

# NEHRP AT 40: *WHERE WE GO FROM HERE*

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## Moderators:

Chris Poland, ACEHR Past Chair

Laurie Johnson, ACEHR Chair

## Speakers:

Kathleen Tierney, *University of Colorado*

Jane Bullock, *Bullock and Haddow*

Chris Rojahn, *ATC*

Jack Moehle, *UC Berkeley*

John Anderson, *University of Nevada, Reno*



# CHRIS POLAND

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Founding Chair, Advisory Committee for  
Earthquake Hazards Reduction (2008-2013)

## Key Milestones



# Before NEHRP

- 1964 Alaska Earthquake started the buildup to NEHRP
- 1965 Earthquake Prediction Report
- 1968 USGS Working Group Report
- 1969 Earthquake Engineering Research report by the National Academy of Science
- 1970 OSTP Steinburgge report
- 1971 San Fernando Earthquake
- 1975 Palmdale Bulge
- 1976 Newmark Report

# NEHRP Milestones:

- Earthquake Hazard Reduction Act of 1977  
Public Law 95-124 42
  - USGS and NSF original funded agencies, 8 other agencies mentioned
    - Earthquake Prediction
    - Public Education
    - Design and Construction Techniques and Model Codes
    - Research
- Reauthorized 11 times through 2004
  - FEMA and NIST (NBS) added as program agencies and FEMA designated as the Lead Agency in 1980.
- Title 42 U.S.Code. 7701 *et.seq.*



# NEHRP Milestones:

- 1980 to 2000 NEHRP Reauthorizations
  - Did not provide annual funding authorizations for all years
  - Annual hearings in both houses called for change and more collaboration
  - Significant changes followed the 1989 and 1994 Earthquakes
    - Clarified objectives
    - Eliminated emphasis on prediction
    - Clarified agency roles
    - Required regulations for new and existing federal buildings

# NEHRP Milestones

- 2004 Reauthorization brought significant change
  - House Science Committee interested in change
  - ASCE Government Affairs interest in Wind and Earthquake
  - ASCE, NAE, EERI 25 Anniversary Commemoration
  - Hearings that pointed to the issues and solutions
  - EERI's Securing Society Report
  - ASCE/EERI NEHRP Coalition common voice
  - Results HR 2608 108<sup>TH</sup> Congress
    - New lead agency, ICC, ACEHR
    - Specific NEES, ANSS, and PBE funding
    - Change in lead agency

# Challenges for the Next Reauthorization

## ■ 109<sup>th</sup> – 114<sup>th</sup> Congresses

- Few Congressional Champions, deadlock
- Wars
- Great Recession
- Changes in Appropriation Procedures
- Wind and Hurricane related disasters
- Multiple voices from the earthquake community

## ■ 115<sup>th</sup> Congress

# Observations on NEHRP and Reauthorization

- Multiple Congressional champions needed
- Change follows significant disasters
- Research implemented into practice sells
- Reauthorizations depend on agreement and a common voice
- Changing agency focus and inertia challenging
- Persistent support from ASCE, EERI and SSA

# LAURIE JOHNSON

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Chair, Advisory Committee for Earthquake Hazards Reduction (ACEHR)

## NEHRP Today



# Current NEHRP Program - Structure

- NEHRP Secretariat at National Institute of Standards and Technology (NIST) as lead federal agency since 2004 reauthorization
  - Jack Hayes served as NEHRP Director 2006 – 2016
  - Steve McCabe, current Earthquake Engineering Group Leader at NIST also Acting NEHRP Director as of January 1, 2017
- Four federal agencies:
  - Federal Emergency Management Agency (FEMA)
  - National Institute of Standards and Technology (NIST)
  - National Science Foundation (NSF)
  - United States Geological Survey (USGS)
- Interagency Coordinating Committee chaired by NIST Director
  - Members: Directors of FEMA, NSF, and USGS; Office of Science and Technology Policy (OSTP); and Office of Management and Budget (OMB)
  - Required by 2004 reauthorization to meet 3 times annually
- Program Coordination Working Group (PCWG)
- Advisory Committee for Earthquake Hazard Reduction (ACEHR)
- Scientific Earthquake Studies Advisory Committee (SESAC)

# Current NEHRP Program - Budget

## Enacted Agency NEHRP Budgets (\$M)<sup>1</sup>

FY	FEMA <sup>2</sup>	NIST <sup>3</sup>	NSF <sup>4</sup>	USGS <sup>5</sup>	NEHRP Total
<b>2005</b>	<b>14.7</b>	<b>0.9</b>	<b>53.1</b>	<b>58.3</b>	<b>127.0</b>
<b>2006– 2016</b>	<b>8.0 (Avg)</b> 9.5 (H: 2006) 6.1 (L: 2008)	<b>3.4 (Avg)</b> 4.1 (H: 2009–2012) 0.9 (L: 2006)	<b>52.9 (Avg)</b> 56.0 (H: 2009) 52.2 (L: 2013, 2015)	<b>59.8 (Avg)</b> 67.0 (H: 2016) 54.5 (L: 2006)	<b>124.1 (Avg)</b> 134.9 (H: 2016) 112.1 (L: 2014)

