

NEHRP Agency Responses to 2015 ACEHR Report Recommendations

GENERAL OBSERVATIONS ON STATE OF NEHRP

Critical Observation 1

ACEHR believes Congressional reauthorization of the Earthquake Hazards Reduction Act is essential for the long-term viability of NEHRP. Such legislation should address sufficient funding levels for NEHRP to maintain its foundational emphasis on earthquake hazards and seismic design for the built environment, and provide an expanded emphasis on critical infrastructure and lifeline systems, and the social and economic dimensions of community seismic resilience.

Lead Agency (NIST) Response: As stated in the testimony of the NEHRP Director in his presentation before the Subcommittee on Research and Technology; Committee on Science, Space, and Technology; U.S. House of Representatives, on July 29, 2014, the NEHRP agencies welcome the reinvigorated partnership with the Legislative Branch that reauthorization would reflect. Decisions on reauthorization rest with the Legislative Branch; further discussion is outside the purview of the NEHRP agencies. Although the budget authorizations in the 2004 NEHRP reauthorization, Public Law (PL) 108-360 have expired, the other provisions remain in effect. Pending future reauthorization, the four NEHRP agencies will continue to support NEHRP under the provisions of PL 108-360.

Critical Observation 2

ACEHR believes a fundamental assessment of the nation's earthquake risk reduction progress to date is essential for guiding future direction and funding levels for improving national earthquake resilience. This assessment should address the extent to which the federal government, states, localities, tribes, and the private sector are taking steps to address the seismic vulnerability of buildings, critical infrastructure and lifeline systems. The assessment should be performed either prior to or as part of a new NEHRP authorization.

Lead Agency (NIST) Response: While this recommendation is very worthwhile, the NEHRP agencies are not presently resourced to undertake such a comprehensive assessment, without redirecting funds that are currently applied to specific hazard assessment and risk reduction efforts. However, two activities related to the recommendation are occurring.

First, FEMA strives to gauge the progress of State and local adoption of disaster-resistant building codes for new construction, including the "I-Codes" (the International Building Code and International Residential Code), as a measure of the progress being made in the nation's earthquake risk reduction efforts. FEMA periodically briefs the ACEHR on the statistics it gathers regarding this progress and will continue to do so.

Second, the U.S. Government Accountability Office (GAO) has been performing a national assessment of the seismic risk mitigation efforts of the Federal, State, and local governments for about a year, at the 2014 request of several U.S. Senators. When completed, this assessment may provide information of interest to the ACEHR and relevant to this observation.

In addition to research-oriented activities, PL 108-360 directed that NEHRP activities be designed to develop effective earthquake risk (hazard) reduction measures and to promote the adoption of those measures by Federal, State, and local governments, national standards and model code organizations, architects and engineers, building owners, and others. The primary NEHRP agency responsible for implementation/outreach is FEMA. In addition to other implementation-related responsibilities, PL 108-360 specifically outlined key FEMA NEHRP responsibilities as promoting implementation of research results and better building practices; operating a program of grants and assistance to the States to support seismic risk mitigation efforts; supporting implementation of comprehensive earthquake risk education and public awareness programs; and, working with NIST and others to prepare, maintain and disseminate seismic design guidance and related information on building codes, standards, and practices. FEMA actively supports activities that are directly tied to these requirements.

For Federal agency seismic safety, Executive Order (EO) 12699, issued in 1990, directed agencies to adopt earthquake-resistant provisions for new building design and construction. In 1994, EO 12941 directed agencies to work through the Interagency Committee on Seismic Safety in Construction (ICSSC) to develop and implement standards for seismic safety in existing Federal buildings. On 2 February 2016, the President issued EO 13717– “ESTABLISHING A FEDERAL EARTHQUAKE RISK MANAGEMENT STANDARD” - that updated the requirements for Federal buildings; the new EO revokes the two older EO’s and provides requirements for Federal buildings using modern, up-to-date building codes and standards. See <https://www.gpo.gov/fdsys/pkg/FR-2016-02-05/pdf/2016-02475.pdf>.

The new EO requires, as a minimum, the use of current national consensus codes and standards for seismic design and construction of new Federal buildings and also requires the use of ICSSC-developed standards seismic evaluation and mitigation for existing buildings.

The ICSSC has developed the existing buildings standards and updated them twice. The latest update (RP8) was issued in 2011 and is available to the public at <http://www.nehrp.gov/pdf/nistgcr11-917-12.pdf>. NIST is currently updating this guidance document via contractor support to incorporate the most recent national consensus standards.

RECOMMENDATIONS FOR INTERAGENCY COORDINATING COMMITTEE (ICC)

ICC Recommendation 1

ACEHR calls upon the NIST Director, as Chair of the ICC, to revitalize the ICC as a mechanism for advancing NEHRP within the respective agencies. Doing so will foster renewed consideration by the leadership of the ICC about the future of NEHRP and how their agencies can assist in moving the Program ahead, along with stronger articulation of how NEHRP activities relate to other priorities and agendas within the respective agencies.

