Building Standards: What about disaster resilience?

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Building Standards

- Primary Structure
- Fire
- Mechanical/Electrical/Plumbing
- Secondary Structure
- Communication/Information/…
- Standards v Model Building Codes
- National Voluntary Consensus Standards (ANSI)

Current Structural Objectives

Safety

- Generally mandatory
- Many structural limit states
  - Yield
  - Fracture
  - Buckling
  - Crushing
  - Fatigue
- Based upon structural reliability
- Influenced by risk

Serviceability

- Generally optional
- Empirical and simplistic (the real sophistication is not standardized)
- Typical limit states
  - Deflections
  - Lateral Drift
  - Durability
  - Vibrations

Primary Structure (New Buildings): Criteria for Safety

DEMAND < CAPACITY

- ASCE 7 *Minimum Design Loads…*

- ACI 318 *…Structural Concrete*
- AISC 360 & 341 *…Structural Steel Buildings*
- NDS *…Wood Construction*
- TMS 402 *…Masonry Structures*
- AISI *…Cold Formed Steel…*
- AA *…Aluminum Structures*

How Safe?

- For most ordinary hazards
  - Approximately 0.15% chance in 50 years of *benign* failure of a structural component in an *ordinary* risk building
- For earthquakes, except near active faults
  - 1% chance of structural collapse in 50 years
  - Higher (even twice as high) near major faults in California

Current Objectives

Existing criteria related to resilience

- Risk adjustments for importance of structure
  I. Relatively unimportant facilities (barns)
  II. Ordinary buildings
  III. Impaired occupants, moderately hazardous, or truly large facilities
  IV. Essential or truly hazardous facilities
- Higher levels of safety / higher levels of functionality

In concept, this is based upon the community

as a system, but it is not well measured

ASCE 7-10 Performance Clause

1.3.1.3 Performance-Based Procedures

Structural and nonstructural components and their connections shall be demonstrated by analysis or by a combination of analysis and testing to provide a reliability not less than that expected for similar components designed in accordance with the Strength Procedures of Section 1.3.1.1 when subject to the influence of dead, live, environmental, and other loads. Consideration shall be given to uncertainties in loading and resistance.

Performance Based Design
is not efficient design, although it may produce efficiency and effectiveness later

- Analysis
- Testing
- Documentation
- Peer Review

Secondary Structure in Buildings

- *Enclosure walls (nonstructural)*
- *Roofing*
- *Cladding*
- *Partitions*
- Ceilings
- Vertical transportation

- Equipment
  - Light
  - Ventilation
  - Heating/Cooling
- Distribution Systems
  - Plumbing: waste & supply
  - Power
  - Fuel
  - Fire suppression

Where Does Resilience Fit?

Risk of failure:

- Life safety at 0.15% to 1% in 50 years?
- Serviceability at 50% in 50 years?
- Or in between??

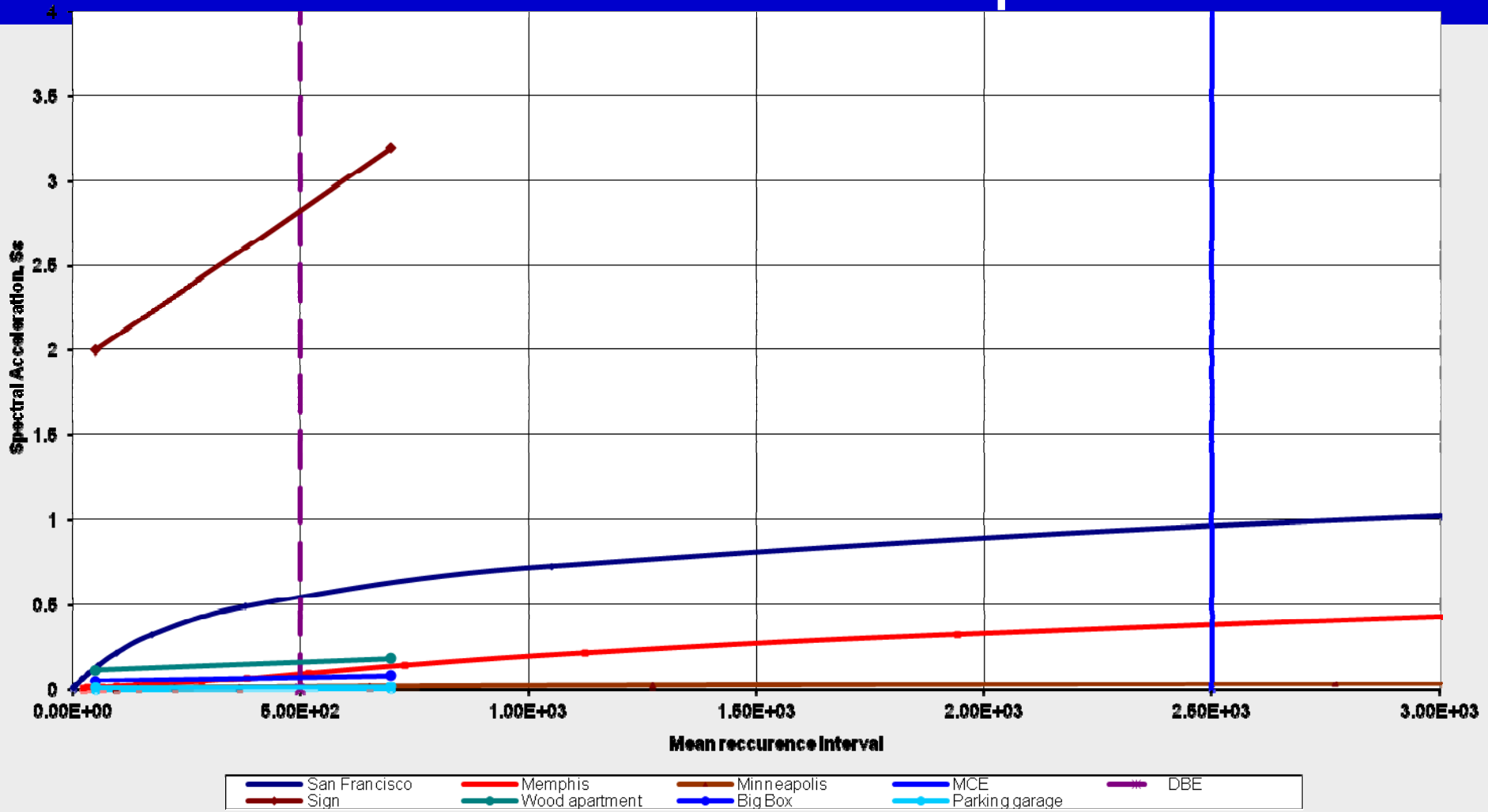
Limit State:

- Component failure?
- System failure?

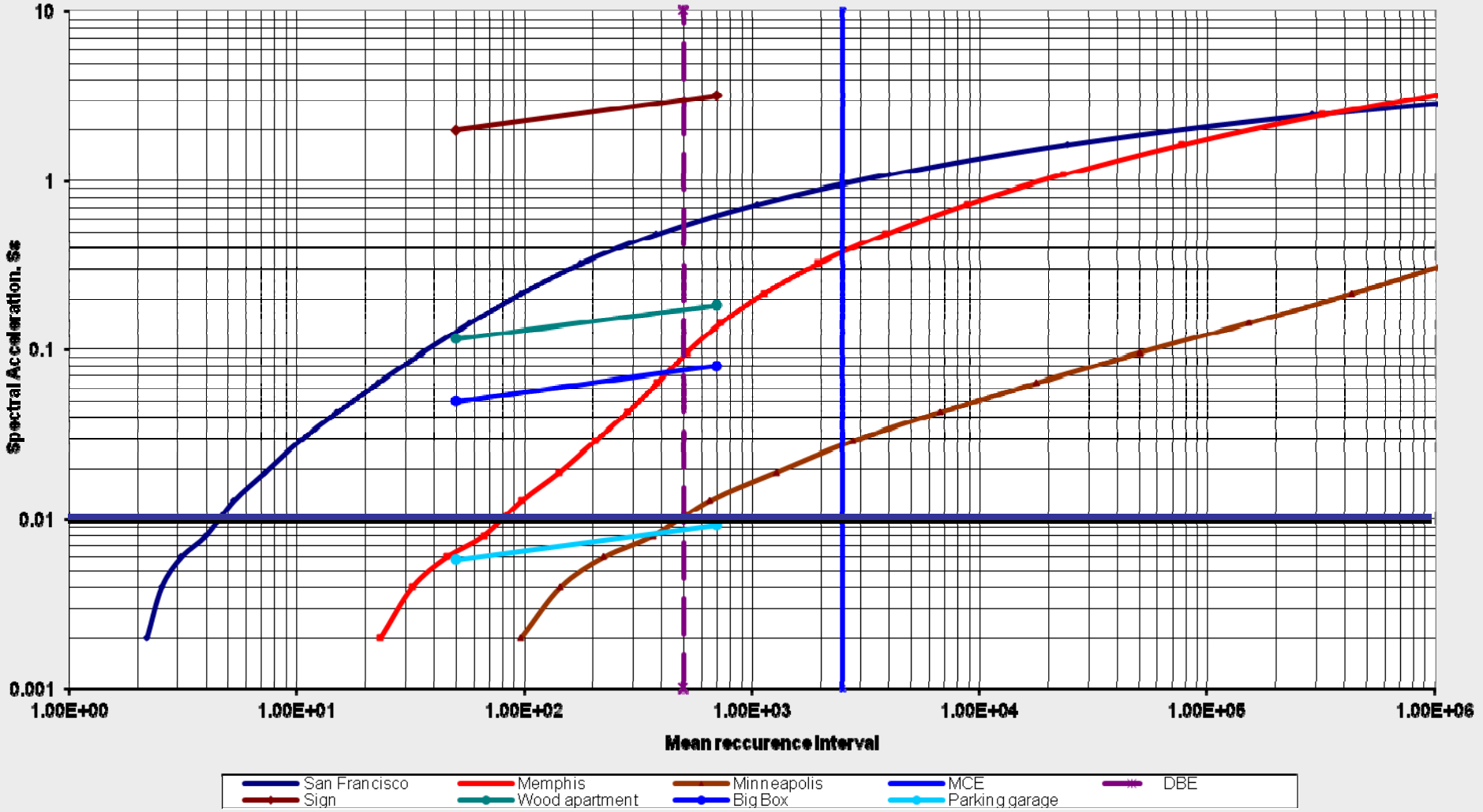
Impediments to Standards for Resilience in Buildings

- Rational basis for establishing the performance target
  - Improved definition of the hazard
  - Robust economic analysis
- Persuasion for long-term planning and spending
- Inherently complex issue of resource allocation

Selected Hazard Curves for wind and earthquake



Selected Hazard Curves



A Possible Opportunity

The Federal disaster assistance, response, and recovery program could have a more effective carrot and stick:

- Separate humanitarian and economic assistance
- Economic assistance is an insurance policy: limit its availability to those who have paid the "premium" – they have taken the steps to mitigate their losses and prepare an resilient community
  - This would be conditioned upon appropriate Federal leadership and technical assistance to define resilience

Resilience is definitely not simple