.6688
1.00	0.6019
1.10	0.5472
1.20	0.5016
1.30	0.4630
1.40	0.4299
1.50	0.4013
1.60	0.3762
1.70	0.3541
1.80	0.3344
1.90	0.3168
2.00	0.3010

All Spectra: S_a - T



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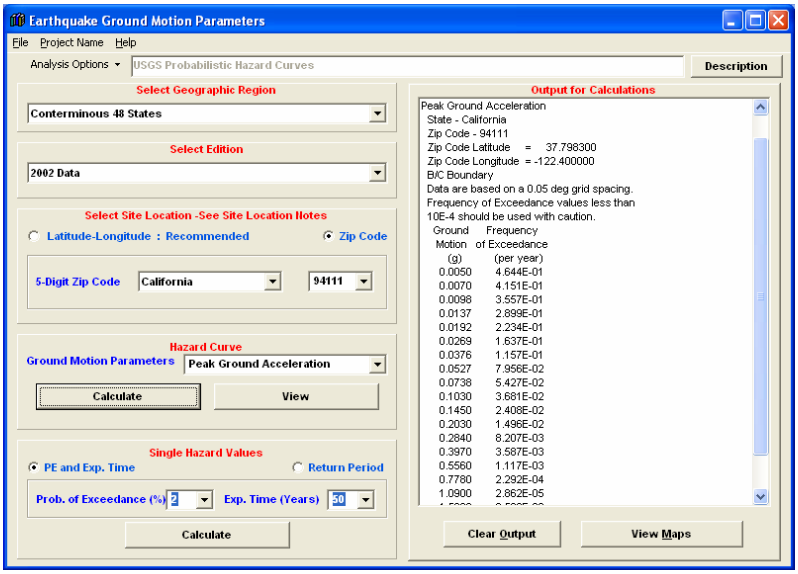
Ground Motion Maps *5b - 27*

Calculate Hazard Curves

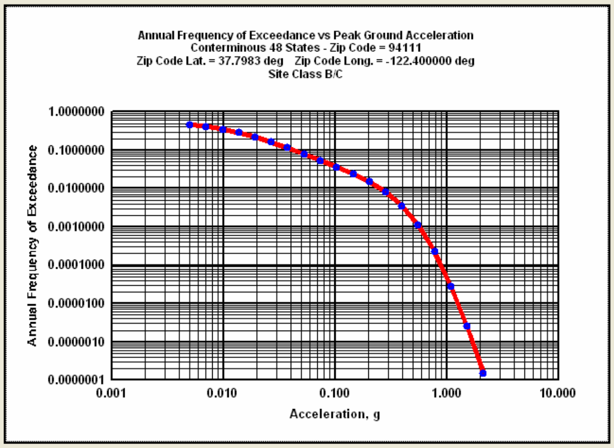


Annual Frequency of Exceedance

Earthquake Ground Motion Parameters

File Edit Graph Scale Help

Select Graph: Hazard Curve of Annual FEX vs Acceleration



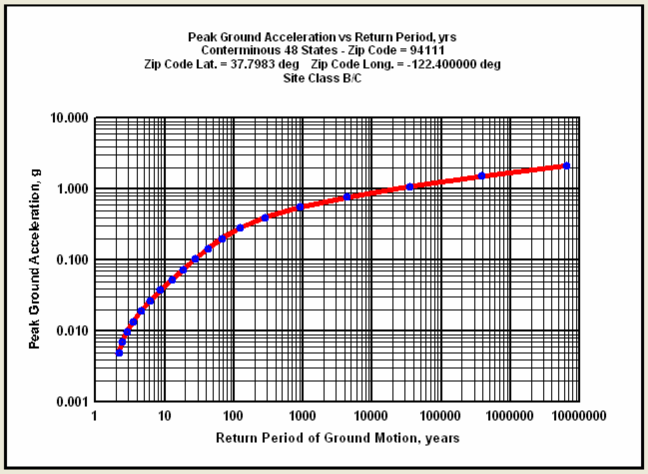
Graph Data	
Sa, g	Annual FEX
0.0050	4.644E-01
0.0070	4.151E-01
0.0098	3.557E-01
0.0137	2.899E-01
0.0192	2.234E-01
0.0269	1.637E-01
0.0376	1.157E-01
0.0527	7.956E-02
0.0738	5.427E-02
0.1030	3.681E-02
0.1450	2.408E-02
0.2030	1.496E-02
0.2840	8.207E-03
0.3970	3.587E-03
0.5560	1.117E-03
0.7780	2.292E-04
1.0900	2.862E-05
1.5200	2.589E-06
2.1300	1.523E-07

