SEISMIC QUALIFIED EQUIPMENT

Eddie Wilkie – Engineering Manager

Power Distribution Organization - Americas

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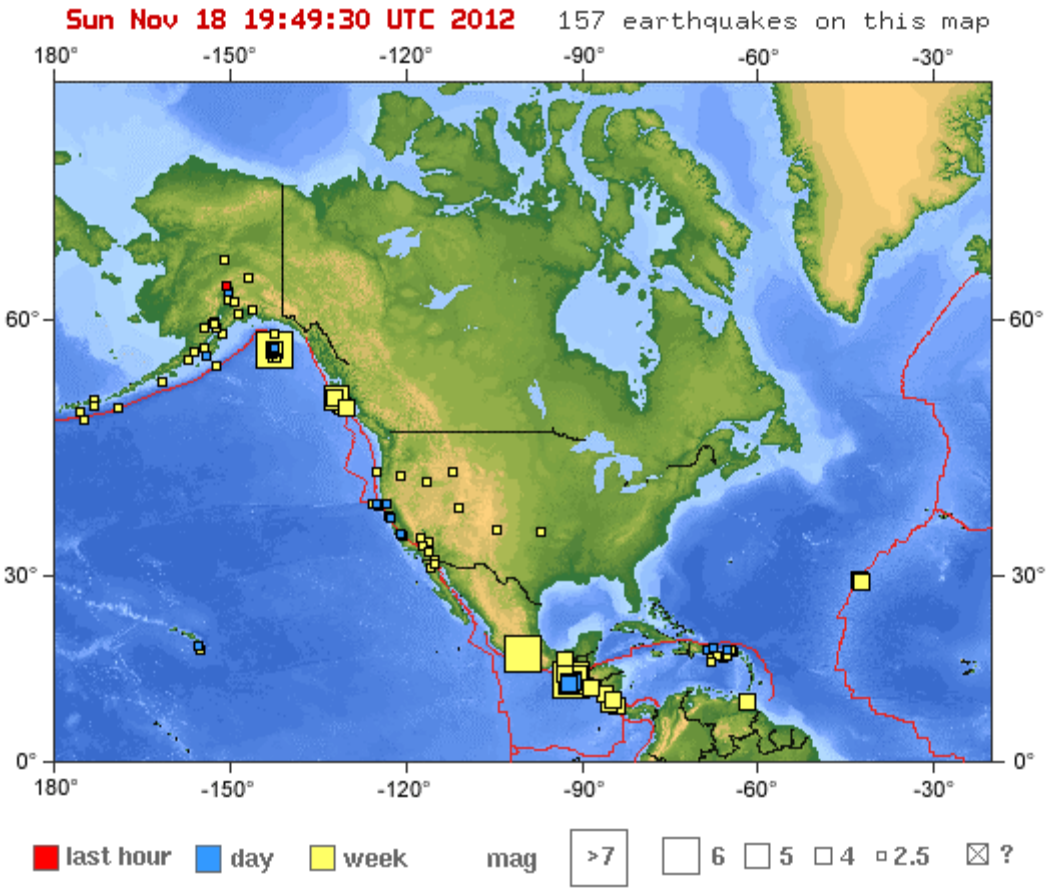
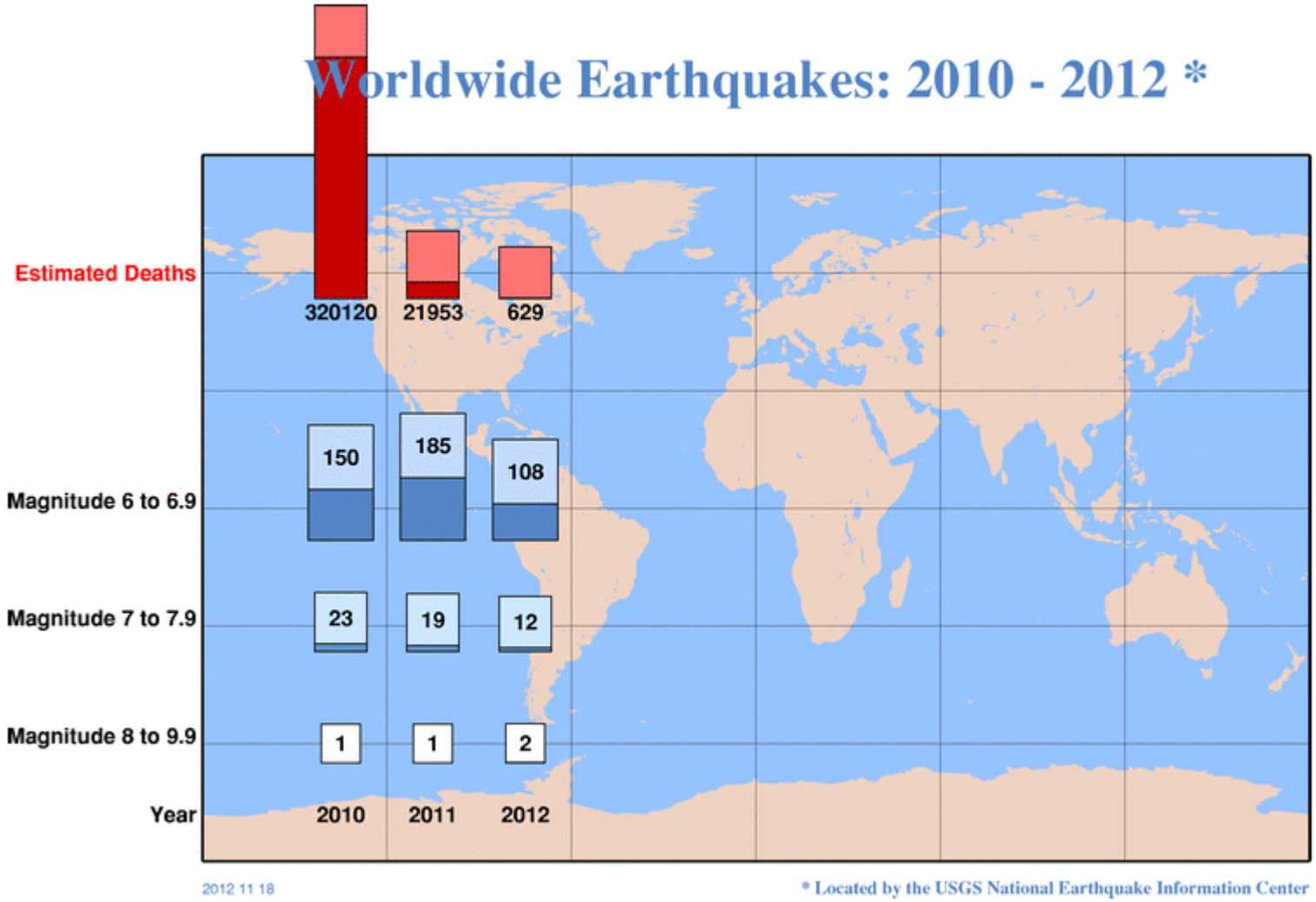
Globally - Anywhere & Everywhere



Globally - Anywhere & Everywhere



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Lessons Learned

Damage to Contents Can Exceed Building Damage

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Lessons Learned

Damage to Contents Can Exceed Building Damage

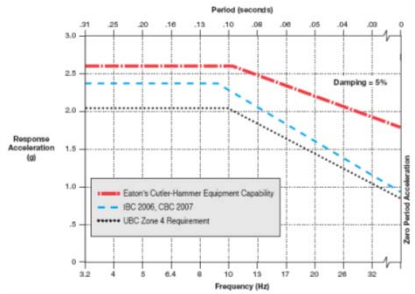
Need for “SEISMIC QUALIFED”

SEISMIC QUALIFIED

TEST CERTIFICATE OF SEISMIC WITHSTAND CAPABILITY

Eaton's Cutler-Hammer® equipment identified below was tested for seismic withstand capability and tested in accordance with the combined requirements specified in the International Building Code, California Building Code and the Uniform Building Code. As required by the codes, the equipment demonstrated its ability to function after the seismic tests. The seismic capability of the equipment exceeds the worst-case required levels, as illustrated in the figure below.

FlashGard MCC
(Free Standing with Side Mounting Plates)



The frequency sweep tests revealed that the lowest equipment natural frequency is:

6.0 Hz

Mostafa A. Ahmed
3RD PARTY TEST ENGINEER IN CHARGE

TESTED BY
Wyle Laboratories
July, 2006 – 53753-1

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For interpretation of testing data refer to Eaton Publication SA12501SE

Drawing Number SA04300005E, Rev. 1

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Codes & Standards Confusion

Which One Applies?

A. IBC

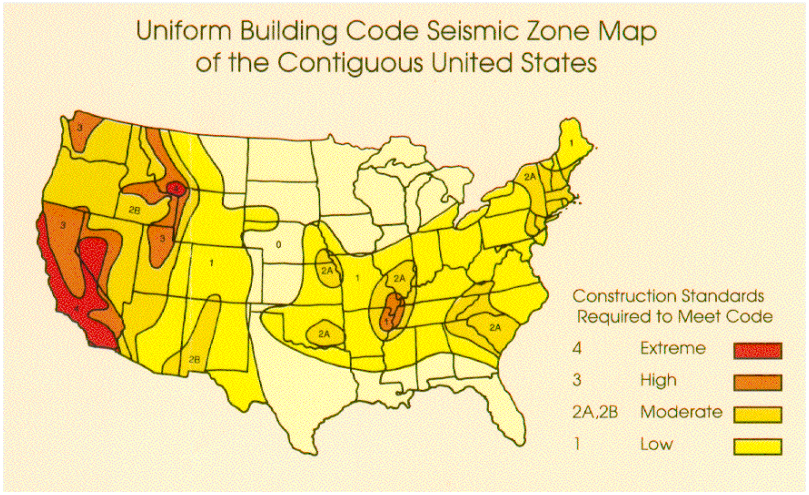
B. CBC

C. UBC

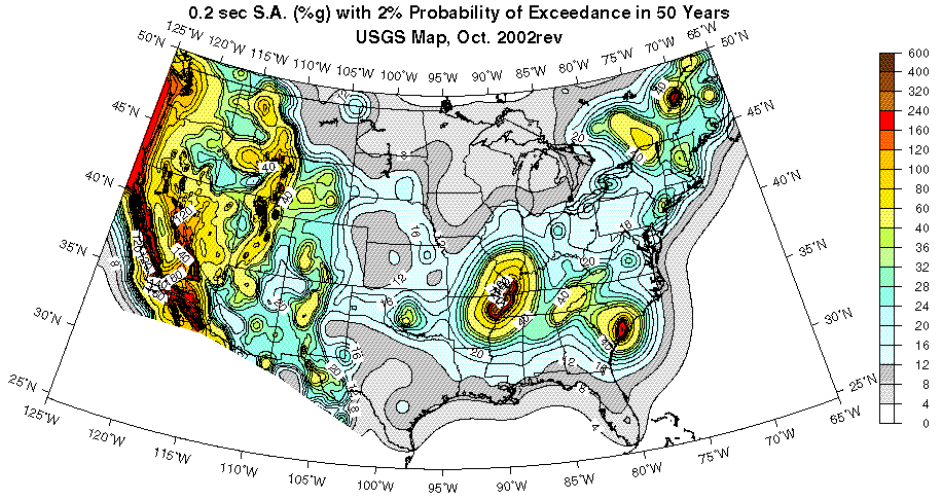
D. BOCA

Code Development Evolution

- **1997 UBC - Last seismic "Zone Map"**
- **2000 IBC - First "Probalistic Seismic Hazard Map" – <u>Results in localized ground motion data that enables site specific analysis</u>**



< 2000 Seismic Zones 1 - 4
(No USGS Revision Since 1969)