## Requested Agency NEHRP Budgets (\$M)<sup>6</sup>

FY	FEMA <sup>7</sup>	NIST <sup>8</sup>	NSF <sup>9</sup>	USGS <sup>10</sup>	NEHRP Total
<b>2017</b>	<b>8.5</b>	<b>5.9</b>	<b>54.2</b>	<b>69.5</b>	<b>138.1</b>

### Notes:

1. Enacted budgets reported by agencies as of 07/25/16. FEMA & NIST budgets were those agencies' allocations for NEHRP activities from total agency appropriations. NSF budget was its expenditure for NEHRP activities from total agency appropriations. USGS budgets were amounts appropriated for USGS NEHRP activities. 2009 ARRA funds are not included.
2. 2005 FEMA budget included program activities and employee salaries & expenses (S&E). 2005-2009 FEMA NEHRP budgets excluded state grants. 2006-2016 budgets covered all program activities, excluding S&E costs.
3. 2005 NIST budget supported NIST earthquake engineering research. 2006-2016 NIST budgets supported expenses for both NEHRP Secretariat and NIST Earthquake Risk Reduction in Buildings & Infrastructure R&D Program. 2016 budget includes \$1.3M of new Disaster Resilience Initiative funding
4. NSF expenditures supported program activities, excluding Agency Operations and Award Management (AOAM) costs. 2005 – 2014 budget included support for George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) and Global Seismographic Network (GSN). 2015-2016 expenditures include support for GSN and the earthquake engineering portion of the Natural Hazards Research Infrastructure (NHERI).
5. USGS budget supports program activities, including the USGS Earthquake Hazards Program (EHP) and USGS portion of GSN.
6. FY 2017 Administration-requested budgets shown were reported by agencies as of 07/25/16. FEMA (DHS), NIST, & NSF budgets are those agencies' planned allocations for NEHRP activities. USGS budget is amount requested for USGS NEHRP activities. Agencies currently under Continuing Budget Resolution through 9 December – at FY 2016 budget levels.
7. FEMA requested budget includes program activities, including S&E.
8. NIST requested budget supports expenses for both NEHRP Secretariat and NIST Earthquake Risk Reduction in Buildings & Infrastructure R&D Program. NIST budget includes \$2.0M of Disaster Resilience Initiative funding.
9. NSF requested NEHRP budget supports program activities, excluding AOAM costs. Budget includes support for GSN and the earthquake engineering portion of NHERI, but excludes EarthScope activities.
10. USGS requested budget supports program activities, including the EHP the USGS portion of the GSN (\$7.3M).



# ACEHR

- Authorized in 2004 and in existence since 2007/8; members to be widely representative of the stakeholder community
- Its charge is to provide a biennial assessment of the:
  - Effectiveness of NEHRP in performing its statutory activities and any need to revise NEHRP
  - Management, coordination, implementation, and activities of NEHRP; and
  - Trends and developments in the science and engineering of earthquake hazards reduction.
- Reports and meeting materials available at:  
<http://nehrp.gov/committees/index.htm>
- 2015 biennial assessment and two 2016 interim reports

# ACEHR Current Members

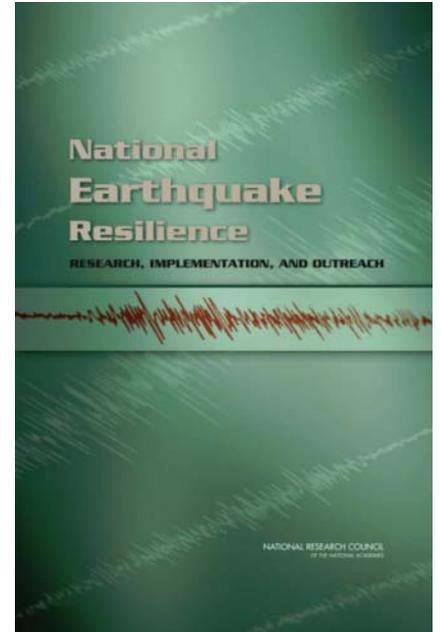
Ralph Archuleta  
Jane Bullock  
Craig Davis  
Gregory Deierlein  
John Gillengerten  
Jim Goltz  
Nathan Gould  
Bob Herrmann

Laurie Johnson  
Ryan Kersting  
Ron Lynn  
Lisa Ludwig  
Peter May  
Lori Peek  
Glenn Rix  
David Simpson



