

**Advisory Committee on Earthquake Hazards Reduction
National Earthquake Hazards Reduction Program**

March 15, 2013

The Honorable Patrick D. Gallagher
Director
National Institute of Standards and Technology
Building 101, Room A1134
100 Bureau Drive
Gaithersburg, MD 20899-1000

Dear Dr. Gallagher:

We are pleased to submit our annual report to you and the Interagency Coordinating Committee (ICC) on the effectiveness of the National Earthquake Hazards Reduction Program (NEHRP), as stipulated in our committee charter and Public Law 108-360.

For the past six years, the Advisory Committee on Earthquake Hazards Reduction (ACEHR) has been meeting and carrying out its charge to advise the program on its effectiveness and its management, coordination, and implementation activities, as well as on new trends and developments. We have presented comprehensive reports with multiple recommendations in 2008, in 2010, and most recently in 2012. In 2009 and 2011, our reports were supplementary in nature and reflected specific developments that were occurring at the time. We have observed that all of our reports have been well received and that our recommendations have been implemented as time and funding have permitted. We continue to be frustrated with the declining funding resources available to NEHRP. The ongoing funding reduction has a negative impact on the program's ability to implement its mandate and strategic plan.



Since the completion of our 2012 report, the committee met once at NIST in Gaithersburg, MD, on November 19–20, 2012. We welcomed five new members, conducted a workshop on the engineering needs for existing buildings, and received briefings from each of the NEHRP agencies. The briefings included a comprehensive summary of the NEHRP Consultants Joint Venture research projects and each agency’s initial response to the recommendations presented in our 2012 report. The committee appreciates the efforts being made by each agency given the current funding constraints and understands that implementation of most of our 2012 recommendations is awaiting sufficient funding. All materials presented at the November meeting, as well as a summary of the meeting, are available on the NEHRP.gov website.

Our 2012 report provided a complete overview of NEHRP and included an update on the related trends and developments observed by committee members. We developed a set of key recommendations derived from the NEHRP strategic plan and the newly published National Research Council road map entitled, *National Earthquake Resilience: Research, Implementation, and Outreach*. Our 2012 report continues to stand as a current assessment of NEHRP.

This 2013 report, similar to earlier reports issued during the year following a comprehensive report, is supplementary in nature. It focuses on four important topics that came up during our November meeting that we believe need immediate attention along with the recommendations provided in 2012. These issues concern the need to:

- reinvigorate the implementation component of NEHRP;
- develop a building performance rating system that can stimulate mitigation activities;
- provide increased monitoring to assess the impact of induced seismicity; and
- endorse the continuation of the National Science Foundation (NSF)-funded George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES).

Reinvigorate the Implementation Component of NEHRP

Since the inception of NEHRP, the Federal Emergency Management Agency (FEMA) has played a pivotal role in implementing the earthquake risk reduction measures developed by NEHRP and its partners. This role has involved preparing state and local governments for responding to and recovering from earthquakes and other disasters, promoting the development and adoption of building codes and the implementation of improved practices in the design professions, and advocating for all-hazards preparedness in our homes, workplaces, and communities. FEMA has been the conduit for delivering NEHRP’s risk-reduction products to state and local governments and the practitioner community through its regional offices and its work in developing guidelines and templates. No other NEHRP agency is charged to provide this interface between those engaged in scientific research and development (R&D) and those with

“on the ground” responsibility for mitigating and preparing for the potential effects of earthquakes.¹

We recognize that FEMA’s investment in post-disaster mitigation has been significant, as evidenced by the retrofit and rehabilitation of public facilities. Regrettably, ACEHR has observed in recent years an ongoing erosion of financial support within FEMA for pre-earthquake mitigation and preparedness efforts. This erosion is diminishing FEMA’s capacity to support the vital implementation component of NEHRP. In fiscal year (FY) 2001, FEMA allocated \$15 million to carry out its NEHRP responsibilities. By FY 2010, the budget allocation for NEHRP had decreased to \$8.98 million, and since then it has declined by an additional 42 percent, to \$5.2 million in FY 2013. We believe that both pre- and post-disaster mitigation are needed to create resilient communities.