2000 Site Specific Lat / Lon

http://geohazards.cr.usgs.gov/eq/2002April03/US/US5hz2500v4.gif

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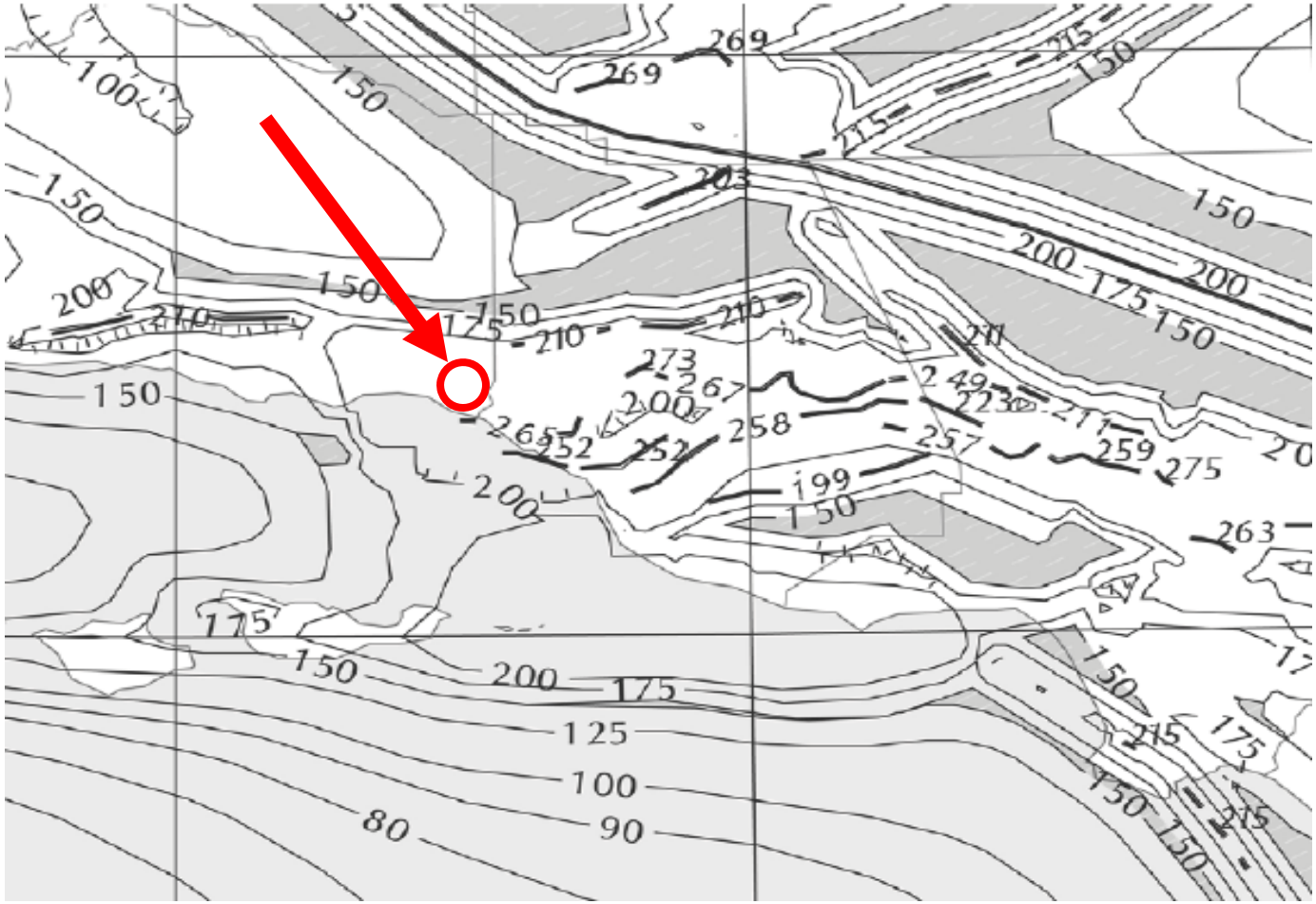
Why Site Specific Design Criteria

S_s

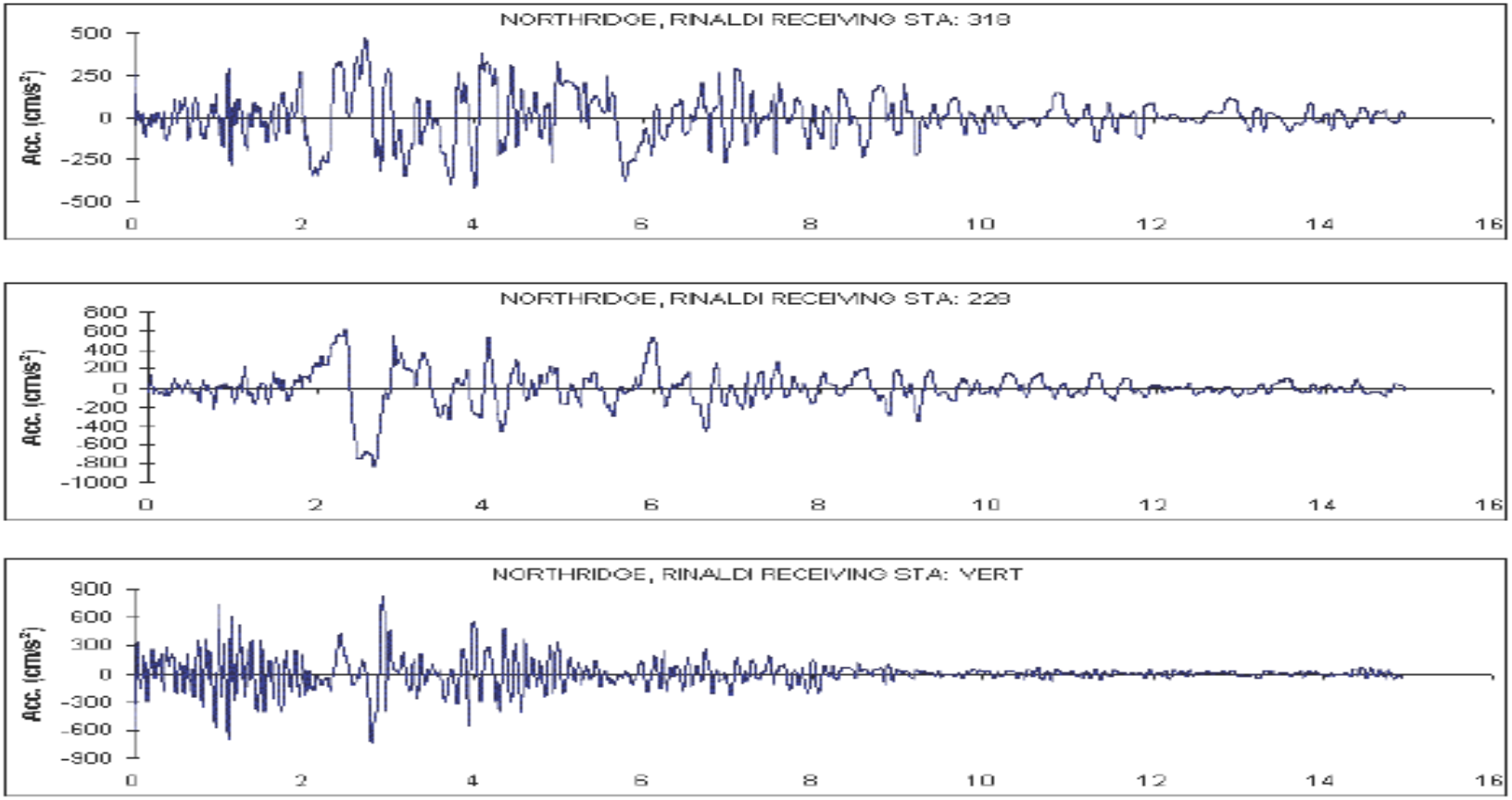
S_1

F_a

F_v



Same Earthquake, Same City



Strong Motion Time History's - Northridge

Trinet

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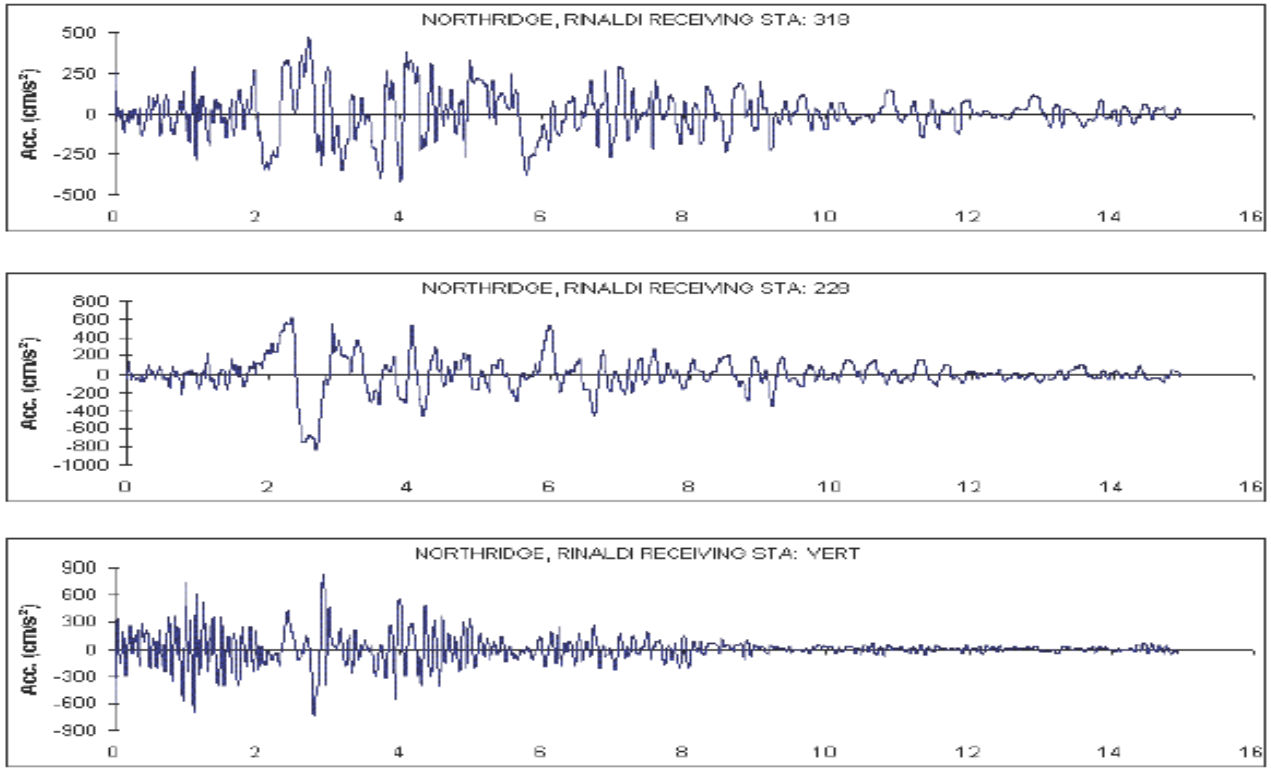
Same Earthquake, Same City

Zip Code OR Longitude & Latitude?



Strong Motion Time History's - Northridge

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Seismic Data Collection Point
Asheville Airport

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Codes & Standards - BOCA

Redirect

Building Officials and Code Administrators (BOCA) (published the BOCA National Building Code and other National Codes) is now the International Code Council. You are being redirected to the International Code Council website. In 2003, more than 190 years of combined building and fire safety code development and 30 years of anticipation for one organization to produce codes for use across the country and around the globe became a reality when BOCA, ICBO and SBCCI consolidated to become the International Code Council.