# ACEHR Assessment Highlights – Critical Observations for Congress

- Congressional reauthorization of the Earthquake Hazards Reduction Act is essential for the long-term viability of NEHRP
  - Address sufficient funding for NEHRP to maintain emphasis on earthquake hazards and seismic building design and expanding on critical infrastructure and lifeline systems, and socio-economic dimensions of community resilience as defined in the National Research Council (NRC) 2011 report, *National Earthquake Resilience: Research, Implementation and Outreach* (**Recommended \$307M annual budget**)
- Prior to or as part of reauthorization, conduct a fundamental assessment of the nation's earthquake risk reduction progress (and gaps) in order to assign appropriate statutory responsibilities and establish adequate funding levels to improve national resilience



# ACEHR Assessment Highlights

- Revitalize ICC as a mechanism for advancing NEHRP within federal agencies and renew consideration by the ICC of the future of NEHRP
  - Consider structural impediments to NEHRP coordination among agencies (i.e. different funding mechanisms, agency budgetary procedures, and different agency priorities)
  - Advancing NEHRP efforts as they relate to other agency priorities  
Review the status of core operational elements authorized and funded under NEHRP
  - Advancing the application of knowledge and implementation of NEHRP research to earthquake hazards reduction
- Specific recommendations for NEHRP Secretariat and the four NEHRP agencies related to program/budget priorities and gaps

# PANEL DISCUSSION

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- Kathleen Tierney, University of Colorado (National Seismic Resilience and Social Science)
- Jane Bullock, Bullock and Haddow (Emergency Management)
- Chris Rojahn, ATC (Engineering Codes/Practice)
- Jack Moehle, UC Berkeley (Engineering Research)
- John Anderson, University of Nevada, Reno (Earthquake Hazards/Risk Assessment)

*For each focus area:*

- *Key milestones and accomplishments of NEHRP*
- *Future needs and focus for NEHRP*
- *Considerations for a NEHRP reauthorization*





# KATHLEEN TIERNEY

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Natural Hazards Center  
University of Colorado Boulder

## National Seismic Resilience & Social Science



# Seismic Resilience & Social Science Key Milestones/Accomplishments

**Background:** NEHRA said the program should

- “improve the understanding of earthquakes and their effects on communities, buildings, structures, and lifelines, through interdisciplinary research that involves engineering, natural sciences, and social, economic, and decisions sciences”; and
- “support research that studies the political, economic, and social factors that influence the implementation of hazard reduction measures”

# Seismic Resilience & Social Science

## Key Milestones/Accomplishments

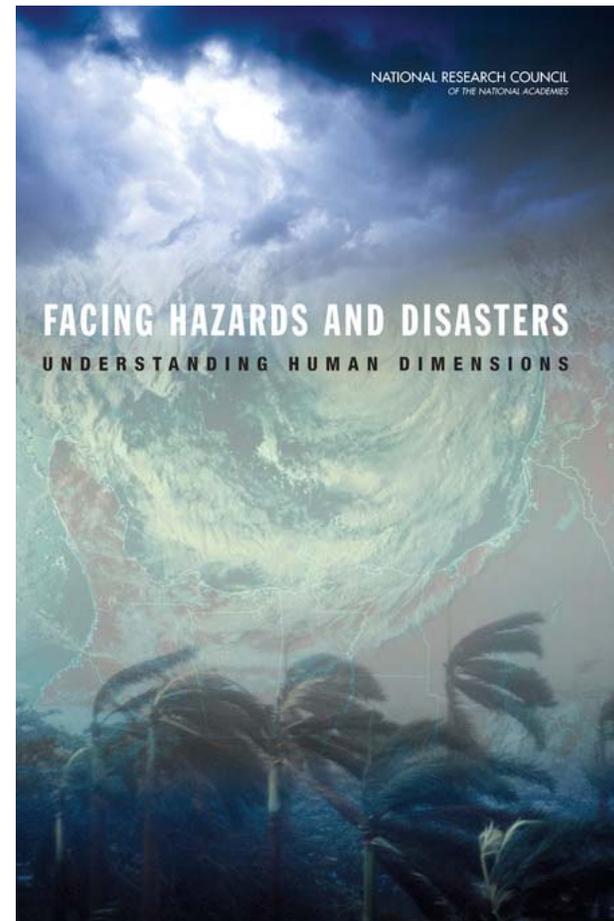
- Societal dimensions of earthquake predictions and warnings
- Earthquake loss estimation, modeling
- Differential impacts on diverse populations, businesses (Whittier Narrows, Loma Prieta, Northridge)
- Differential recovery trajectories and outcomes for social groups and at different scales
- Research on disaster response