These cuts have reduced support for state and local mitigation and preparedness programs, and for the regional earthquake consortia, which have been an important source of mitigation advocacy. NEHRP staffing has been reduced in FEMA’s national and regional offices; these personnel have been the face of NEHRP among state and local governments and a visible and accessible resource in support of NEHRP implementation activities. Reduced support for seismic risk mitigation programming targeted to buildings and lifelines has also diminished FEMA’s role in creating a safer built environment.

NEHRP is like a three-legged stool, supported by basic research, applied R&D, and implementation activities. These three legs, grounded in the earth sciences, engineering, and the social sciences, work together to reduce earthquake risk and strengthen earthquake resilience in many ways. FEMA’s diminishing support for NEHRP has weakened the implementation leg of the stool, without which NEHRP cannot stand. Failure to support FEMA’s proactive advocacy of mitigation activities and programs will result in continued loss of life and property and increased financial burdens for the federal government in future disasters. Unless and until FEMA’s

¹ *The following were presented as FEMA NEHRP responsibilities at ACEHR’s November 2012 meeting:*

- *Promote implementation of research results*
- *Promote better building practices*
- *Operate program of grants and assistance for the States*
- *Support implementation of comprehensive earthquake education and awareness program*
- *Assist Federal agencies and private-sector groups in preparation and dissemination of seismic design guidance and in development of performance-based design guidelines*
- *Develop, coordinate, and execute the National Response Plan*
- *Develop approaches to combine earthquake hazards reduction with other natural and technological hazards*
- *Provide preparedness, response, and mitigation recommendations to communities after an earthquake prediction has been made*
- *Enter into cooperative agreements or contracts to establish demonstration projects on earthquake hazard mitigation*

support can be strengthened, NEHRP is in urgent need of a supplementary source of support for its vital implementation function.

Recommendation

The committee recommends that FEMA be given, and FEMA management allocate, increased funding to restore all mitigation activities, including state and local government mitigation and preparedness programs, to their historic levels.

Develop a Building Performance Rating System That Can Stimulate Mitigation Activities

A key element in building resilience is providing communities and decision makers with an understanding of how seismic risk relates to their built environment—a framework that measures, monitors, and evaluates the existing building stock and rates the code-based design of new buildings. A standardized, broadly accepted building performance rating system is needed that would provide this type of information in a concise, consistent, and understandable fashion. To be truly useful, such a system would need to be simple with minimal gradation, similar to the LEED Green Building Rating System (<http://new.usgbc.org/leed>). This system would take into account building performance measures such as repair costs, repair time, potential for unsafe placards, likelihood of casualties, and collapse potential given different levels of earthquake ground shaking. Finally, development of the rating system would require participation and, ultimately, buy-in from all the stakeholders that would use or be impacted by it.

Over the past 10 years there have been several workshop-based efforts to outline the challenges, solutions, and research needs associated with earthquake engineering and the seismic performance of buildings. These efforts have focused on issues ranging from meeting the challenges of existing buildings to developing a plan for national earthquake resilience. Their products include the following:

- ATC–57, *The Missing Piece: Improving Seismic Design and Construction Practices*
- ATC–71, *NEHRP Workshop on Meeting the Challenges of Existing Buildings*
 - *Part 1: Workshop Proceedings*
 - *Part 2: Status Report on Seismic Evaluation and Rehabilitation*
 - *Part 3: Action Plan for the FEMA Existing Buildings Program*
- ATC–73, *NEHRP Workshop on Meeting the Challenges of Existing Buildings, Prioritized Research for Reducing the Seismic Hazards of Existing Buildings*
- NIST GCR 09–917–2, *Research Required to Support Full Implementation of Performance-Based Seismic Design*
- National Research Council, *Grand Challenges in Earthquake Engineering Research, A Community Workshop Report*

- National Research Council, *National Earthquake Resilience: Research, Implementation, and Outreach*

Dozens of research needs are outlined and prioritized in these reports. Creating a simple building performance rating system will require a technical foundation that can be used to set the initial rating categories and to assess the performance of existing buildings and code-designed new buildings. While assessment tools currently exist, this technical foundation requires the development of improved assessment and analysis tools to better predict structural and nonstructural behavior and to benchmark the expected performance of code-designed buildings.