Codes & Standards - UBC

UBC – Uniform Building Code

The International Conference of Building Officials (ICBO), the publisher of the UBC, announced that the 1997 Edition was going to be the last edition of the UBC – long before the edition was even published.

Source: “CODE WATCH”

Codes & Standards - UBC

UBC – Uniform Building Code

The 2000 ***International Building Code*** (IBC) is the successor of the 1997 UBC…..The basis of the 2001 CBC continued to be the 1997 UBC, thus extending the life of the code.

Source: “CODE WATCH”

Codes and Standards – Not UBC

Which One Applies?

A. IBC – In most states
B. CBC – in California
~~C. UBC~~
~~D. BOCA~~

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Codes & Standards – CBC

CBC – California Building Code

California's Building Standards Commission, a body with members who are appointed by the governor and ratified by the state senate process, produces the ***California Building Standards Code*** (of which the CBC is a part). The ***California Building Standards Code*** is published in its entirety every three years, with supplements published in the intervening years.

Source: "CODE WATCH"

Codes & Standards – IBC

Origin

The International Code Council (ICC) was established in 1994 as a nonprofit organization dedicated to developing a single set of comprehensive and coordinated national model construction codes. The founders of the ICC are Building Officials and Code Administrators International, Inc. (BOCA), International Conference of Building Officials (ICBO), and Southern Building Code Congress International, Inc. (SBCCI). Since the early part of the last century, these nonprofit organizations developed the three separate sets of model codes used throughout the United States. Although regional code development has been effective and responsive to our country's needs, the time came for a single set of codes. The nation's three model code groups responded by creating the International Code Council and by developing codes without regional limitations the International Codes.

Codes & Standards – IBC

50 states now use the ICC

The *International Building Code* (IBC) is in use or adopted in 50 states, the District of Columbia, the U.S. Virgin Islands, NYC, Guam, and the Northern Marianas Islands.

Source: ICC Website

IBC Seismic Standards

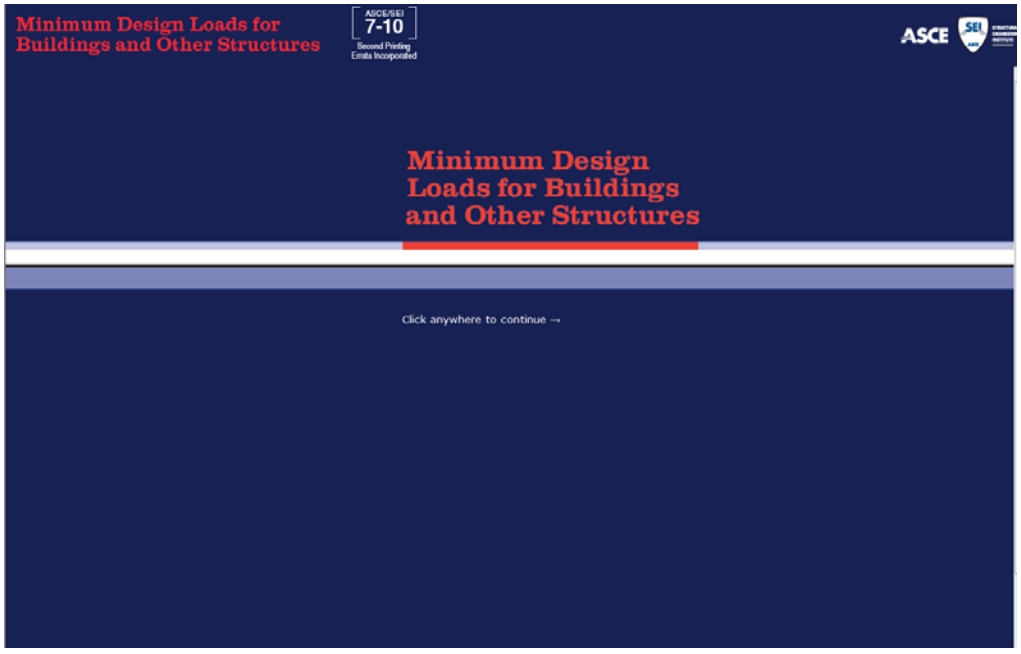
Standards

- 2012 IBC

ASCE 7-10 Seismic Design Requirements

Standards

- ASCE-7-10 provides that backbone for IBC Section 1613, “Earthquake Loads”



ASCE 7-10 Seismic Design Requirements

13.2 GENERAL DESIGN REQUIREMENTS

13.2.1 Applicable Requirements for Architectural, Mechanical, and Electrical Components, Supports, and Attachments.

Architectural, mechanical, and electrical components, supports, and attachments shall comply with the sections referenced in Table 13.2.1. These requirements shall be satisfied by one of the following methods:

ASCE 7-10 Seismic Design Requirements

1. Project-specific design and documentation submitted for approval to the authority having jurisdiction after review and acceptance by a registered design professional.
2. Submittal of the manufacturer's certification that the component is seismically qualified by:
    a. Analysis
    b. Testing in accordance with the alternative set forth in Section 13.2.5
    c. Experience data in accordance with the alternative set forth in Section 13.2.6

ASCE 7-10: Project Specific Documentation

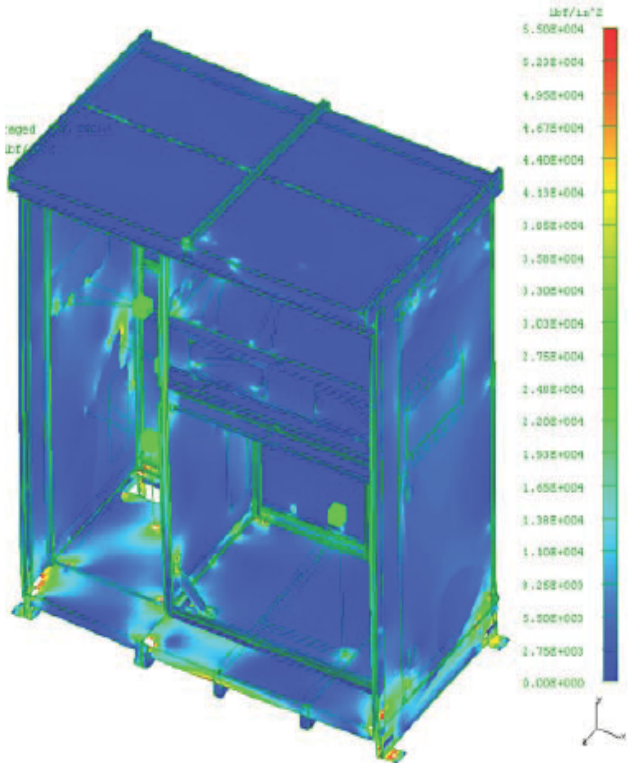
1. Project-specific design and documentation prepared and submitted by a registered design professional.

   NOTE: Shall include longitude & latitude based on the project address; seismic criteria for that location and any restrictions

ASCE 7-10: Certification by Analysis

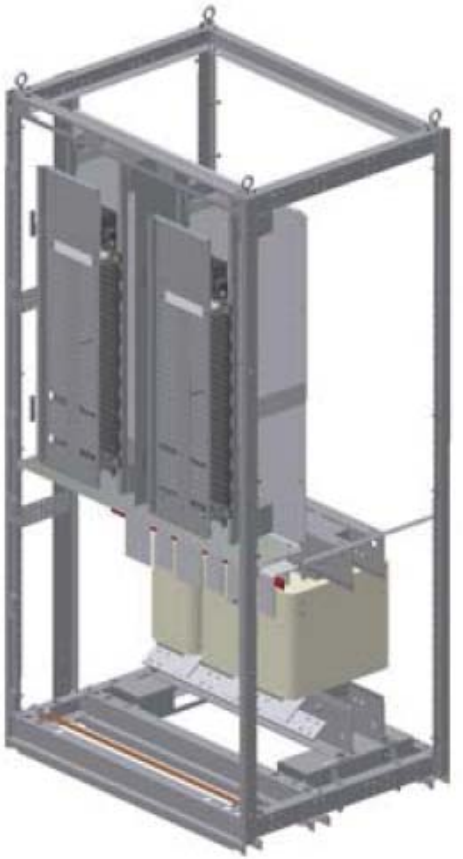
2. Submittal of the manufacturer's certification that the component is seismically qualified by:
    a. Analysis

$$F_p = \frac{a_p C_a I_p}{R_p}\left(1 + 3\frac{h_x}{h_r}\right)W_p$$



ASCE 7-10: Certification by Analysis

ANALYSIS of a similar piece of equipment that has actually been TESTED by a 3rd party independent laboratory by recognized test standards, and the results have been recorded for extrapolation by specialty software for seismic modeling.



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ASCE 7-10: Certification by Testing

2. Submittal of the manufacturer's certification that the component is seismically qualified by:
    a. Analysis
    b. Testing in accordance with the alternative set forth in Section 13.2.5

ASCE 7-10: Certification by Testing

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ASCE 7-10: Certification by Testing

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ASCE 7-10: Testing to What Standard

13.2.5 Testing Alternative for Seismic Capacity Determination. As an alternative to the analytical requirements of Sections 13.2 through 13.6, testing shall be deemed as an acceptable method to determine the seismic capacity of components and their supports and attachments. Seismic qualification by testing based on a nationally recognized testing standard procedure, such as ***ICC-ES-AC 156***, acceptable to the authority having jurisdiction, shall be deemed to satisfy the design and evaluation requirements provided that the substantiated seismic capabilities equal or exceed the seismic demands determined in accordance with Sections 13.3.1 and 13.3.2.

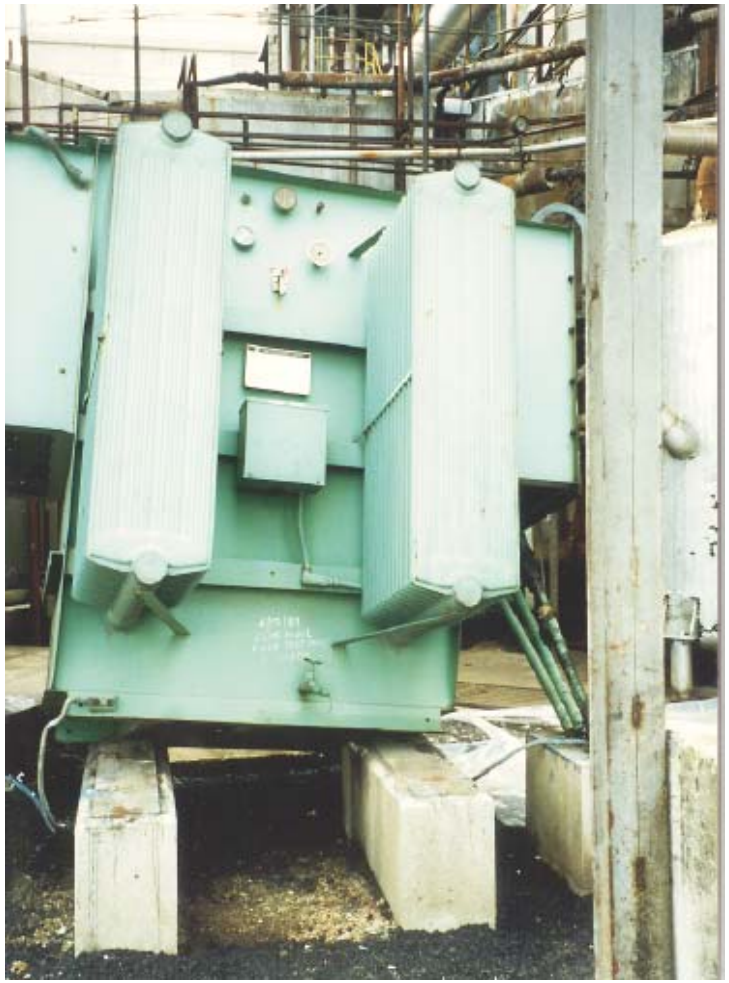
Seismic Testing – Performance Criteria

- Equipment maintains structural integrity, no projectiles
- Perform its design function immediately after the event.
- Equipment mounting will maintain structural integrity
- Equipment and its insulating systems must be verified to perform function at the certified levels
- We often check stability of circuit breakers and switches during testing to ensure they do not change state. However, this is not a requirement.