# Seismic Resilience & Social Science Key Milestones/Accomplishments

- Conceptualization and measurement of earthquake/disaster resilience
- Factors associated with the adoption and implementation of risk reduction measures at different scales
- Policy learning and focusing events
- Cross-societal comparative research
- Research on other types of hazards/disasters

# Seismic Resilience & Social Science Key Milestones/Accomplishments

National Academies  
report on knowledge  
gained through NEHRP-  
sponsored social science  
Research (2006)



# Seismic Resilience & Social Science

## Future Needs and Focus

- Greater emphasis on research that explores factors that influence the adoption and implementation of loss-reduction measures at the community scale
- Research to better understand long-term recovery from earthquakes and other disasters
- Research on the societal dimensions of new technologies and social media

# Seismic Resilience & Social Science: Considerations for NEHRP Reauthorization

- Expansion of interdisciplinary research programs
- More disciplinary balance in existing research centers
- Repository/clearinghouse focusing on resilience conceptualization, measurement, application, implementation, and program evaluation

# JANE BULLOCK

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Bullock&Haddow, LLC  
(Formerly with NEHRP at FEMA)

## Emergency Management



# Emergency Management

## Key Milestones/Accomplishments

- Advancing EQ code adoption and implementation (NEHRP Provisions, ASCE series, etc)
- Passing Executive Orders, most recently E.O. 13717
- Promoting EQ awareness (State, Regional programs, Shakeout, Quake Smart)
- Disseminating technical guidance (NETAP, post-EQ rebuilding, training)

# Emergency Management

## Key Milestones/Accomplishments

- Using disaster recovery to advance NEHRP (PA minimum standards rule)
- Persevering as resources declined

# Emergency Management Future Needs and Focus

- Renewed Federal Commitment & Leadership
- Create local based implementation effort
- Greater emphasis on lifelines standards and resilience
- Insert NEHRP expertise into National priority initiatives
- Get Political – Broaden Constituencies- Cultivate political support with local officials, local Congressional offices, move on to Big 7
- Increase partnerships with non-traditional communities, i.e. banking, technology, agricultural, and societal organizations

# Emergency Management Future Needs and Focus

- Think Future, Think Practical: If a big EQ hits tomorrow, what resources do we need to achieve NEHRP goals?

# Emergency Management Considerations for NEHRP Reauthorization

- Request authority for adequate appropriations
- Request authority for a separate local based implementation program
- Include language that requires NEHRP consultation/involvement in any National Infrastructure Initiative
- Provide authority for NEHRP agencies to engage in/ accept non-governmental funds

# CHRISTOPHER ROJAHN

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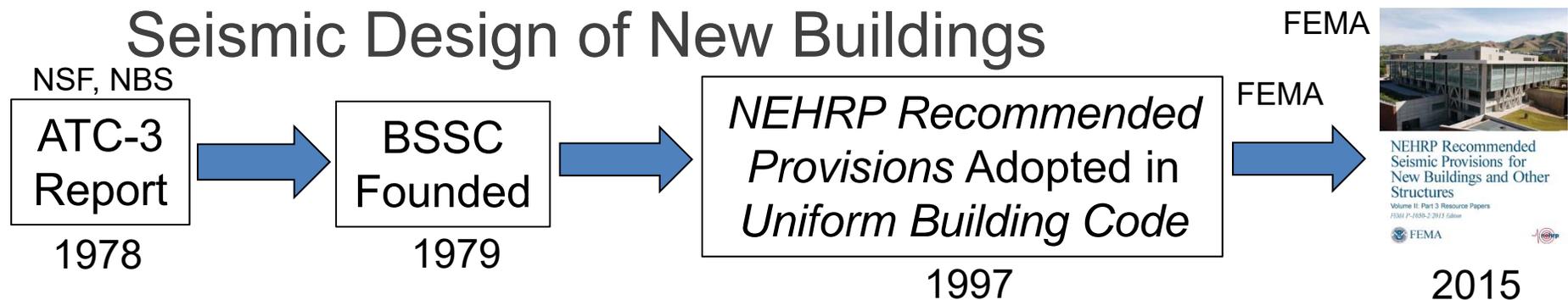
Applied Technology Council (retired)