Return Period

Earthquake Ground Motion Parameters

File Edit Graph Scale Help

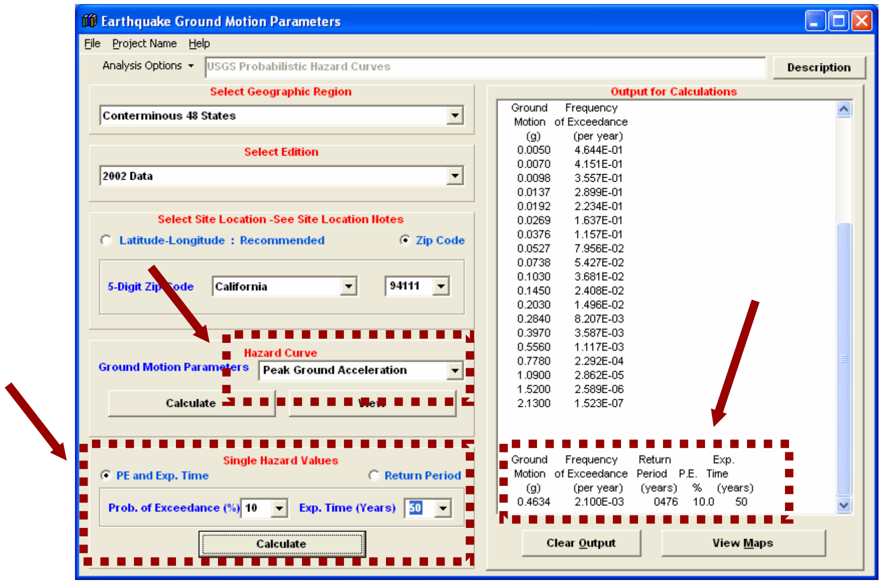
Select Graph: Hazard Curve of Acceleration vs Return Period



Graph Data

Return Period	Sa, g
2.153E+00	0.0050
2.409E+00	0.0070
2.812E+00	0.0098
3.449E+00	0.0137
4.477E+00	0.0192
6.107E+00	0.0269
8.643E+00	0.0376
1.257E+01	0.0527
1.843E+01	0.0738
2.717E+01	0.1030
4.154E+01	0.1450
6.686E+01	0.2030
1.218E+02	0.2840
2.788E+02	0.3970
8.952E+02	0.5560
4.363E+03	0.7780
3.494E+04	1.0900
3.863E+05	1.5200
6.564E+06	2.1300

Single Values



Deaggregation

- Breaking apart of the probabilistic hazard analysis
- Helps remove some of the “black box” effect
- Helps visualize the source of the hazard
- Many uses, e.g. liquefaction analysis, time history determination

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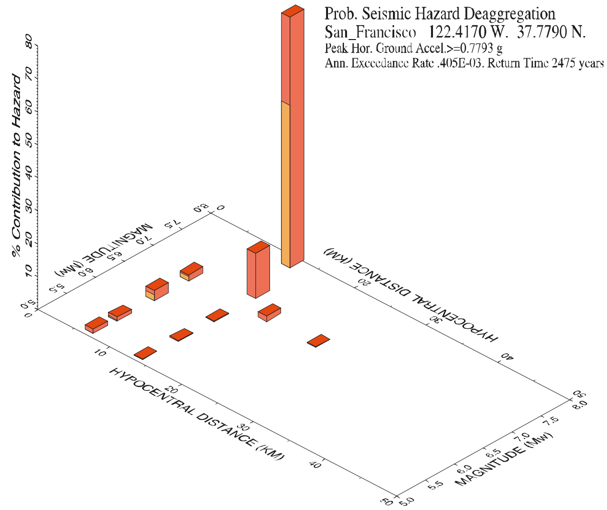
Deaggregation – San Francisco