ASCE 7-10: Certification by Experience

1. Project-specific design and documentation prepared and submitted by a registered design professional.
2. Submittal of the manufacturer's certification that the component is seismically qualified by:
    a. Analysis
    b. Testing in accordance with the alternative set forth in Section 13.2.5
    c. Experience data in accordance with the alternative set forth in Section 13.2.6

ASCE 7-10: Certification by Experience



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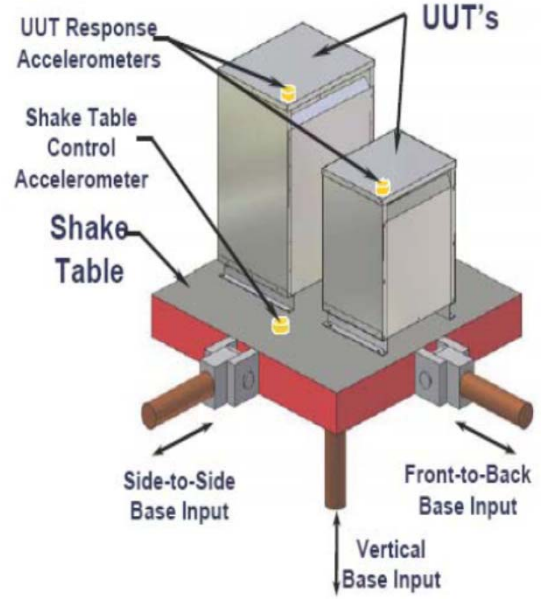
ASCE 7-10: Certification by Experience

Experience Data

- Permanent graphic elements
  - Subjected to Known String Motion Events
  - Detailed Engineering Studies of Performance
  - Anchorage Evaluation
  - Root Cause of Failure Determined by Experts
- Project Site Lower Demand Than Database
- Equipment Must Be of Equal or Better Construction

UBC Zone 4 vs. ASCE 7-10 Certification

$$F_p = \frac{0.4\, a_p\, S_{DS}}{\left(\frac{R_p}{I_p}\right)} \left(1 + 2\frac{z}{h}\right) W_p$$



Code basis was

Static Lateral

Push Over Forces

Illustration by Jeff Gatscher & Scott Littler

Shake Table Test is ***Dynamic*** Demand

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Ground VERSUS Roof Mounted

1994 Northridge Earthquake - Instrumented Building LA County Olive View-UCLA Medical Center

Sylmar, California

EATON
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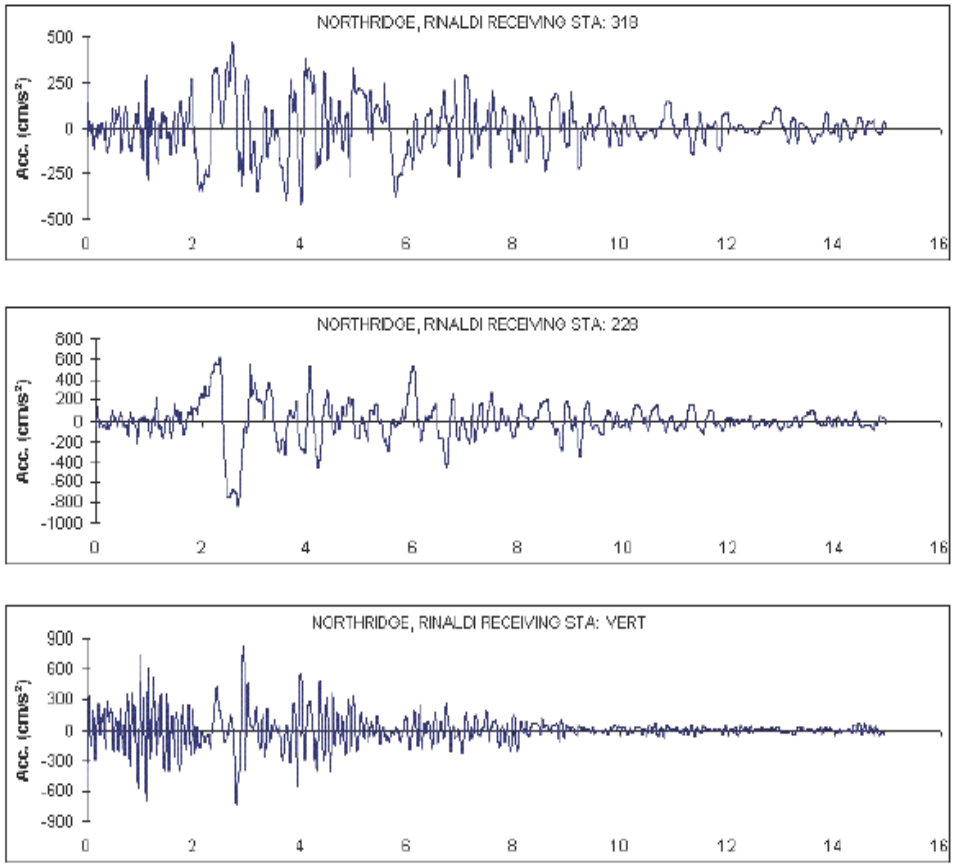
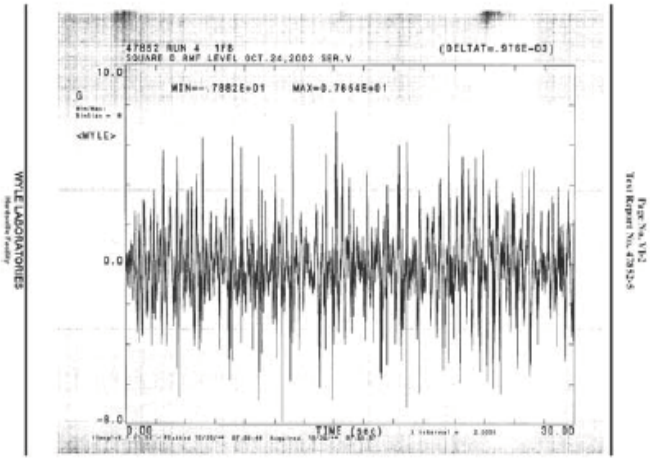
Shaker Table Test VERSUS Seismic Event



Strong Motion Time History's - Northridge

Trinet

Actual Test Tries to Cover "Worse Case" and Full Spectrum



Shaker Table Test Motion

Wyle Labs

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Manufacturer's Recommendations

Considerations for Seismic Qualified Installations

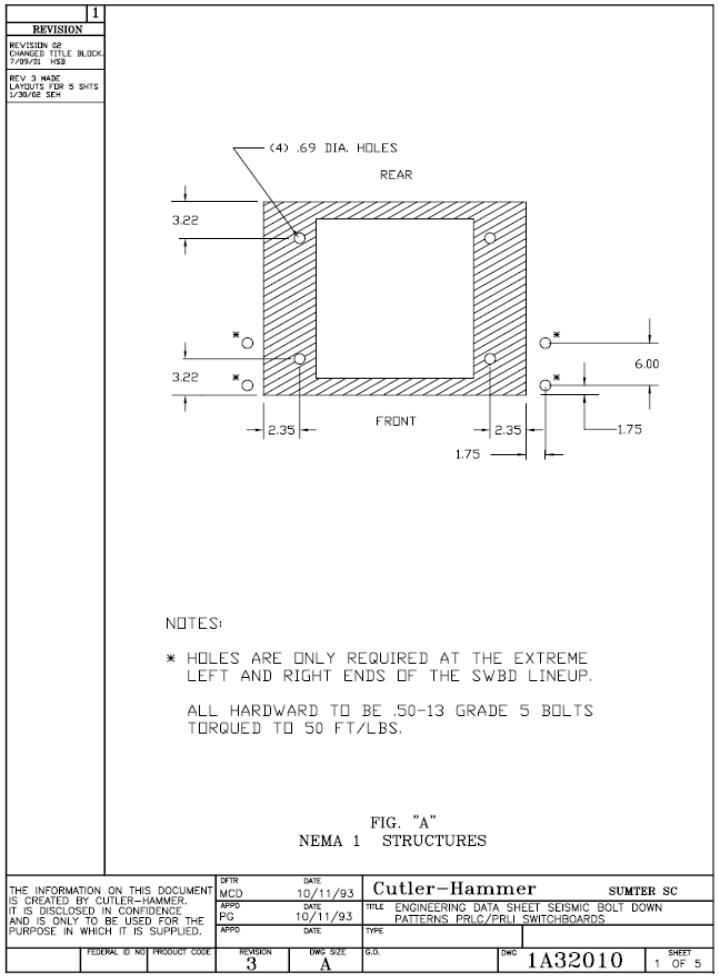
Switchboards that are "Seismically Qualified" require additional considerations. Since electrical equipment is installed as part of a system, pre-engineering layouts are critical in seismic applications.

When seismic qualified and marked Cutler-Hammer brand switchboards are used, anchoring the switchboard recommended by the design engineer is critical. Experienced engineers in seismic requirements should select methods and techniques of attachment and tested anchoring systems. Embedded concrete anchors or steel attachments must be adequate to resist the forces established by the local building code. Bolts of the proper grade of steel must be correctly sized and torqued. The embedded anchors must be correctly installed in accordance with the method specified by the anchor manufacturer.

Conduit layout in concrete for loads entering and/or exiting the bottom must be designed and installed to prevent damage from an earthquake. If top entry is necessary, seismic fittings or flexible conduit is needed.

Consult applicable local building codes and regulatory agencies for other specific requirements for seismic installations.

Follow Anchorage Instructions



Type & Embedment & Location of Anchor

- **Fastened to a Wall?**
  A. Center-Line of Gravity and Weight
  B. Construction Material of Wall
  C. Type of Anchor
  D. Depth of Anchor
  E. Quantity Per Structure or Line-up
- **Concrete Slab?**
  A. Center Line of Gravity and Weight
  B. PSI
  C. Type of Anchor
  D. Depth of Anchor
  E. Per Structure or Line-up

Will the Structure Handle It?