Lead Agency (NIST) Response: NIST is committed to conducting an ICC meeting as soon as it can be scheduled, and NIST is working on that. NIST will inform the ACEHR members when the meeting has been scheduled.

ICC Recommendation 2

ACEHR recommends the NIST Director, as Chair of the ICC, conduct a review of the status of core operational elements authorized and funded under NEHRP with attention to those elements that have been dropped or cut back, and those that have been expanded or added.

Lead Agency (NIST) Response: First, to clarify how NEHRP operates in relation to this recommendation, we offer brief explanation of “NEHRP funding.” PL 108-360 is an authorization bill and is not directly tied to annual agency appropriations. Only USGS, of the four NEHRP agencies, receives appropriations that are designated for NEHRP. FEMA, NIST, and NSF allocate funds from their total agency appropriations to support activities covered by the NEHRP authorizing legislation.

We will recommend this as a discussion topic for the next ICC meeting, after which the NEHRP agencies can report back to the ACEHR as appropriate.

RECOMMENDATION FOR NEHRP SECRETARIAT

NEHRP Secretariat Recommendation

ACEHR recommends the NEHRP Secretariat work with the four NEHRP agencies to promote the development of consensus standards for a market-based, private-sector-led rating system for the seismic performance of buildings.

Joint FEMA-NIST response: Experience in recent major earthquakes around the world has repeatedly shown that the public often misunderstands the relative earthquake safety and damage resistance of buildings, typically overestimating their positive impacts on community resilience.

The NEHRP agencies encourage the development and application of best practices that will provide transparent and validated science-based means of assessing building and infrastructure contributions to community resilience. The most effective resilience assessments for buildings will not only address life safety, which is the essential first step, but they will also analyze potential damage/repair costs and project degrees of occupant disruption and post-earthquake recovery times. A building rating system that is based on sound scientific and engineering principles and has these attributes can be a valuable tool for the assessments that are needed.

Led by FEMA, the NEHRP agencies have been working to help promote the development and use of a building rating system for the seismic performance of buildings that is based on sound engineering principles. For a more in-depth description of those activities, the reader is referred to the paper *NEHRP Response to 2013 ACEHR Recommendation Regarding Building Rating Systems* that was submitted in response to a similar recommendation in the 2013 ACEHR report¹.

Recently, one such private sector-led rating system for engineered buildings was released by the

¹ See page 5 of the following:
<http://www.nehrp.gov/pdf/Agency%20Responses%20to%202013%20ACEHR%20Recommendations%20081414.pdf>.

U.S. Resiliency Council (USRC), a California-based 501(c)3 non-profit organization. The framework for the USRC rating system was originally developed by the Structural Engineers Association of California (SEAOC), with some support from FEMA, and is primarily based on applying a consensus standard, the American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI) 41, *Seismic Evaluation and Retrofit of Existing Buildings*, to develop the majority of ratings. Much of the information found in ASCE/SEI 41 has been developed in projects that were supported by the NEHRP agencies.

The USRC rating system also incorporates FEMA's *Performance Based Seismic Assessment Methodology* (FEMA P-58) as an evaluation tool. The only way a building can receive a USRC "five star" ratings by using FEMA P-58 procedures to evaluate it. Further development of FEMA P-58 and possible future adoption of it by national standards bodies is contingent upon available FEMA funding and staff.

In addition to rating systems for engineered buildings, similar systems for residential construction could support enhanced community resilience. FEMA's *Simplified Seismic Assessment of Detached, Single-Family, Wood-Frame Dwellings* (FEMA P-50) and *Seismic Retrofit Guidelines for Detached, Single-Family, Wood-Frame Dwellings* (FEMA P-50-1) provide a prototype rating system for residential construction. This rating system could be adopted/adapted for use in conjunction with systems for engineered buildings and has already been adopted for residential building seismic performance rating by the California Earthquake Authority (CEA), a California State entity that provides earthquake insurance for residential structures.

The NEHRP agencies will continue to encourage the development and general application of transparent, scientifically sound, and accurate building rating systems, not only for the earthquake hazard but also for other natural and man-made hazards. Such rating systems would have many applications that can enhance societal resilience.

Developing and applying a building rating system should consider the perspectives of building owners, insurers, and lenders, as well as State and local governments. The ultimate goal should be a national consensus-based building rating system that can be applied in a manner that is consistent with building codes that are promulgated by the International Code Council (ICC), design standards that are promulgated by the American Society of Civil Engineers (ASCE) and various construction materials organizations, and principles of the American National Standards Institute (ANSI) accreditation process. Should these rating systems ultimately involve Federal buildings, system development should also be in accordance with principles delineated in OMB Circular A-119 and policies outlined by the Interagency Committee on Seismic Safety in Construction (ICSSC). It will, of course, be important to distinguish between what is needed for a building rating system and what is needed for building design standards; the two can be complementary while somewhat different.