## Engineering Codes/Practice

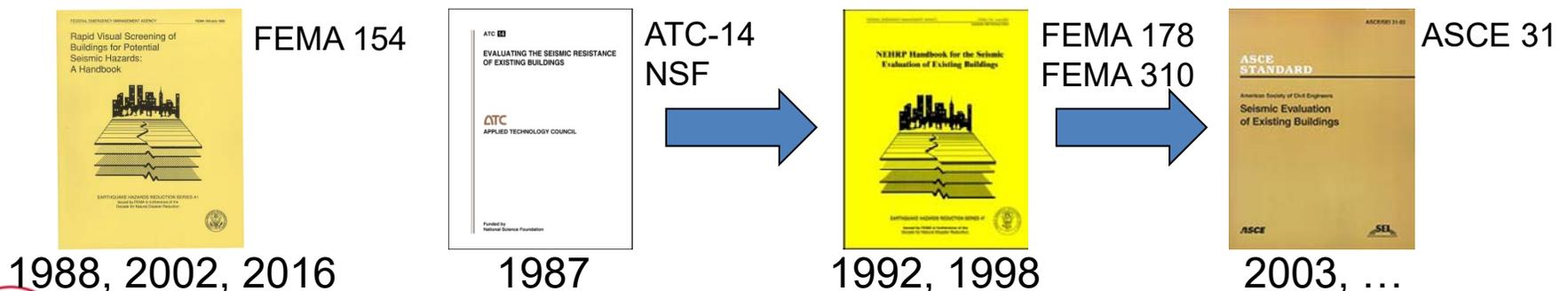


# Engineering Codes/Practice: Key Milestones/Accomplishments

- Continual Updating of Model Code Provisions for Seismic Design of New Buildings

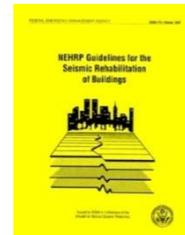


- Procedures for Rapid and Detailed Seismic Evaluation of Existing Buildings



# Engineering Codes/Practice : Key Milestones/Accomplishments

- NEHRP Guidelines for Seismic Rehabilitation of Existing Buildings



1997, 2000

FEMA 273  
FEMA 356



ASCE 41

2006, ...

- National Seismic Hazard Maps  
(with added probability of occurrence levels, e.g., for large-infrequent earthquakes)



USGS

- Program to Reduce the Earthquake Hazards of Steel Moment-Resisting Frame Structures

FEMA 350  
351, 352,  
353, 354,  
355 Series

2000

- Next-Generation Performance-Based Seismic Design Procedures for New and Existing Buildings



FEMA P-58  
10 years to develop  
Cost: \$8 million  
Published, 2012



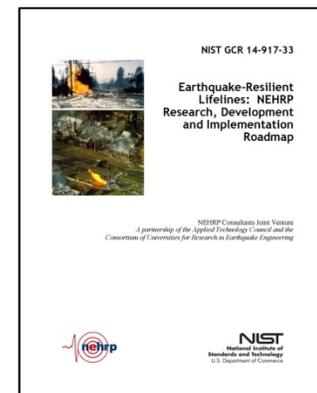
# Engineering Codes/Practice : Future Needs and Focus

- Continued NSF-sponsored **basic research on earthquake engineering issues** (life blood for innovation and hazard mitigation)
- Updating of **seismic hazard design maps** by USGS as new research information emerges
- Increased FEMA and NIST support for development of **new building code advances, guidelines, analysis tools, and other resources** for mitigating earthquake impacts (based on new knowledge as it emerges)

# Engineering Codes/Practice: Future Needs and Focus

- Broad new program to **improve the seismic resilience of lifelines** (water, wastewater, telecommunication, transportation, electric power, gas and liquid fuel systems):
  - Establish national lifeline systems performance and restoration goals
  - Develop lifeline system specific performance manuals, guidelines, standards, and codes
  - Conduct problem focused research for various lifeline systems
  - Enable the adoption and implementation of lifeline system performance goals and standards

NIST GCR 14-917-33



2014

Defines a 10-yr,  
\$50+ mil. program

# Engineering Codes/Practice: Considerations for NEHRP Reauthorization

(As pertaining specifically to treatment of lifelines)

- Lifeline earthquake performance standards do not exist or are in need of significant enhancement
- Infrastructure in 45 states/ territories vulnerable to earthquake damage (FEMA 2001)
  - \$6 billion annually; \$100-200 billion for single event (Pacific NW, California, Midwest)
- ASCE 2013 D+ Grade for 16 categories of infrastructure
- Some infrastructure >50 to 100 years old





# JACK MOEHLE

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University of California, Berkeley

## Engineering Research



# Engineering Research: Key Accomplishments – Structural Engineering

- Modern structural systems
- Computer simulation
- Performance-based earthquake engineering
- Existing hazardous construction
- Setting the stage for resilient communities



*Image: AASArchitecture*

# Engineering Research: Key Accomplishments – Geotechnical Engineering

- Site-specific ground motions
- Ground failure
  - Fault rupture
  - Liquefaction triggering, spreading, interaction
- Soil-foundation-structure interaction
- Increased awareness of geo-hazards



# Engineering Research: Key Accomplishments – Lifeline Engineering

- Components and Systems
  - Electric power, gas and liquid fuels, telecommunications, transportation, waste disposal, and water supply.
- Modeling -> network performance and interdependencies
- Visualization, decision-support systems
- Multi-hazard applications