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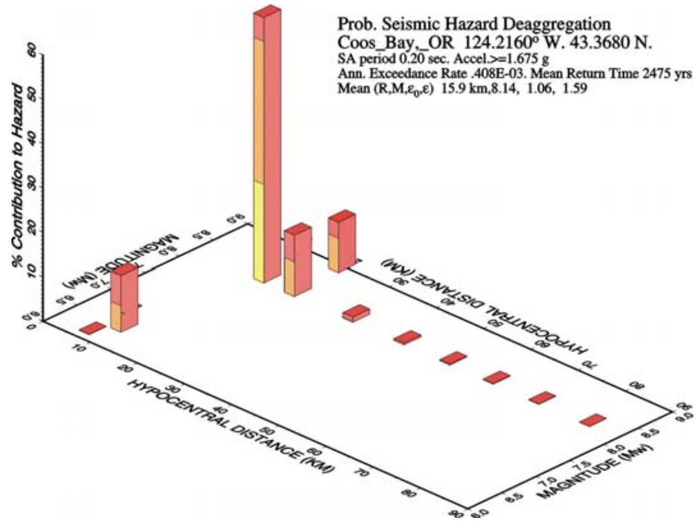
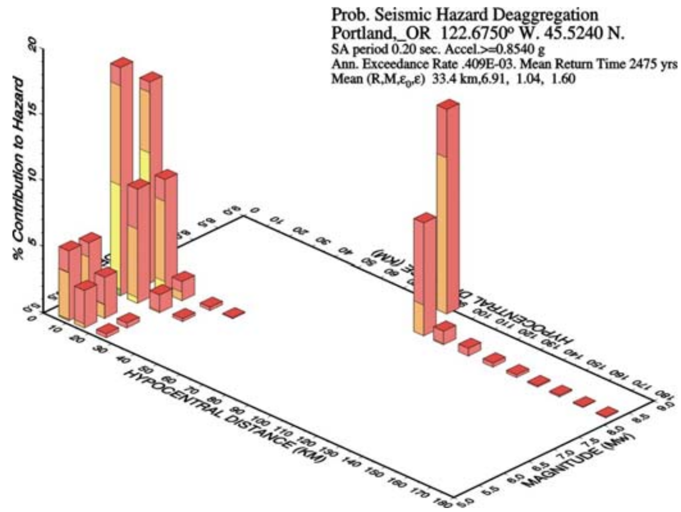
Ground Motion Maps *5b - 33*

Deaggregation - Coos Bay, Oregon



Deaggregation - Portland, Oregon



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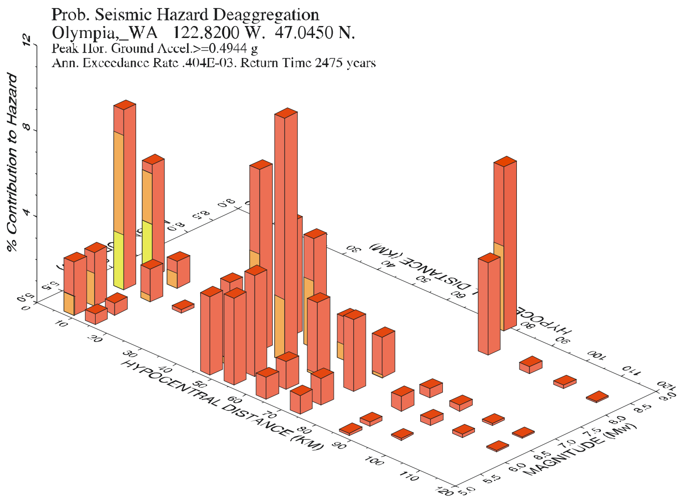
Ground Motion Maps *5b - 35*