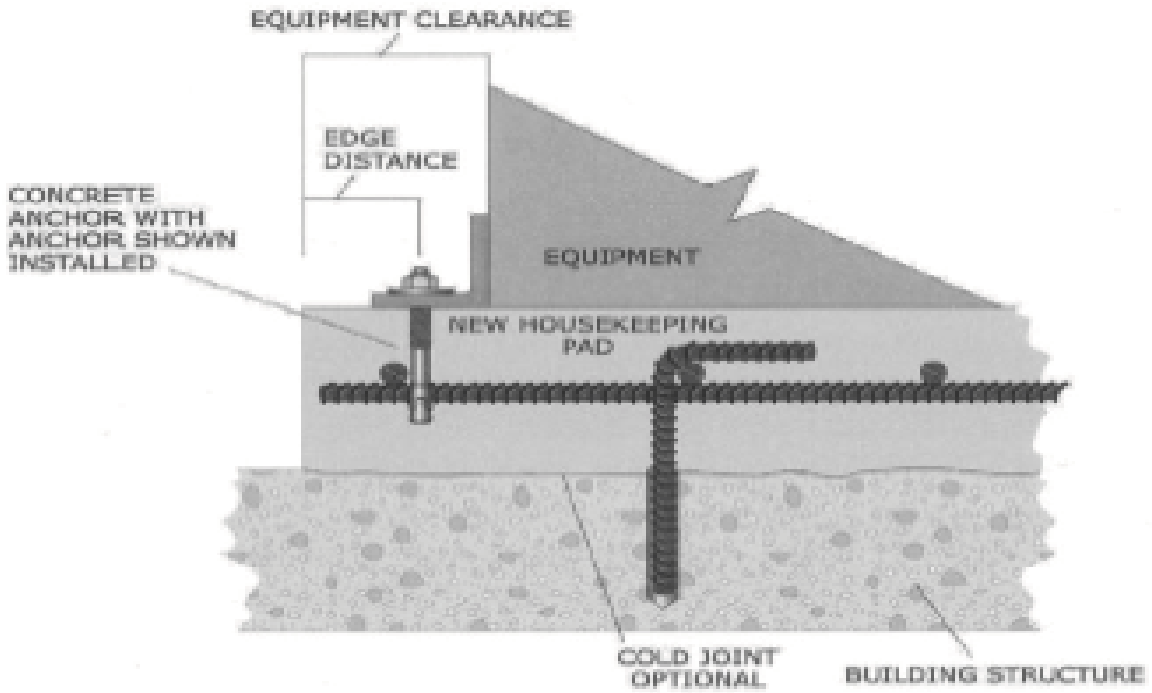


Figure 159: Housekeeping pad in section view.

If edge distance is not met, get an evaluation from your supervisor.

Illustration from: FEMA 413

Was This Installation “Seismic Qualified”?

Housekeeping Pad was NOT tied to the Slab or Building Steel

How To Specify Seismic Qualified Equipment

As an Electrical Consultant, You May Wonder:

What Type of Specification Should be Used?

Where Do We Find Site Specific Information?

I’m not a Structural Engineer, What Criteria Do I Need to Use and is Important to Include?

EATON Sample Specification

NOTE to SPEC WRITER:

To help understand the 2009 IBC/2010 CBC seismic parameters for a specific location, the attached link to the US Geological Survey will be extremely helpful:

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

Download the file "Java Ground Motion Parameter Calculator - Version 5.0.8 (4.6 MB)" and save it to your hard drive, then run the executable (.exe) that was downloaded.

Enter the latitude and longitude of your project location.

(To find exact Latitude and Longitude, go to http://geocoder.us/ and type in the address.)

The IBC seismic criteria for that location will then be displayed. It is simply a matter of verifying that the criteria shown for your specific building location is less than those listed above.

Sample Specification

The equipment and major components shall be suitable for and certified ***by actual seismic testing*** to meet all applicable seismic requirements of the 2009 International Building Code (IBC), Site Classification [Enter classification from above website]. The site coefficients F_a = [Enter value from above website], and spectral response accelerations of S_S = [Enter value from above website]g, S_1 = [Enter value from above website]g are used. The test response spectrum shall be based upon a 5% damping factor, and a peak (S_{DS}) of at least [Enter value from above website]g's (3 - 12 Hz) applied at the base of the equipment in the horizontal direction. The forces in the vertical direction shall be at least 66% of those in the horizontal direction. The tests shall cover a frequency range from 1 to 100Hz. Guidelines for the installation consistent with these requirements shall be provided by the equipment manufacturer and based upon testing of representative equipment. Equipment certification acceptance criteria shall be based upon the ability for the equipment to be returned to service immediately after a seismic event within the above requirements without the need for repairs.

Abbreviations & Definitions

F_a = Site Coefficients @ 0.2 Second Short Period

F_v = Site Coefficients @ 1.0 Second Period

S_S = 0.2 Second Spectral Response Acceleration

S_1 = 1.0 Second Spectral Response Acceleration

S_{MS} = Maximum Spectral Response @ 0.2 Second

S_{M1} = Maximum Spectral Response @ 1.0 Second

S_{DS} = Peak Response @ 0.2 Second

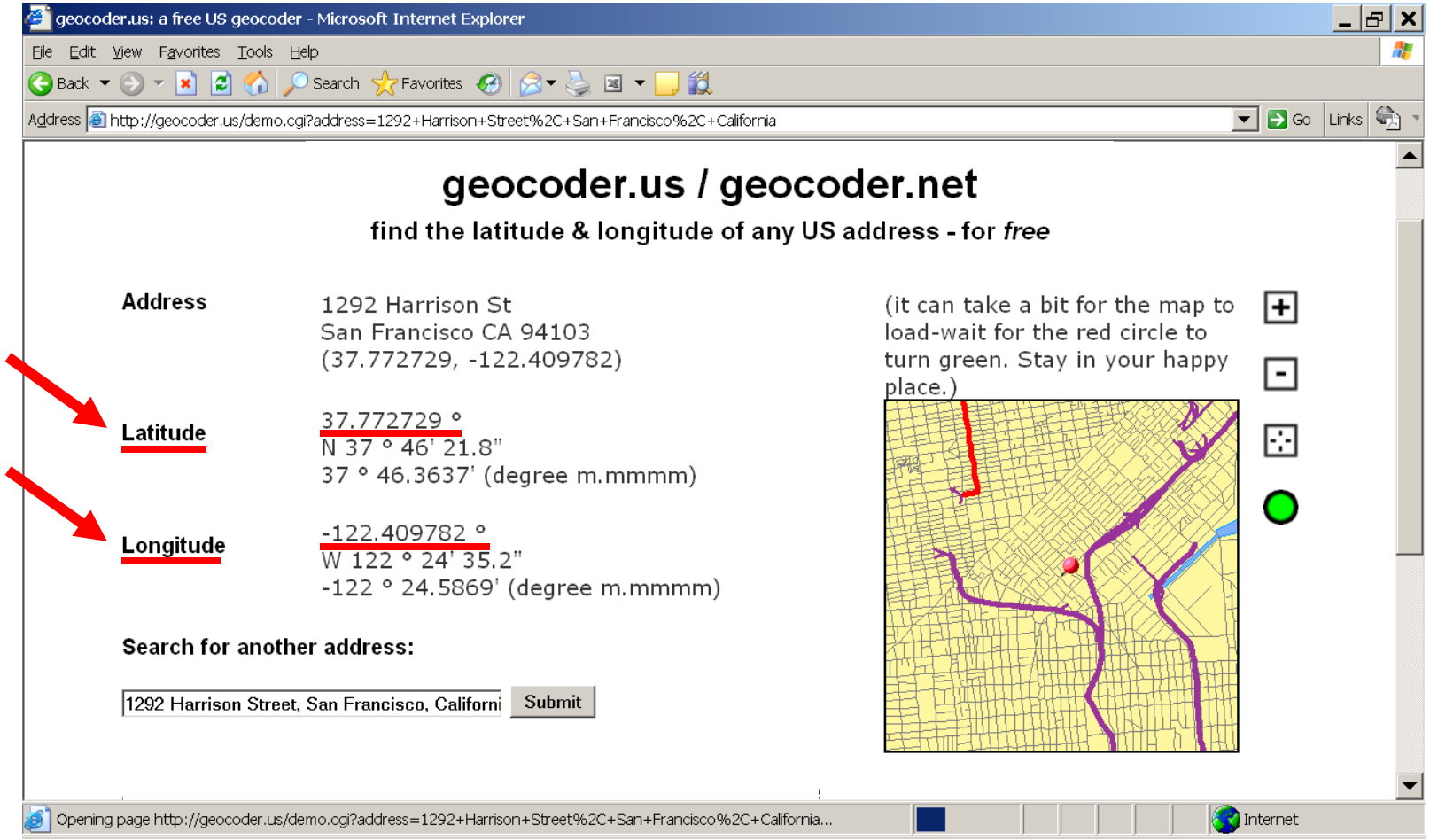
S_{D1} = Peak Response @ 1.0 Second

T_S = Response Spectrum Curve Start

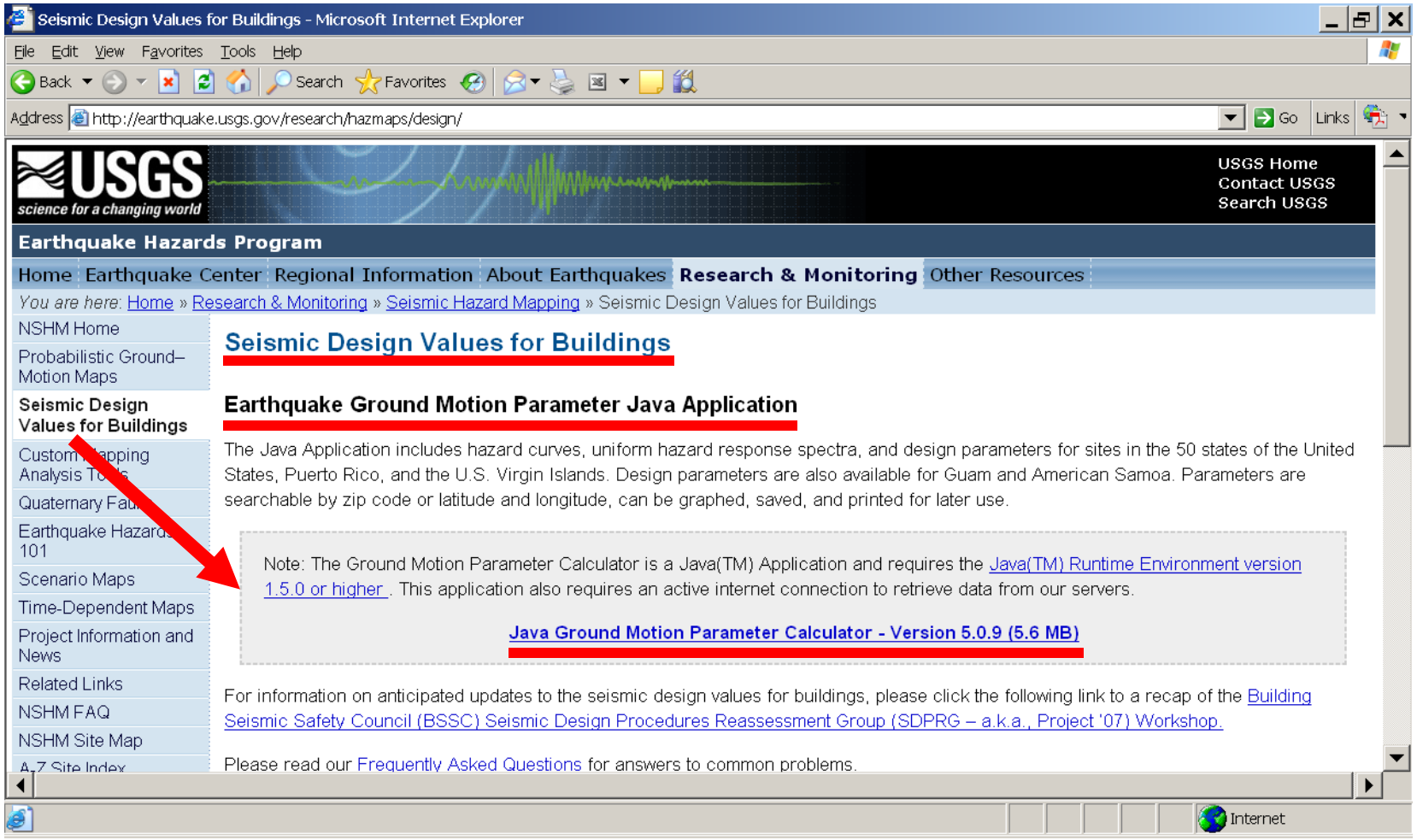
T_O = Response Spectrum Curve Acceleration Band