While the NEHRP agencies do not have a regulatory role that can be applied with respect to rating building performance and could not in any event endorse a particular private-sector rating system, the NEHRP agencies will continue in their role of providing the underlying scientific and engineering knowledge that enables the development and deployment of such systems.

RECOMMENDATIONS FOR FEMA

FEMA Recommendation 1

ACEHR recommends FEMA increase support for its earthquake mitigation mission and NEHRP-related implementation and outreach activities.

FEMA response: FEMA's Federal Insurance and Mitigation Administration (FIMA), where FEMA's NEHRP responsibilities reside, has taken a large step toward encouraging the nation to learn what to do before, during, and after an earthquake strikes. One way we support this is through cooperative agreements with partners such as the Southern California Earthquake Center (SCEC), which provides nationwide support to states and territories with moderate to high earthquake risk. With this support, FIMA has been able to partner with FEMA Regions, the States and territories, local governments, educators, businesses, and the private sector in understanding the importance of the annual *Great ShakeOut* drills. The first *ShakeOut* drill was held in California in 2008 and had over 5 million participants. These drills have grown nationally, and internationally, and in 2015 included 48 states, 5 territories, and the District of Columbia, for a total of over 21.2 million registered participants².

Federal Agencies are also encouraged to share earthquake resources to conduct drills, group discussions, and exercises, which can be downloaded at ready.gov/prepare. Furthermore, participation in annual *Shakeout* Earthquake Drills is registered as participation in FEMA's *America's PrepareAthon!*

FEMA also provides modest funding to several regional, non-profit, earthquake consortia and other partners who support earthquake risk mitigation by working closely with States and territories on the important concept of mitigation. This funding allows the partners to help States and territories develop strategies and projects that educate the public on ways to lessen injuries and loss of life and help maintain a local economy after an earthquake by taking pre-earthquake mitigation actions.

Thirty-three States and territories in the U.S. with moderate to high seismic risk have been identified by a formula of weighted risk based on the 2008 USGS Seismic Map, the International Residential Code, and FEMA 366, which provides the HAZUS Annualized Estimated Losses for each State. Using this formula and the amount of funding that is available to support the States and territories, FEMA is able to provide focused mitigation support to these States/territories for their seismic risk. Recent studies have shown that as many as 48 states/territories have an increased seismic risk in the U.S.³ With more funding, FIMA could support more of the identified states/territories with risk that is lower than those with moderate to severe earthquake risk. Due to limitations of the current budget that is available for this assistance, which is below the \$3.5M suggested by Congress, FIMA must focus on States/territories with greatest earthquake risk to deliver cost-effective support.

² See <http://shakeout.org> for an insightful overview of this activity.

³ See http://www.usgs.gov/blogs/features/usgs_top_story/nearly-half-of-americans-exposed-to-potentially-damaging-earthquakes/.

Other outreach activities include our work with the *Quake Smart* earthquake business program that promotes awareness and specific earthquake mitigation actions, as well as broad communication tools like FEMA's *gov.delivery* e-mail system.

FEMA Recommendation 2

ACEHR recommends FEMA return to a directly-funded state-based program for earthquake hazard mitigation, planning, education and preparedness efforts and work, as part of a future NEHRP reauthorization, to ensure its full funding.

FEMA response: External factors directly impact FEMA's actions regarding the funding mechanism related to seismic risk to support the States and territories.

The most recent NEHRP re-authorization, PL 108-360⁴, and the Code of Federal Regulations (CFR) at chapter 44, part 361 describe the policies that are still in effect for providing assistance to the States and Territories. Specifically, 44 CFR, Part 361.4-361.5 states that beginning in the 4th year of funding for the Earthquake Hazards Reduction Assistance Program, and all future years of the direct cooperative agreements to States and territories, each State or territory must match any FEMA funding with a "cash" match contribution, which is one dollar of State or Territorial funding for every one dollar provided to them by FEMA.

In 2012, a survey of the 33 State Earthquake Program Managers (EPM's) was conducted to determine which States/territories were able to meet the required direct cash match. The survey determined that less than half of the States/territories could meet the required full cash match for direct cooperative agreement assistance. For that reason, the direct funding to the States and territories, called the "State Assistance Program," was discontinued and a different approach toward state assistance was established.

Beginning in FY 2013, the funding for the "State Assistance Program" for all 33 states with the previously defined moderate to high risk for earthquake was distributed to FEMA NEHRP's Earthquake Consortia and Partners, who then provided needed support to the States and territories. This new support mechanism used the teamwork of the earthquake consortia and other partners to work individually with the States and territories to jointly develop, manage, and deliver successful earthquake resilience projects.

In 2015, another survey was taken of the EPM's to assess if State ability to meet a "cash" cost match had changed. The results of the survey revealed that the percentage of States able to meet the matching requirement had not changed measurably, and no majority or consensus existed among them.

FEMA Recommendation 3

ACEHR recommends FEMA restore and give priority to its earthquake hazard mitigation and resilience initiative for critical infrastructure and lifeline systems.