# Engineering Research: Future Needs and Focus

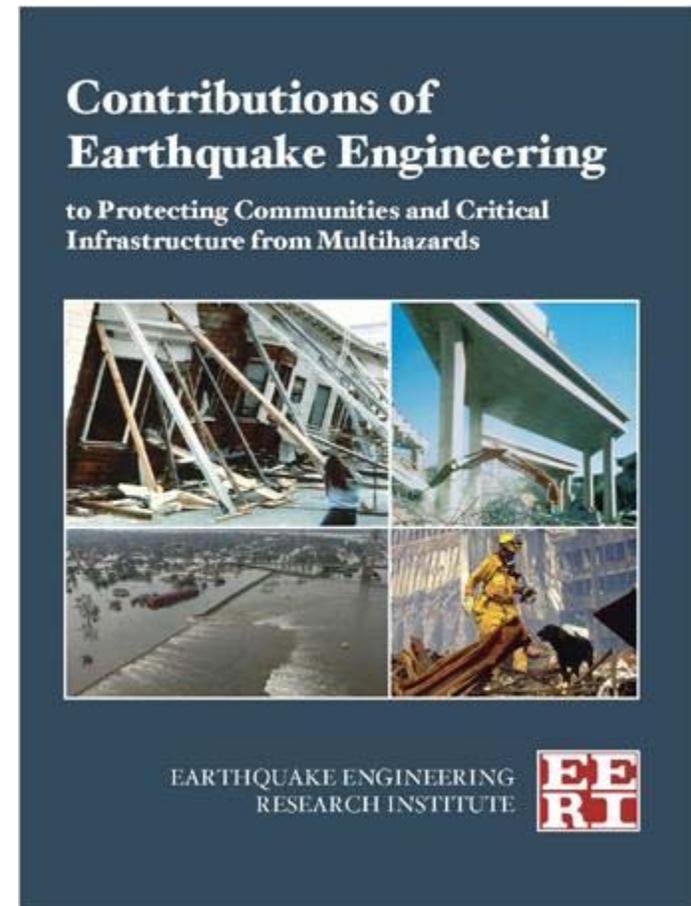
- Engage the community to define grand challenges and focus areas
- Research modes
  - Individual investigator vs Small groups vs Centers
- Multi-disciplinary research teams
- NEES → NHERI
- Post-earthquake reconnaissance

# Training Future Generations



# International Leadership

“Research supported by NEHRP not only contributes to improved seismic performance at home, but also distinguishes the United States as being at the forefront of important, life-saving technology throughout the world.”