How to Find Longitude & Latitude

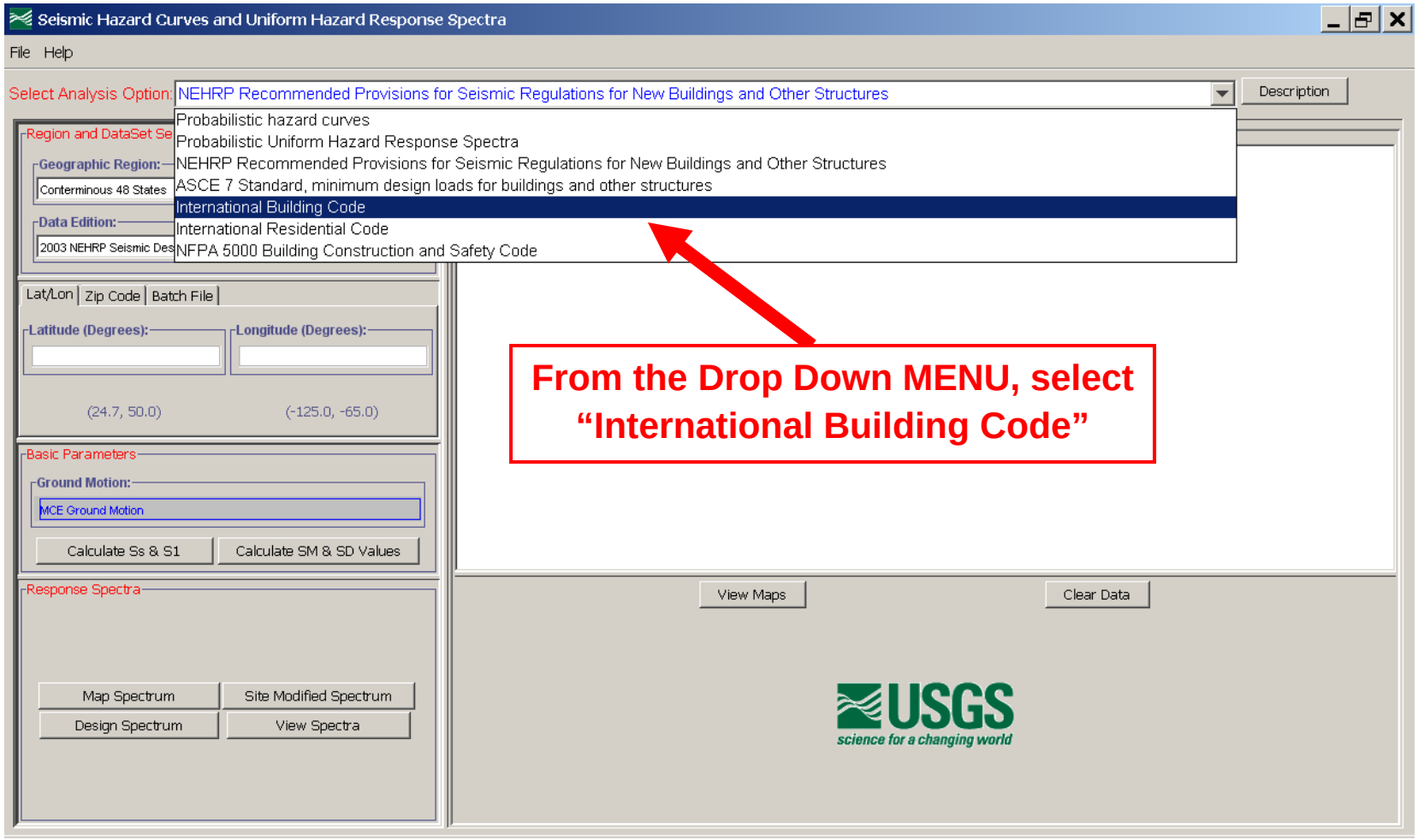
How to Find Longitude & Latitude



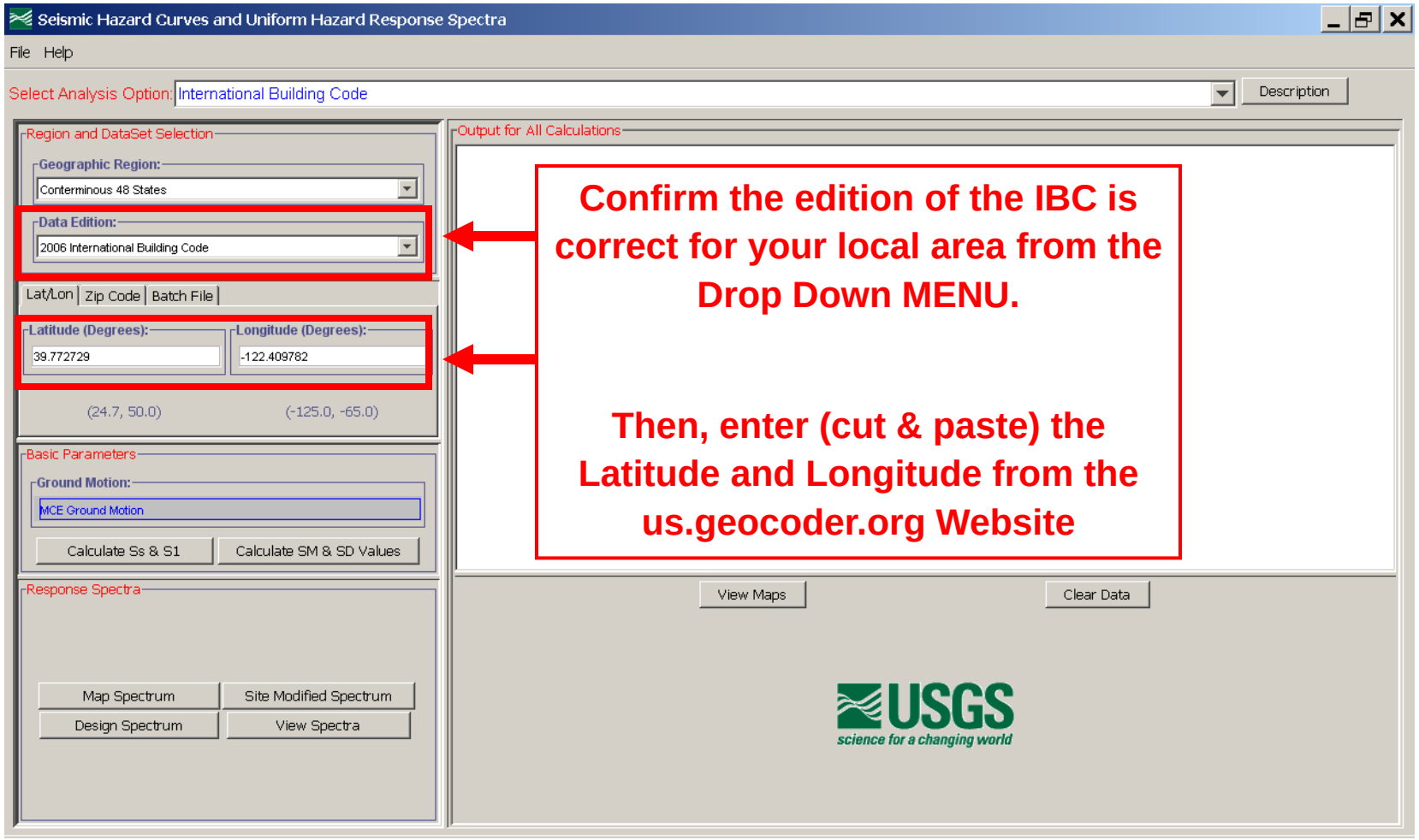
USGS - Ground Motion Parameter Calculator



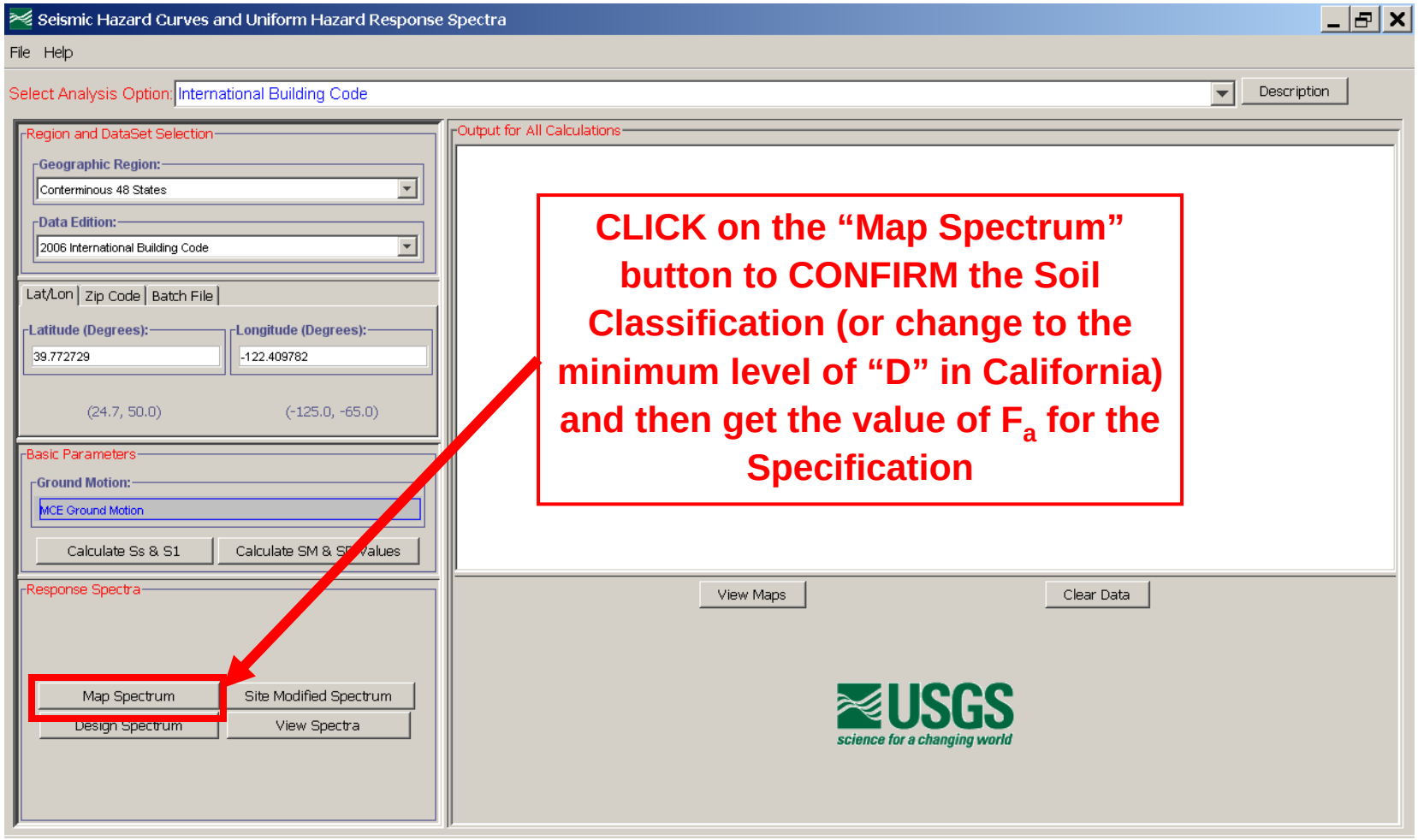
USGS - Ground Motion Parameter Calculator