⁴ See <http://www.nehrp.gov/about/PL108-360.htm> .

FEMA response: FEMA's responsibilities under NEHRP⁵ include:

“Sec. 5(b)(2)(A)(v) assist the National Institute of Standards and Technology, other Federal agencies, and private sector groups, in the preparation and wide dissemination of seismic resistant design guidance and related information on building codes, standards, and practices for new and existing buildings, structures and lifelines, and aid in the development of performance-based codes for buildings, structures, and lifelines that are cost effective and affordable;”

Until the mid-1990's, the FEMA Earthquake Program was operated as a separate office within FEMA, with its own appropriations budget line item and staff engineer specifically assigned to address the development of mitigation guidance for lifelines, otherwise known as critical infrastructure. During that time, FEMA published several voluntary mitigation guidelines that addressed lifelines and related issues. These publications included:

- *Earthquake Resistant Construction of Electric Transmission and Telecommunication Facilities Serving the Federal Government*, 1990 (FEMA 202),
- *Seismic Vulnerability and Impact of Disruption of Lifelines in the Conterminous United States*, 1991 (FEMA 224),
- *Collocation Impacts on the Vulnerability of Lifelines during Earthquakes with Applications to the Cajon Pass, California: Study Overview*, 1991 (FEMA 221),
- *Inventory of Lifelines in the Cajon Pass, California*, 1992 (FEMA 225),
- *Collocation Impacts on the Vulnerability of Lifelines during Earthquakes with Applications to the Cajon Pass, California*, 1992 (FEMA 226); and,
- *Earthquake Resistant Construction of Gas and Liquid Fuel Pipeline Systems Serving or Regulated by the Federal Government*, 1992 (FEMA 233).

FEMA and the other NEHRP agencies recognize the importance of addressing earthquake risk mitigation of critical infrastructure and lifeline systems, as well as the work related to new and existing buildings. In addition, the myriad of critical interdependencies that exist between buildings, infrastructure and lifelines highlights the fact that mitigating risks only for buildings, but not lifeline systems or other components of community infrastructure, will still leave communities unable to recover quickly. *Community resilience requires that all elements of the built environment be resilient so that the entire community recovers quickly and performs well.*

Historically, FEMA has invested time and resources in the study of selected critical infrastructure and lifeline systems. A key example is our work with the American Lifelines Alliance. Much was accomplished in this area during the 1990's and early 2000's. Unfortunately, staffing and resource limitations over the past 10+ years have significantly limited our work in this area. The challenge FEMA faces with presently available resources is that we would have to discontinue several ongoing areas of work in order to re-establish a strong infrastructure and lifelines effort. Ongoing activities such as our work with the national model building codes, the “NEHRP Recommended Provisions” and the performance-based seismic design methodology development might all be impacted.

⁵ *Ibid.*

Said another way, work priority decisions came down to the fact that building failures directly kill people while lifelines are not perceived as doing so. Virtually all lifelines-related work was discontinued and remaining resources were focused developing and maintaining adequate building codes for new and existing construction. FEMA will continue its very modest and limited activities in this area and hopefully work toward a situation where additional resources would make additional new work possible.

FEMA Recommendation 4

ACEHR recommends FEMA invest in maintaining Hazus® as a utilizable, publicly available earthquake hazard mitigation tool and ensure that the tsunami module is fully integrated and functioning within the Hazus® software platform.

FEMA response: HAZUS® is a widely used multi-hazard loss estimation platform. It is an effective and crucial tool that supports FEMA, States and local communities' disaster preparedness, mitigation planning, and post disaster response and recovery. FEMA continues to maintain and update HAZUS for the user community. Over the last year and a half, FEMA has invested in HAZUS modernization. This effort is necessary and critical, as much of the code and data formats were outdated and unsupported. Additionally, the General Building Stock was updated with 2010 Census data. Functional enhancements were centered around the HAZS flood module.

The HAZUS earthquake module plays a key role in developing earthquake scenarios for FEMA's national and regional exercises. States and local communities also use earthquake scenarios for local earthquake preparedness and mitigation activities such as inventory of at-risk buildings, risk awareness for URM buildings, and seismic screening and retrofit of schools. While the fundamental methodology of the earthquake module was largely validated and accepted by the user community over more than two decades, calibration of the earthquake damage functions and comparison of loss estimations against recent earthquake actual loss data have been continued including the 2011 Mineral, VA, earthquake and the 2014 South Napa, CA, earthquake. Some recent updates to the earthquake module include integration of USGS ShakeMap, adoption of USGS updated seismic hazard maps, enhancements of the Comprehensive Data Management System (CDMS) and User-Defined Facilities capabilities. FEMA NEHRP realizes that a major update to the earthquake module will add significant benefits for the users, and that a major update should incorporate new knowledge developed by the research community and recent NEHRP projects on structural and non-structural damage in earthquakes, performance-based seismic evaluation of buildings, improvements to building inventory, as well as new earth science and earthquake hazard information. Since FEMA presently has to focus on the HAZUS software overhaul, a major update to the earthquake module will remain as a future effort to be pursued upon completion of the HAZUS modernization project.

