NEHRP AT 40: WHERE WE GO FROM HERE

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

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 108TH Congress
    - New lead agency, ICC, ACEHR
    - Specific NEES, ANSS, and PBE funding
    - Change in lead agency
Challenges for the Next Reauthorization

- 109th – 114th Congresses
  - Few Congressional Champions, deadlock
  - Wars
  - Great Recession
  - Changes in Appropriation Procedures
  - Wind and Hurricane related disasters
  - Multiple voices from the earthquake community

- 115th 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
Chair, Advisory Committee for Earthquake Hazards Reduction (ACEHR)

NEHRP Today
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 ($M)$^1^$

<table>
<thead>
<tr>
<th>FY</th>
<th>FEMA$^2$</th>
<th>NIST$^3$</th>
<th>NSF$^4$</th>
<th>USGS$^5$</th>
<th>NEHRP Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>14.7</td>
<td>0.9</td>
<td>53.1</td>
<td>58.3</td>
<td>127.0</td>
</tr>
<tr>
<td>2006–2016</td>
<td>8.0 (Avg)</td>
<td>3.4 (Avg)</td>
<td>52.9 (Avg)</td>
<td>59.8 (Avg)</td>
<td>124.1 (Avg)</td>
</tr>
</tbody>
</table>

#### Requested Agency NEHRP Budgets ($M)$^6^$

<table>
<thead>
<tr>
<th>FY</th>
<th>FEMA$^7$</th>
<th>NIST$^8$</th>
<th>NSF$^9$</th>
<th>USGS$^{10}$</th>
<th>NEHRP Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>8.5</td>
<td>5.9</td>
<td>54.2</td>
<td>69.5</td>
<td>138.1</td>
</tr>
</tbody>
</table>

**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.


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 Gillengarten
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

- 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
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
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
Applied Technology Council (retired)

Engineering Codes/Practice
Engineering Codes/Practice: Key Milestones/Accomplishments

  - ATC-3 Report Founded: 1978
  - BSSC Founded: 1979
  - ATC-14 NSF (1987)
  - FEMA 178, FEMA 310 (2003, …)
  - NEHRP Recommended Seismic Provisions for New Buildings and Other Structures

- Procedures for Rapid and Detailed Seismic Evaluation of Existing Buildings
  - NSF, NBS
  - BSSC Founded: 1979
  - ATC-14 NSF (1987)
  - FEMA 178, FEMA 310 (2003, …)
  - NEHRP Recommended Seismic Provisions for New Buildings and Other Structures
Engineering Codes/Practice: Key Milestones/Accomplishments

- NEHRP Guidelines for Seismic Rehabilitation of Existing Buildings
- National Seismic Hazard Maps (with added probability of occurrence levels, e.g., for large-infrequent earthquakes)
- Program to Reduce the Earthquake Hazards of Steel Moment-Resisting Frame Structures
- Next-Generation Performance-Based Seismic Design Procedures for New and Existing Buildings

ASCE 41

1997, 2000

FEMA 273
FEMA 356

2006, ...

USGS

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

2000

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

2017 EERI Annual Meeting
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 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
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: AASArchicture
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
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**

- Interactive Map
- Regional Information
- Felt Report - Tell Us!
- Did You Feel It? VIII

**ShakeMap**

- Contributed by NC³

**PAGER**

- Estimated Economic Losses
- Estimated Fatalities

- Contributed by US⁴
Earthquake Hazards/Risk Assessment: Key Milestones/Accomplishments

- Motivated Earth scientists to focus on earthquake hazard issues.
- Trained thousands of students.
- 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.

1976: Primarily based on earthquake history.

2014: Uses earthquake history, geology, geodesy, much better ground motion models.
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.
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.