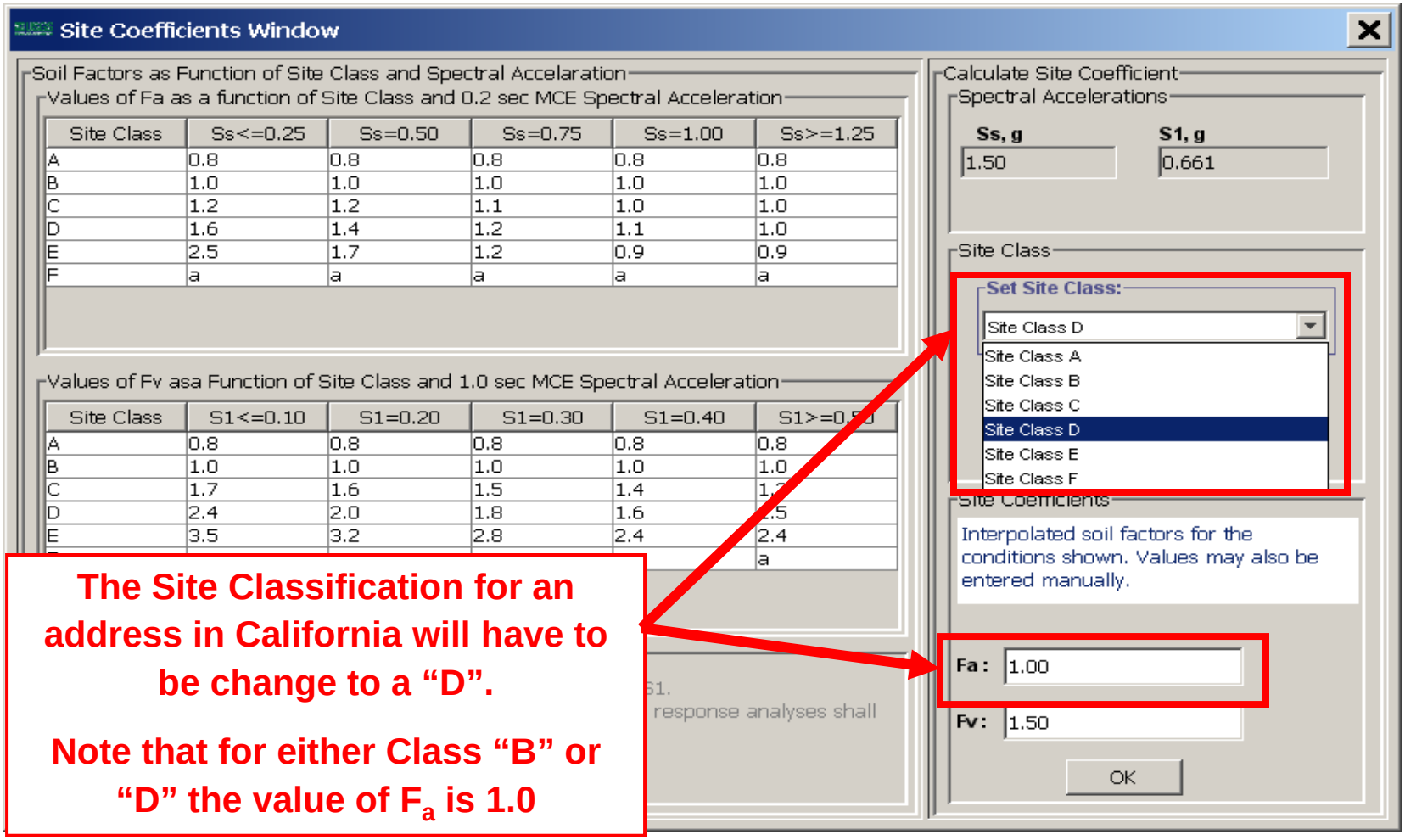
Confirm Code Reference & Location



Confirm Soil Classification & F_a



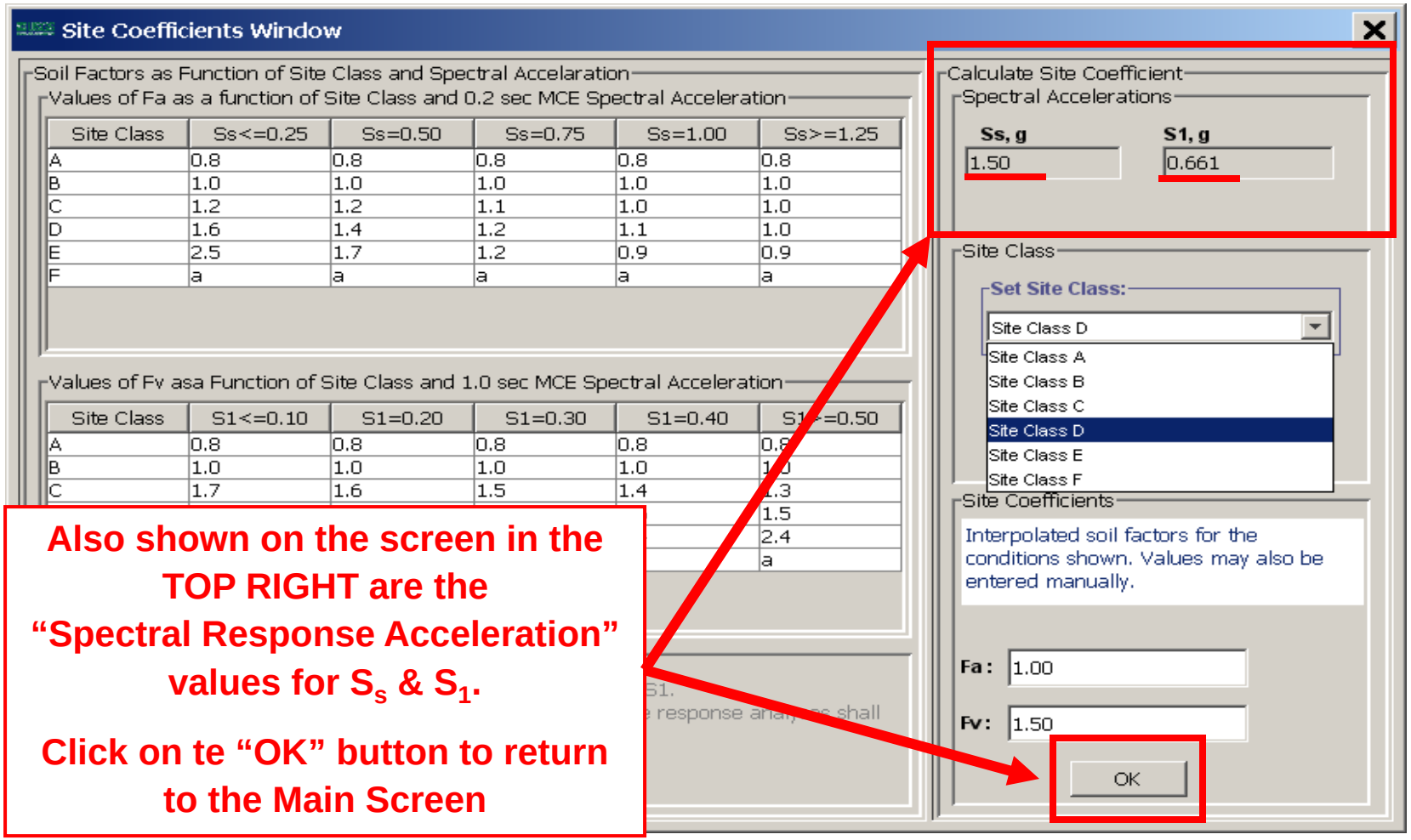
Confirm Soil Classification & F_a



The Site Classification for an address in California will have to be change to a "D".