The HAZUS tsunami module has been on FEMA's high priority list. The tsunami methodology was developed in 2013. During the development phase, some limited validation studies were performed using tsunami damage data from the 1964 Alaska earthquake and the 2011 Tohoku earthquake. In 2015, FEMA Region X has sponsored and completed a pilot study to validate and test the methodology for two coastal counties, Grays Harbor and Pacific, WA. FEMA Region IX is also conducting a similar study for Hilo, HI, and Crescent City, CA. The Region X pilot study

has provided valuable information about potential damage and economic losses by scenario tsunami events induced from Cascadia fault ruptures. The information will be shared with local communities for tsunami preparedness and mitigation. FEMA NEHRP will strive to reduce tsunami risk in hazard-prone communities. Although implementation of the tsunami methodology is beyond the scope of current HAZUS modernization, and the new tsunami module is better developed for the next generation HAZUS software platform, FEMA is exploring possible collaboration with federal partners to work it in sooner or jointly support it in the future.

RECOMMENDATIONS FOR NIST RESEARCH

NIST Recommendation 1

ACEHR recommends NIST improve the dissemination of NEHRP- related information and products to the architectural and engineering professions.

NIST response: In late CY 2015, NIST posted information regarding its recent techbrief publications in web communications of the Earthquake Engineering Research Institute (EERI) and the American Society of Civil Engineers (ASE). During CY 2016, NIST will continue to contact publications and organizations in the structural and earthquake engineering communities with notices about available downloads on the NEHRP web site. NIST will also expand the distribution of reports in hardcopy and electronic (jump drive) format at future technical conferences (in concert with FEMA's continuing efforts in this area); a new jump drive containing all NIST NEHRP-related publications of the past 10 years is in preparation and should be available very soon. In the past, the Applied Technology Council (ATC) has presented webinars based on some recent NIST NEHRP reports that it has prepared, and NIST will work with ATC on possible future webinars featuring NIST-supported research results. In addition, at the invitation of the National Council of Structural Engineers Associations, NIST plans to present a webinar in the near future on the results of recent ASCE 41-related research at NIST.

NIST Recommendation 2

ACEHR recommends NIST continue and emphasize NEHRP-related research and development programs on critical infrastructure and lifeline systems, geotechnical engineering, non-structural elements, and residential and industrial structures that have seismic vulnerabilities.

NIST response: NIST will consider this recommendation as NIST plans future research.

In general, NIST has attempted to be faithful to the goals outlined in NIST GCR 13-917-23, *Development of NIST Measurement Science R&D Roadmap: Earthquake Risk Reduction in Buildings*, as augmented by the recommendations of several other roadmaps (e.g., performance-based seismic design and existing buildings) that the NEHRP agencies have commissioned since 2006. These roadmaps were developed by substantial groups of leading researchers and practitioners.

As NIST has briefed the ACEHR, the Administration requested FY 2016 NIST funding for several new resilience-related activities. Included with that request were plans for a NEHRP

initiative to undertake research on earthquake-resilient lifelines and existing buildings, in keeping with the roadmap to which the ACEHR referred. No decision on this initiative has been reached, as of 19 February 2016.

NIST has supported some extramural geotechnical engineering work already (see NIST GCR 11-917-15, *Selecting and Scaling Ground Motions for Performing Response History Analyses*; NIST GCR 12-917-21, *Soil-Structure Interaction for Building Structures*; and NIST GCR 12-917-22, *Seismic Design of Reinforced Concrete Mat Foundations*) and has additional geotechnical work planned; this work has been and will be accomplished via extramural contract support.

There is a large ongoing extramural contract effort that takes first steps in addressing non-structural elements. Recent techbriefs address issues that are found in residential and industrial structures: NIST GCR 14-917-31, *Seismic Design of Special Reinforced Masonry Shear Walls*; and NIST GCR 14-917-32, *Seismic Design of Wood Light-Frame Structural Diaphragm Systems*.

Ongoing projects addressing issues related to deep wide flange steel beam-columns and thin concrete walls were strongly recommended by leading practitioners and are well along in their performance. NIST sees this work as both valuable and near enough to completion that curtailing remaining research to bring this work to a conclusion is not prudent. NIST is working to bring the collapse simulation research to completion by the end of FY 2016.

Moving to the future, NIST will welcome the ACEHR's highlighting specific research activities in, for example, residential and industrial structures that it wishes to move forward at NIST. In doing this, it would be very helpful for ACEHR to review NIST GCR 13-917-23, the "roadmap," which outlined a very large volume of needed research. NIST believes that the needs outlined there include many of the areas recommended here by ACEHR. With its relatively small research program, NIST is addressing these many needs as quickly as it can while maintaining technical quality and timely performance on each project. NIST believes that many of the topics in roadmap address issues for the kinds of structures mentioned in the ACEHR's recommendations (low-rise; residential, at least multi-family; and industrial). None of NIST's recent NEHRP research has focused on high-rise construction; such construction has not specifically been a major area of NIST NEHRP research.