# JOHN G. ANDERSON

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University of Nevada, Reno

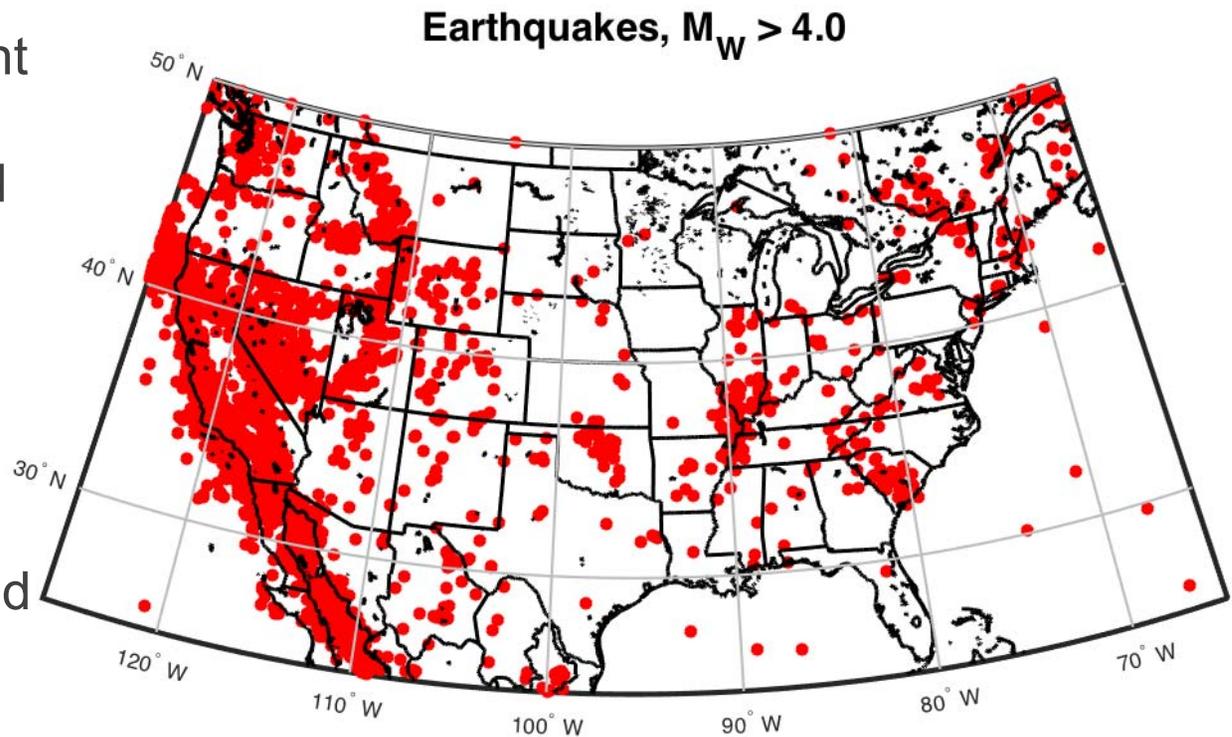
## Earthquake Hazards / Risk Assessment



# Earthquake Hazards/Risk Assessment: Key Milestones/Accomplishments

## Advanced National Seismic System

- Largely independent university seismic networks organized into a national system.
- Improvements in quality and density of instruments.
- Earthquakes located and reported within minutes.



# Earthquake Hazards/Risk Assessment: Key Milestones/Accomplishments

Effective, rapid earthquake notification

## M 6.0 – 6km NW of American Canyon, California

2014-08-24 10:20:44 UTC | 38.215°N 122.312°W | 11.1 km depth

[Interactive Map](#)

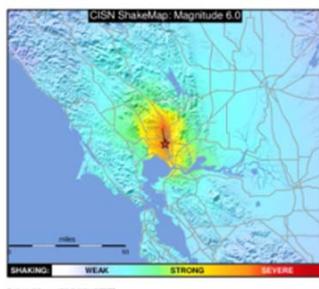


Contributed by NC<sup>3</sup>

[Regional Information](#)

[ShakeMap](#)

**IX**



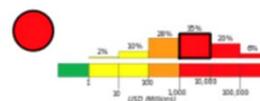
Contributed by NC<sup>3</sup>

[Felt Report - Tell Us!](#)

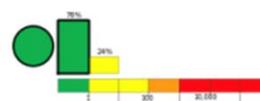
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**RED**

Estimated Economic Losses



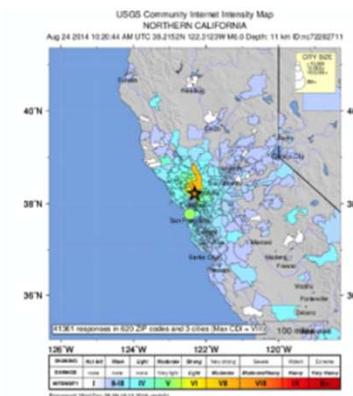
Estimated Fatalities



Contributed by US<sup>4</sup>

[Did You Feel It?](#)

**VIII**



Contributed by US<sup>4</sup>

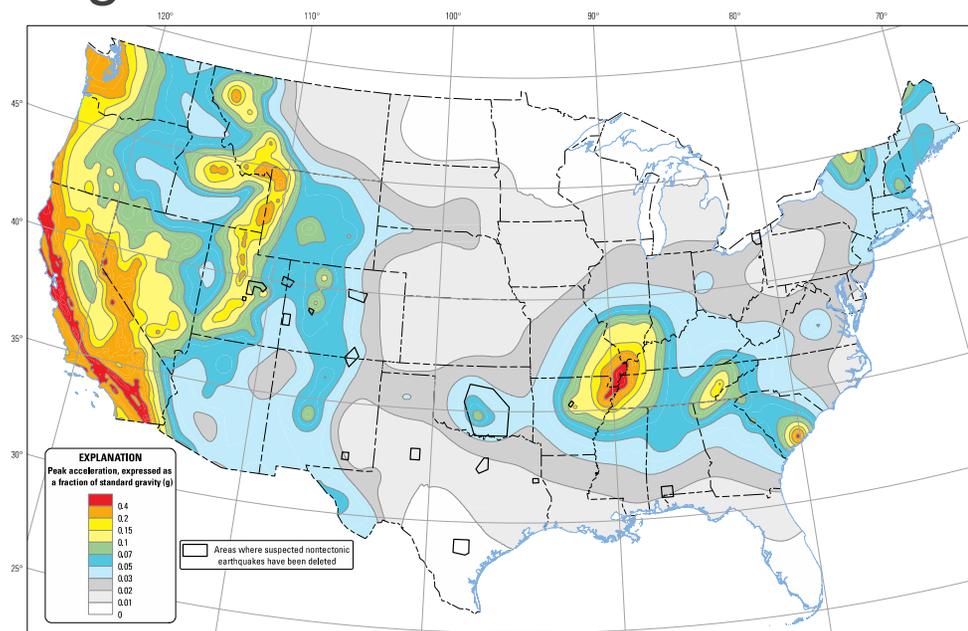
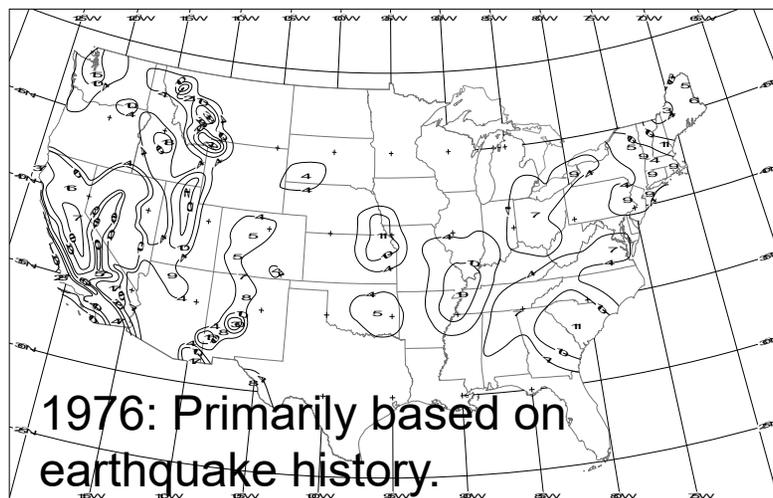
# Earthquake Hazards/Risk Assessment: Key Milestones/Accomplishments

