Use and Definition of Deterministic Parameters

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Summary Definition of Deterministic $\text{MCE}_R$ Ground Motions (Section 21.2.2)

- 5%-damped response spectral acceleration, maximum direction response at the period of interest (e.g. 0.2s and 1.0s for defining values of $S_{MS}$ and $S_{M1}$)
- Largest response of characteristic (?) earthquakes on all known active faults within the region
- 84th percentile response (e.g., 1.8 x median response)
- Not less than “lower limit” (plateau region) based on design spectrum shape (Fig. 21.2-1) shape anchored to:
  - $S_{MS} = 1.5F_a$ at short-periods ($S_s = 1.5$) and
  - $S_{M1} = 0.6F_v$ at a period of 1-second ($S_1 = 0.6$)
Notional Illustration of Design Earthquake (*Project 97*)

- **2/3 x Probabilistic [2% in 50 years]**
- **2/3 x 1.5 x Deterministic [Median Mmax]**
- **1994 UBC (S₁)**
- **1997 UBC (S₈)**

1-Second Spectral Acceleration (g)

![Graph showing source distance vs. spectral acceleration](image)

- **UBC Zone 4**
- **Deterministic (Near-Source)**
- **Probabilistic (Mod./Low Seismicity)**
Notional Illustration of Design Earthquake *(Project ’07)*

- **2/3 x Probabilistic**: 1% in 50-year risk
- **2/3 x 1.5 x Deterministic [Median Mmax]**
- **1994 UBC (S₁)** vs. **1997 UBC (S₂)**

- **UBC Zone 4**
- **Deterministic (Near-Source)**
- **Probabilistic (Mod./Low Seismicity)**
Example Hazard Curves (USGS, 2003)

**1-Second Spectral Acceleration (g)**

- **San Francisco**
- **Los Angeles**
- **Seattle**
- **Salt Lake City**
- **Sacramento**
- **Memphis**
- **Charleston**
- **St. Louis**
- **New York City**
- **Chicago**

- **SA[10%/50-yr]:**
  - Los Angeles: 0.40 g
  - Memphis: 0.06 g

- **2/3 x SA[2%/50-yr]:**
  - Los Angeles: 0.45 g
  - Memphis: 0.25 g
Should buildings be designed for earthquake ground motions which occur only once every 2,500 years, or so, on average (e.g., when the Big One occurs once every 250 years, or so, on average)?
Comparison of Notional Collapse Risk for Frequent (250-yr MAF) and Infrequent (1,250-yr MAF) Deterministic MCE Ground Motions

If deterministic MCE ground motions occur every 1,250 years, or so, on average, then:
Collapse Risk (MCE only) = 0.4% probability of collapse in 50 years (i.e., 10% x 50/1,250)

If deterministic MCE ground motions occur every 250 years, or so, on average, then:
Collapse Risk (MCE only) = 2.0% probability of collapse in 50 years (i.e., 10% x 50/250)
Apparent Collapse Risk

![Graph showing apparent collapse risk with cities and regions marked on a 2D probability plot.](image)
Map showing selected Northern California city sites used to compare $MCE_R$ ground motions (and high slip rate WUS faults)

- Hayward Fault
- Rogers Creek Fault
- San Andreas Fault System
- Calaveras Fault
- Hayward Fault

Building Seismic Safety Council

San Andreas Fault System

Hayward Fault

Calaveras Fault

Map by Google

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Image by NASA

FEMA
USGS
Map showing selected Southern California city sites used to compare MCE$_R$ ground motions (and high slip rate WUS faults)
De-aggregation of 2,475-year mean annual return period seismic hazard at the SCEC Riverside site - 1s response (USGS)

San Jacinto Fault (San Bernardino Segment)

San Andreas Fault (San Bernardino Segment)
Comparison of Probabilistic and Deterministic MCE\textsubscript{R} Response Spectra - SCEC Riverside Site

SCEC Riverside Site Response Spectra - Vs,30 = 1,200 fps (CD) - RotD100

Probabilistic MCE\textsubscript{R} ≈ 3 x median response of an M7.8 earthquake

Likely ground motions due to the next M7.8 earthquake on the San Jacinto Fault
Summary of Deterministic MCE_R Issue

• Eliminate Deterministic MCE_R Ground Motions:
  – Use probabilistic MCE_R ground motions (only) for all seismic regions with consistent 1% in 50-year collapse risk objective
  – Risk - Overly conservative seismic loads for design of buildings in regions of very high seismicity

• Retain Deterministic MCE_R:
  – Avoid unwarranted over conservatism in seismic design loads
  – Risk - In consistent with 1% in 50-year risk objective in regions of very high seismicity
  – Resources (USGS with practitioner oversight) – Develop (and vet) site-specific (mapped) values of M and R (and other) deterministic MCE_R ground motion criteria