RECOMMENDATIONS FOR NSF

NSF Recommendation 1

ACEHR calls upon NSF to clarify current and future programmatic funding commitments in support of NEHRP. This information should be integral to NEHRP coordination efforts by the ICC and the NEHRP Secretariat.

NSF response: At the request of the NIST/NEHRP Secretariat, NSF annually has provided its estimated enacted NEHRP budgets from 2005 to 2015 (<http://www.nehrp.gov/pdf/2005-2015NEHRPAgencyBudgets.pdf>), as well as estimated next year NEHRP budgets each year, for inclusion in the NEHRP Annual Report prepared by the NIST/NEHRP Secretariat, e.g., Tables

2.2 and 2.3 for FY 2013 and FY 2014, respectively, in the FY 2013 NEHRP Annual Report (<http://www.nehrp.gov/pdf/2013NEHRPAnnualReport.pdf>). NSF's Directorate for Geosciences coordinates with NEHRP partner USGS to support the Global Seismographic Network and the Southern California Earthquake Center (led by the University of Southern California).

NSF Recommendation 2

ACEHR recommends NSF develop a mechanism for documenting, reporting, and publicizing current NEHRP-related research and the findings from it.

NSF response: Access to publications resulting from NSF-supported earthquake-related research, including research supported as part of NEHRP, will be provided through the new NSF's Public Access initiative (http://www.nsf.gov/news/special_reports/public_access/) and Public Access Plan (NSF 15-052, http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf15052). Beginning with new awards resulting from proposals submitted, or due, on or after the effective date of the NSF *Proposal & Award Policies & Procedures Guide* (PAPPG) that will be issued in January 2016, NSF will require articles in peer-reviewed journals and papers accepted as part of juried conference proceedings, in which the research is funded wholly or in part by NSF, to be deposited in a public access compliant repository designated by NSF. In the initial implementation, NSF has identified the Department of Energy's PAGES (Public Access Gateway for Energy and Science) system as its designated repository, which will require NSF-funded authors to upload a copy of their journal articles or juried conference paper to the DOE PAGES repository in the PDF/A format, an open, non-proprietary standard (ISO 19005-1:2005). Either the final accepted version or the version of record may be submitted. This repository will provide scholarly scientific publications resulting from NSF-supported research to be publicly accessible and searchable at no charge to users.

NSF Recommendation 3

ACEHR recommends NSF report the status of earthquake-related research and funding commitments under the Natural Hazards Engineering Research Infrastructure (NHERI) initiative.

NSF response: NHERI supports research infrastructure. Under program solicitation NSF 14-605, *Natural Hazards Engineering Research Infrastructure (NHERI)* (<http://www.nsf.gov/pubs/2014/nsf14605/nsf14605.htm>), in FY 2015, NSF made eight awards to establish NHERI: one for cyberinfrastructure and seven for experimental facilities:

- [Cyberinfrastructure](#) at University of Texas at Austin,
- [Twelve-Fan Wall of Wind](#) at Florida International University,
- [Large-Scale, Multi-Directional, Hybrid Simulation Testing Capabilities](#) at Lehigh University,
- [Large Wave Flume and Directional Wave Basin](#) at Oregon State University,
- [Geotechnical Centrifuges](#) at the University of California, Davis,
- [Large, High-Performance Outdoor Shake Table](#) at the University of California, San Diego,

- [Boundary Layer Wind Tunnel, Wind Load and Dynamic Flow Simulators, and Pressure Loading Actuators](#) at the University of Florida; and,
- [Large, Mobile Dynamic Shakers for Field Testing](#) at the University of Texas at Austin.

In FY 2016, three NHERI components are being competed under NSF 15-598 (<http://www.nsf.gov/pubs/2015/nsf15598/nsf15598.htm>): Network Coordination Office, Computational Modeling and Simulation Center, and Post-Disaster, Rapid Response Research Facility. Awards are anticipated to be made in spring 2016.

The five-year NHERI funding profile, as stated in NHERI program solicitations NSF 14-605 and NSF 15-598 and subject to the annual budgets of NSF, the annual performance of the NHERI awards, and the extent of utilization of NHERI resources by NSF-supported research and education awards, is as follows:

- FY 2015 \$12,000,000 (actual \$18,235,978),
- FY 2016 \$13,000,000,
- FY 2017 \$12,500,000,
- FY 2018 \$12,500,000; and,
- FY 2019 \$12,000,000.

NSF Recommendation 4

ACEHR recommends NSF review lessons of multi-disciplinary hazard- related initiatives to assess the quality of cross-disciplinary, and especially social science, participation. At the same time, NSF should continue and enhance investment in social science research related to earthquake hazards and disasters.