- Motivated Earth scientists to focus on earthquake hazard issues.
- Trained thousands of students.
- New and improved tools, methods: strong motion networks, Earthscope, global positioning, InSAR, Lidar, fault trenching & dating geological materials.
- Improved understanding of earthquake processes.
- Apply processes, earthquake history, geology, and geodesy to estimate hazards.

# Earthquake Hazards/Risk Assessment: Key Milestones/Accomplishments

## National Seismic Hazard Model

- Vastly improved methodology.
- Incorporated into building codes.
- A community model.



# Earthquake Hazards/Risk Assessment: Future Needs and Focus\*

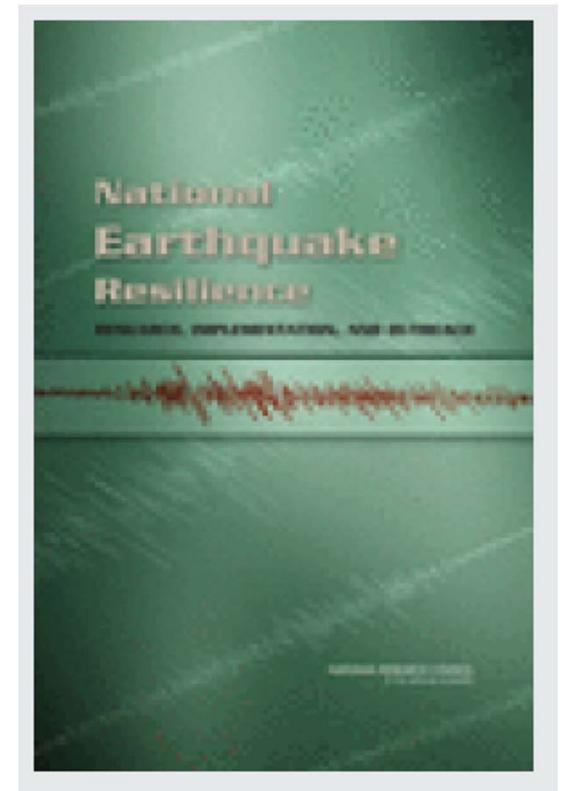
- To improve hazard estimates, Research on:
  - Pacific Northwest
  - Earthquakes east of the Rocky Mountains
  - Induced seismicity
  - Southern California (overdue for M>7.5)
- To serve users, Implement:
  - Earthquake early warning
  - Hazard Maps: More products and reduced uncertainty
  - Earthquake scenarios to estimate loss



\*2015 opportunities from the Scientific Earthquake Studies Advisory Committee (SESAC) – achievable with sufficient resources. 2017 EERI Annual Meeting

# Earthquake Hazards/Risk Assessment: Future Needs and Focus

- Implement recommendations from *National Earthquake Resilience* (2011 National Research Council)



# Earthquake Hazards/Risk Assessment: Considerations for NEHRP Reauthorization

- NEHRP is a catalyst, bringing together far more resources from external partners than the cost to the federal government.
- Must not be complacent with what we know ... every large earthquake yields valuable data and some surprises.
- Strong NEHRP strengthens competitiveness of US companies in global marketplace.