Note that for either Class "B" or "D" the value of F_a is 1.0

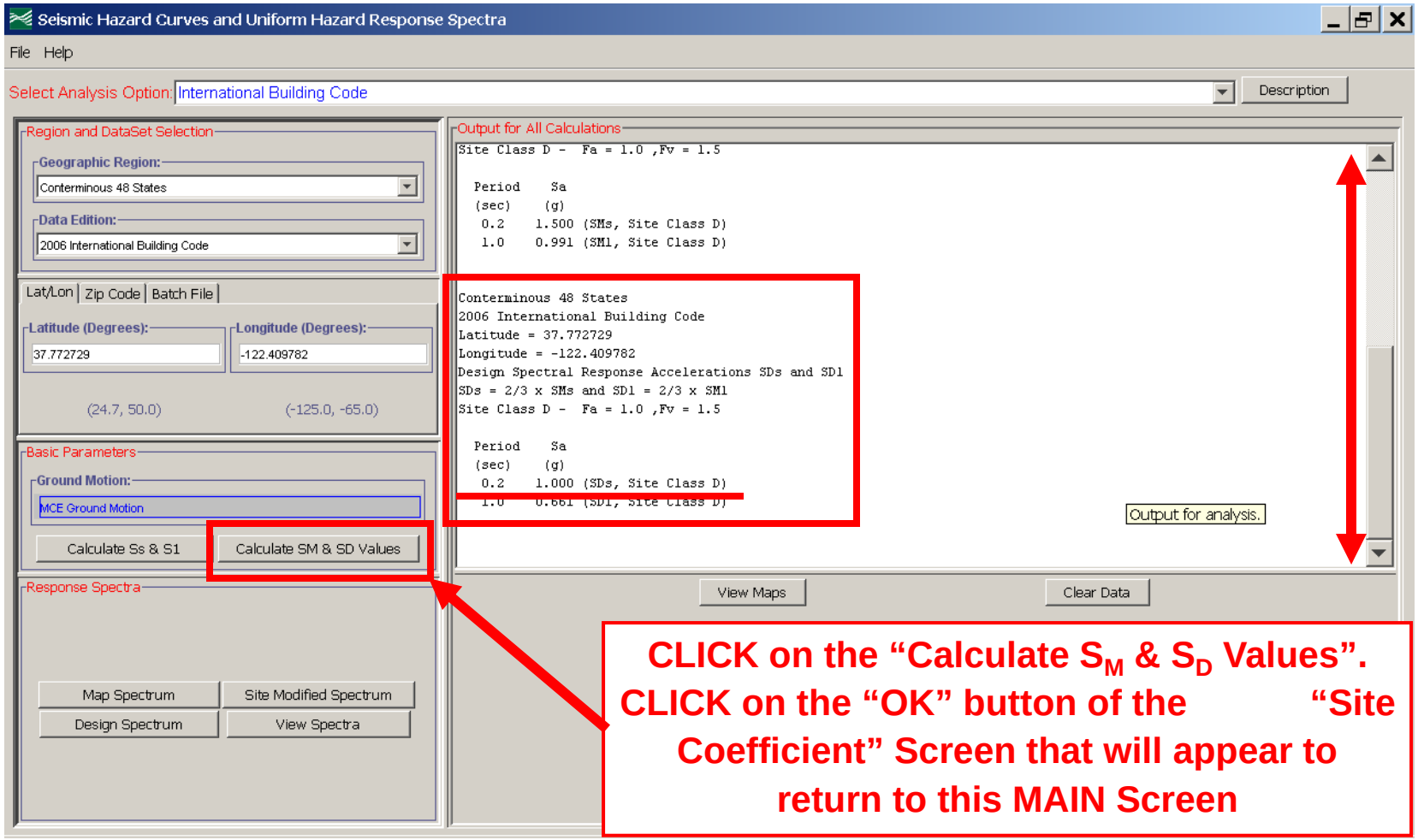
Confirm S_s & S_1 Values



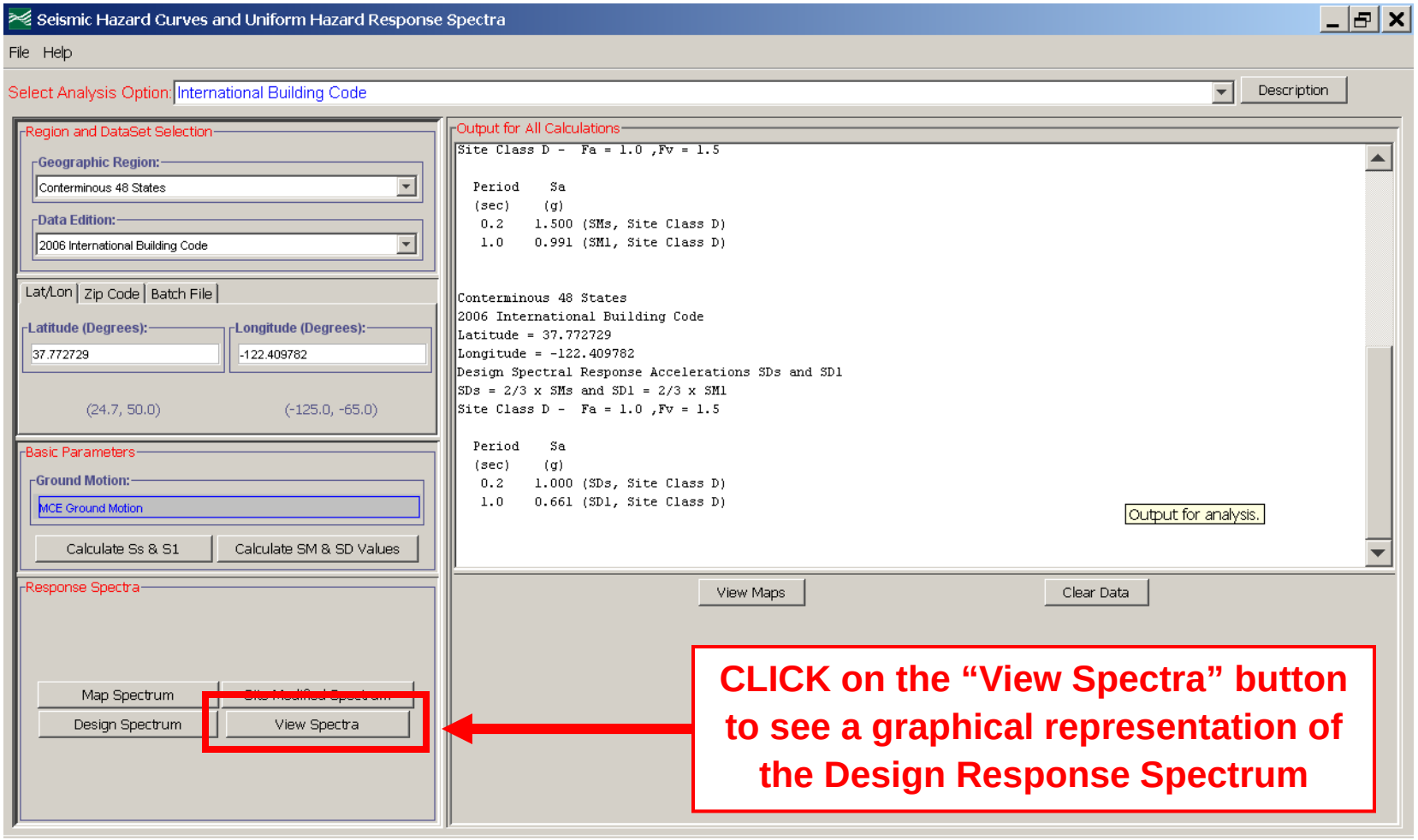
Also shown on the screen in the TOP RIGHT are the "Spectral Response Acceleration" values for S_s & S_1.

Click on te "OK" button to return to the Main Screen

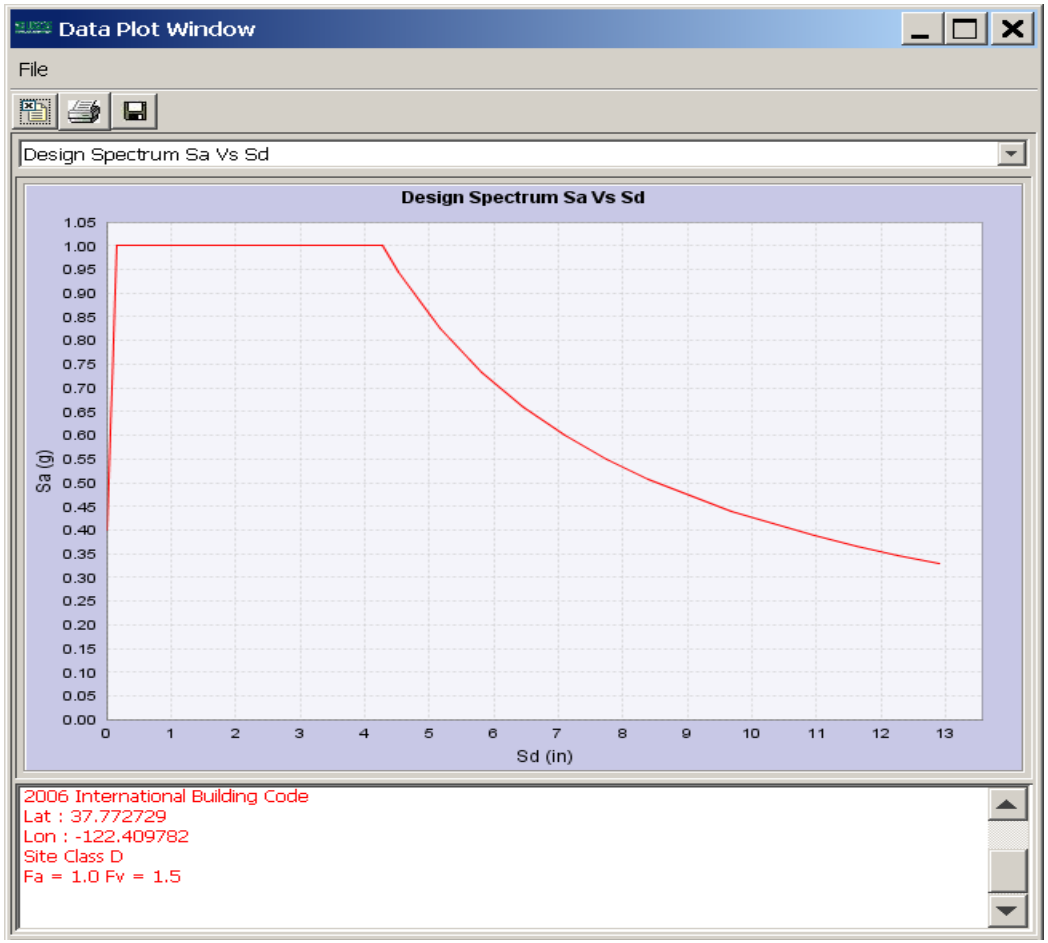
Confirm S_{DS} Value



View “Spectral Data”



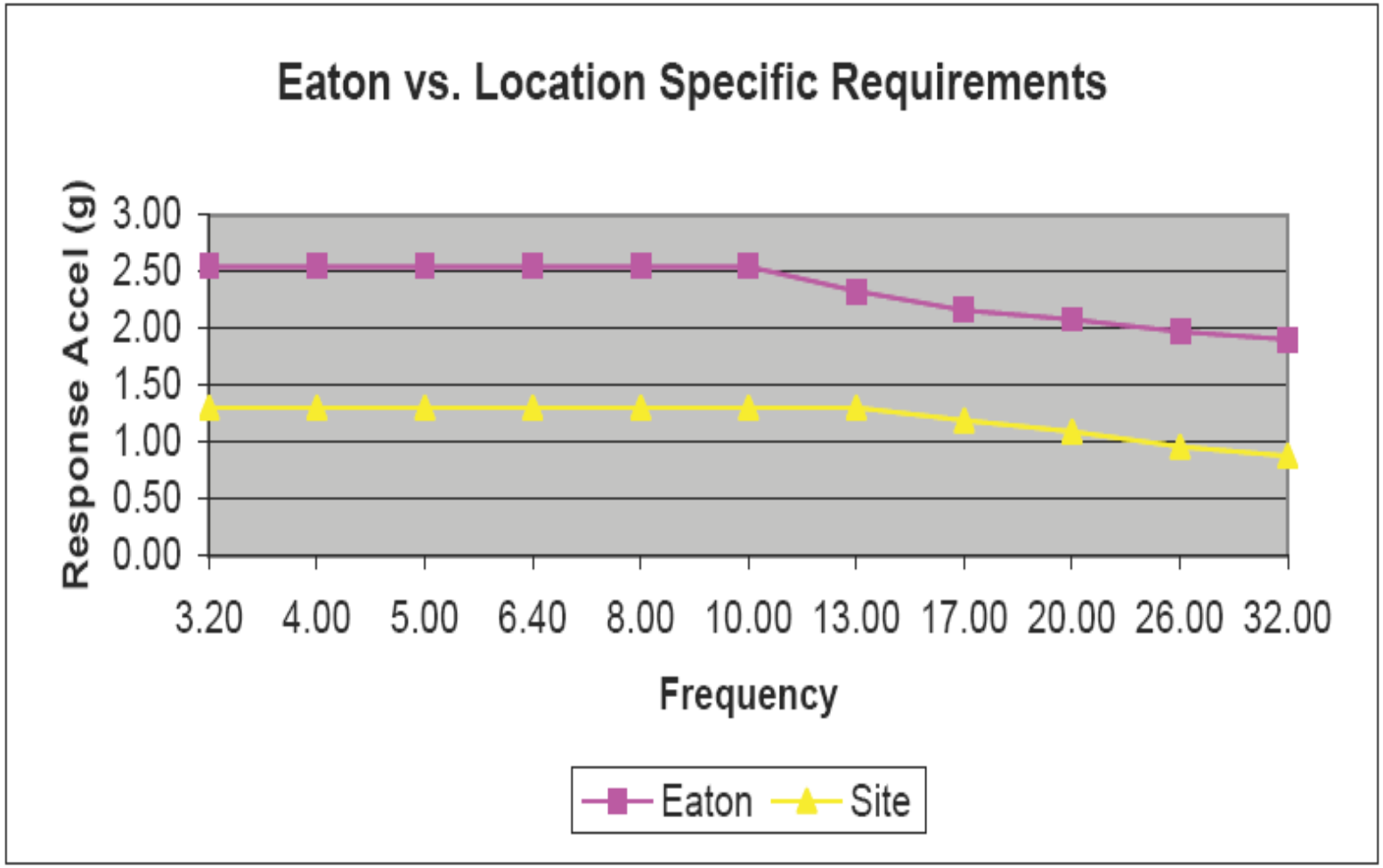
View “Spectral Data”



The Completed Specification

The equipment and major components shall be suitable for and certified ***by actual seismic testing*** to meet all applicable seismic requirements of the 2009 International Building Code (IBC), Site Classification D. The site coefficients F_a = 1.00, and spectral response accelerations of S_S = 1.5g, S_1 = .661g, are used. The test response spectrum shall be based upon a 5% damping factor, and a peak (S_{DS}) of at least 1.0g's (3 -12 Hz) applied at the base of the equipment in the horizontal direction. The forces in the vertical direction shall be at least 66% of those in the horizontal direction. The tests shall cover a frequency range from 1 to 100Hz. Guidelines for the installation consistent with these requirements shall be provided by the equipment manufacturer and based upon testing of representative equipment. Equipment certification acceptance criteria shall be based upon the ability for the equipment to be returned to service immediately after a seismic event within the above requirements without the need for repairs.

The Bottom Line



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For Additional Information

EATON Equipment Seismic Website

- www.eaton.com/seismic
- “Seismic Qualified” Certificates
- White Paper #SA122501SE on:

  “Earthquake Requirements and Seismic Capabilities for EATON’s Electrical Distribution and Control Equipment”
- Specification Template