NSF response: NSF continues to review the accomplishments and continuing challenges of cross-disciplinary and multi-disciplinary research. In recent years - and with explicit attention to these concerns - NSF-supported researchers in engineering, social sciences, computer science, and other fields have undertaken strongly cross- and multi-disciplinary research, through both multi-investigator and single-investigator projects. NSF's RAPID funding mechanism, which supports the collection of perishable research data, particularly regarding new or emergent phenomena, has been instrumental in this regard, as have larger, multi-year programs such as Critical Resilient Interdependent Infrastructure Systems and Processes (CRISP) - NSF 15-531 and its predecessor, Resilient Interdependent Infrastructure Processes and Systems (RIPS) - NSF 14-524, and the Interdisciplinary Research in Hazards and Disasters (Hazards SEES) - NSF 12-610 and NSF 14-581. Finally, the Infrastructure Management and Extreme Events program in the Directorate for Engineering, Division of Civil, Mechanical and Manufacturing Innovation, continues to provide a stable base for the growth and development of a broadly multi-disciplinary research community devoted to the investigation of sociotechnical phenomena associated with hazard preparation, mitigation, response and recovery.

Recent awards through these programs:

- Directorate for Engineering, Division of Civil, Mechanical, and Manufacturing Innovation, core research program: *Infrastructure Management and Extreme Events (IMEE)*. Recent awards: https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13353 (see link at bottom of page),
- Cross-Directorate (Computer and Information Science and Engineering; Engineering; and Social, Behavioral, and Economic Sciences): *Resilient Interdependent Infrastructure Processes and Systems (RIPS)* NSF 14-524. Recent awards: http://www.nsf.gov/news/news_summ.jsp?cntn_id=132852,
- Cross-Directorate (Computer and Information Science and Engineering; Engineering; and Social, Behavioral, and Economic Sciences): *Critical Resilient Interdependent Infrastructure Systems and Processes (CRISP)* NSF 15-531. Recent awards: https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505180 (see link at bottom of page); and,
- Cross-Directorate (competitions involved Computer and Information Science and Engineering; Engineering; Geosciences; Mathematical and Physical Sciences; Social, Behavioral, and Economic Sciences; and Office of Integrative and International Activities): *Interdisciplinary Research in Hazards and Disasters (Hazards SEES)* NSF 12-610 and NSF 14-581. Recent awards: http://nsf.gov/funding/pgm_summ.jsp?pims_id=504804 (see link at bottom of page).

RECOMMENDATIONS FOR USGS

USGS Recommendation 1

ACEHR recommends the USGS work to provide the data necessary to reduce uncertainty in ground motion scaling in the eastern and central United States. This may require assessing the merits of different strategies that include upgrading new stations obtained from NSF with strong motion sensors as well as placing more focus on rapidly instrumenting aftershock sequences and other targets of opportunity.

USGS Response: On page 36, the ACEHR report states, "By 2017, 160 stations from the NSF *EarthScope* Transportable Array will be transferred to the USGS." However, the USGS EHP has not yet secured the funding needed to operate the Central and Eastern U.S. Network (CEUSN), approximately \$1.5M per year, and it was not requested by the administration in its FY 2016 budget to Congress.

Regarding strong motion (SM) sensors in the CEUSN, the subset of approximately 60 CEUSN stations that have SM sensors was selected based on mapped higher hazard. The EHP agrees that it would be desirable to have strong-motion recording at all 160 CEUSN stations, and we have multi-agency and administration agreement on the basic network design. However, funding is not yet secured for the long-term operation of the network, and therefore it is not an opportune time to request a change to the approved network design. If funding is secured for long-term operations, USGS will then seek to enhance the network over time.

Related to the ACEHR's recommendation on improved understanding of Central and Eastern U.S. (CEUS) ground motions, we note that some USGS scientists are initiating research on both short-term (e.g., validation of NGA-East) and long-term (seismic wave propagation and earthquake source mechanics) projects to improve our understanding of CEUS ground motion. USGS is also making a considerable effort to deploy portable seismic sensors after significant earthquakes in the CEUS.

In the Appendix to the ACEHR report, on pp 36-37, the ACEHR notes that the USGS only funded central and eastern regional seismic networks for three years, while funding other regional seismic networks for five years. This was a strategic decision by EHP related to the uncertainty in the funding of the CEUSN. The 3-year award letters state: "Possible funding for years 4 and 5 will be decided in the future and will depend on whether USGS has sufficient resources to take over operation of the Central and Eastern U.S. Network (CEUSN) and the resultant implications for overall monitoring in the central and eastern U.S." Based on the future funding situation (near the end of the 3-year term), EHP will seek advice from the ANSS Steering Committee on how best to proceed.

USGS Recommendation 2

ACEHR recommends the USGS make Earthquake Early Warning (EEW) a funding priority. Additional federal funding will be required in order to develop, implement, and operate an EEW with priority given to the most seismically active regions in the United States.