Deaggregation – Olympia, Washington



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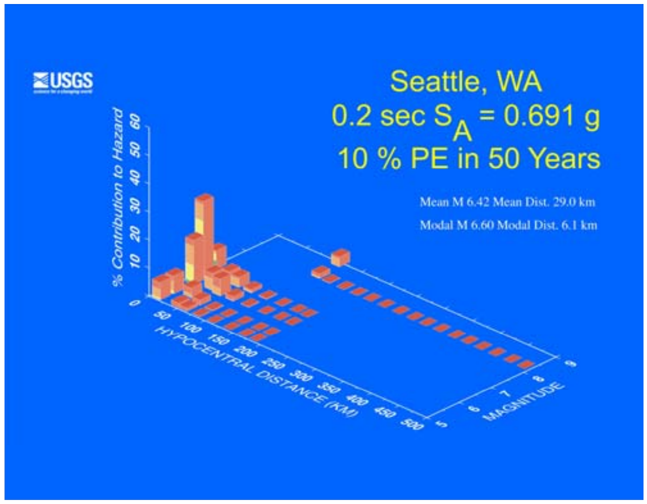
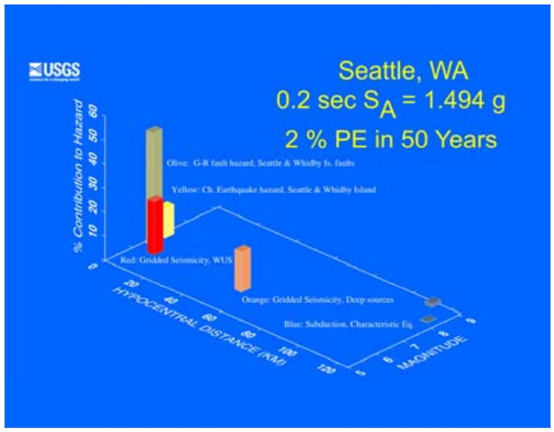
Ground Motion Maps *5b - 36*

Seattle – 0.2 sec, Detailed



Seattle – 0.2 sec



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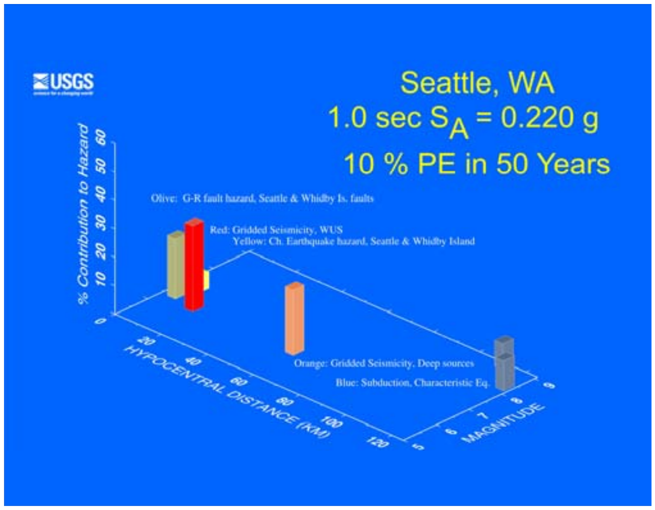
Ground Motion Maps *5b - 38*

Seattle – 1.0 sec



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Ground Motion Maps *5b - 39*

Design Values Outside the United States

- Based on GASHAP Data
- 10% PE in 50 years
- PGA only
- Estimate 2% from 10% PE by multiplying by 2.0
- S_s = 2.5xPGA
- S_1 = PGA
- Use site-specific studies where available
- USGS studies where available

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UFC 3-310-1

UFC 3-310-01

UNIFIED FACILITIES CRITERIA (UFC)

STRUCTURAL LOAD DATA

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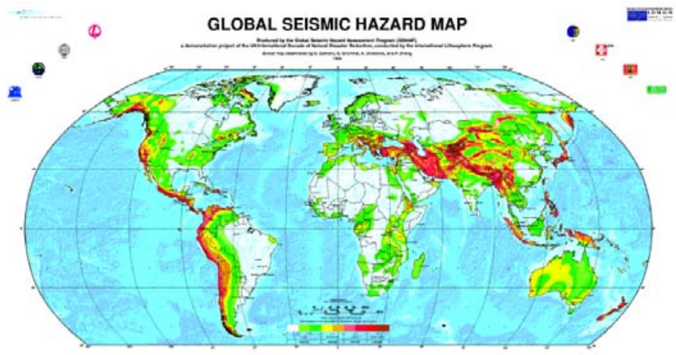
What is GSHAP?



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Ground Motion Maps *5b - 42*