USGS Response: The USGS continues to make EEW a priority in its budget requests. In 2015, EHP allocated \$4 million for new cooperative agreements with four universities, focusing on the implementation of the system; these were supplemented by \$1 million in new equipment purchases for network upgrades. In 2016, the USGS expects to complete the production prototype system in the first quarter, thereby enabling some users to take actions on warnings.

USGS Recommendation 3

ACEHR recommends the USGS enhance its efforts to understand, educate and communicate the risks posed by induced seismicity.

USGS Response: We are currently making a substantial effort to address the ACEHR's primary recommendation regarding the assessment of hazard from induced seismicity. With respect to the recommendation to form an advisory group of state and local stakeholders, our approach has been to focus on workshops and conferences to get broad community-stakeholder feedback, since the breadth of the stakeholder community is large. For example, we held a community workshop on this topic in Oklahoma in the Fall of 2014, with about 150 people attending. We likewise held a "User Needs" workshop (focused on the tectonic hazard map products) in the summer of 2015, also with a large group of attendees.

In 2015, stakeholder engagement has been complemented in Dallas, TX, by a smaller working group of local officials: the Dallas Area Earthquake Working Group (DAEWG). USGS

engagement with this group is responsive to the ACEHR's recommendation, "that an advisory group of state and local stakeholders be part of... product development". USGS staff, including an expert from the Science Application for Risk Reduction (SAFRR) project, is working directly with DAEWG representatives in evaluating what types of information are of most interest to inform the various planning efforts underway in the area, and what types of products are best for conveying that information. However, we point out that the dramatic increase in induced seismicity over the past few years has seriously taxed USGS resources, and that the SAFRR group and EHP-supported Science Centers are limited by manpower when it comes to such stakeholder engagements.

USGS Recommendation 4

ACEHR recommends the USGS expand earthquake scenario development in conjunction with stakeholder engagement in order to examine consequences of earthquakes in high-risk urban areas.

USGS Response: Numerous scenarios were completed in 2015, including two scenarios for induced earthquakes in the Dallas-Fort-Worth, TX, area and one for an induced earthquake in Cushing, OK. The USGS will continue to do more in this area; ongoing and future efforts include the "HayWired" (Hayward)⁶, Wasatch, and Seattle earthquake scenarios. In 2016, we expect to launch a "scenario" version of *ComCat* (the ANSS Comprehensive Earthquake Catalog), which will make it easier for users to find recent and archived scenarios.

USGS Recommendation 5

ACEHR recommends the USGS work with operators of critical infrastructure and lifeline systems to define and integrate near real-time earthquake data and other seismic information into system monitoring so that operators can quickly assess system impacts from earthquake movements and take appropriate actions. This development should be linked with the EEW program.

USGS Response: The ANSS product *ShakeCast* is the product to celebrate when it comes to working with operators of critical infrastructure and lifeline systems to define and integrate real-time earthquake data. A task for the future will be to integrate *ShakeCast* with earthquake early warning. USGS will gladly update the ACEHR on *ShakeCast* usage and potential at the next scheduled ACEHR meeting.

General Comments from USGS:

We thank the chair and members of the ACEHR for thoughtful and helpful advice on USGS priorities and the management of its programs under NEHRP. In general, we find the ACEHR recommendations to the USGS are consistent with recent, ongoing or planned actions by the USGS Earthquake Hazards Program (EHP), the USGS Science Centers and projects supported by the EHP⁷, and the USGS Science Applications for Risk Reduction (SAFRR) project.

⁶ http://www.usgs.gov/natural_hazards/safrr/projects/haywired.asp

⁷ Among the Science Centers supported by the EHP, the two largest are the Earthquake Science Center (ESC), located in Menlo Park CA, and the Geologic Hazards Science Center in Golden CO.

Regarding the NEHRP Interagency Coordinating Committee (ICC), the EHP strongly supports the recommendation for the NIST Director, as Chair of the ICC, to revitalize that committee as a mechanism for advancing NEHRP. We believe that the lack of engagement of the NEHRP-agency directors through the ICC has, in recent years, limited the success of NEHRP as an interagency partnership.

Regarding the ACEHR's comments pertaining to FEMA, the USGS agrees that FEMA has performed a critical role in implementation and funding of earthquake risk reduction activities at the state and local levels, and the translation of technical information into applicable tools for earthquake risk reduction. We also believe that this role has been seriously threatened in recent years, apparently due to diminished agency support. The USGS EHP now routinely receives proposals to its external funding activity for worthy projects in the area of earthquake risk translation and communication, but that area is a core responsibility of FEMA, not the USGS, within in the NEHRP partnership.

Regarding the ACEHR's comments pertaining to NSF Engineering, a similar situation to that of FEMA exists: The EHP now routinely receives proposals to its external funding activity for worthy projects in the area of earthquake engineering research (for example, soil liquefaction), but that area is not a core responsibility of the USGS within the NEHRP partnership. Like the ACEHR, EHP is also concerned that NSF's decision to move to a new multi-hazard engineering research program might further erode support for earthquake-specific engineering research, thereby increasing appeals from researchers for USGS support of worthy projects.