Recommendations The committee recommends that a building performance rating system be developed and implemented, and that to accomplish this, NIST should make the development of required tools and standards a priority, and FEMA should make implementation of the system a priority.

Provide Increased Monitoring to Assess the Impact of Induced Seismicity

A recent upswing in oil and gas activity, particularly in the central and eastern United States, has raised concerns about triggered or “induced” seismicity related to the injection of wastewater generated by this (and other industrial) activity. Furthermore, work is beginning on pilot projects investigating large-scale underground injection and permanent storage (sequestration) of CO₂.

ACEHR has identified three significant issues and opportunities for NEHRP related to seismicity induced by subsurface injection of wastewater or other fluids. Researchers cannot make progress on them without additional, more extensive seismic instrumentation. The issues are as follows:

- 1) Quantify the local seismic risks posed by injection-induced seismicity that are not captured in U.S. national seismic hazard maps
- 2) Determine whether induced seismicity has skewed or potentially could skew seismicity rate models used as inputs for U.S. national seismic hazard maps
- 3) Take advantage of the seismic-monitoring opportunities afforded by injection sites to better understand subsurface fluid migration and to better constrain seismic attenuation in the central and eastern United States, a significant source of uncertainty in current seismic hazard maps for these regions.

The first two issues are self-explanatory. Additional information about issue (3) follows. The USGS is the federal agency responsible for monitoring and reporting on earthquake occurrence throughout the nation. At the ACEHR meeting held in November 2012, the committee learned of a new planned partnership between the USGS and NSF intended to directly increase the number and coverage of seismic stations in the central and eastern United States.

Presently, there are approximately 400 modern, broadband seismic stations temporarily recording in the central and eastern United States as part of the “Transportable Array” of NSF’s EarthScope initiative, which is focused on increasing basic knowledge of the structure of the earth’s crust. This portable array has “rolled” across the lower 48 states over the past seven years, and its current configuration is shown in Figure 1. Under the planned USGS–NSF partnership, 150 to 200 of these stations would be left in place and incorporated into the existing USGS national earthquake monitoring network. The USGS would take over operation and maintenance of the stations, while NSF would purchase replacement stations, some of which may be used for the “proposed” 2014 deployment of the Transportable Array in Alaska. This will provide an added benefit to the EarthScope initiative since the challenging surface conditions in Alaska will be better monitored by different seismic stations that are designed for optimal scientific value.

The cost to implement this partnership and effectively double the amount of high-quality seismic instrumentation in the central and eastern United States is very modest, \$3 million per year for five years, and was included in the President’s 2013 budget request for NSF. However, because of the ongoing federal budget uncertainties, no action has yet been taken to initiate the transfer of the EarthScope stations to the USGS. This partnership is time-critical. Every month, as the portable array continues to roll across the central and eastern United States, a number of the stations that are planned to remain in place are being removed from the backside of the array and moved to the front of the array.

Furthermore, even though the addition of the NSF sponsored stations would significantly improve the existing USGS national earthquake monitoring network, these stations would not provide the dense sampling needed to improve ground-motion models at short distances, which is important for critical facilities. ACEHR believes that there is an opportunity for private industry to partner with the USGS to provide additional funding for the installation of temporary seismic instrumentation in dense arrays near injection sites to collect ground motion data in the near-source region.

The deployment of additional seismic instrumentation near injection sites, however, will not permit adequate investigation of injection-induced seismicity if there is no access to conduct field studies at those sites. ACEHR understands that the U.S. Department of Energy (DOE) has declined USGS requests to engage in seismic monitoring at CO₂ sequestration sites such as the site near Decatur, IL. Instead, DOE has hired Schlumberger, a private oil services company, to monitor seismicity. The data will not be made public nor will it be integrated into regional seismicity monitoring.

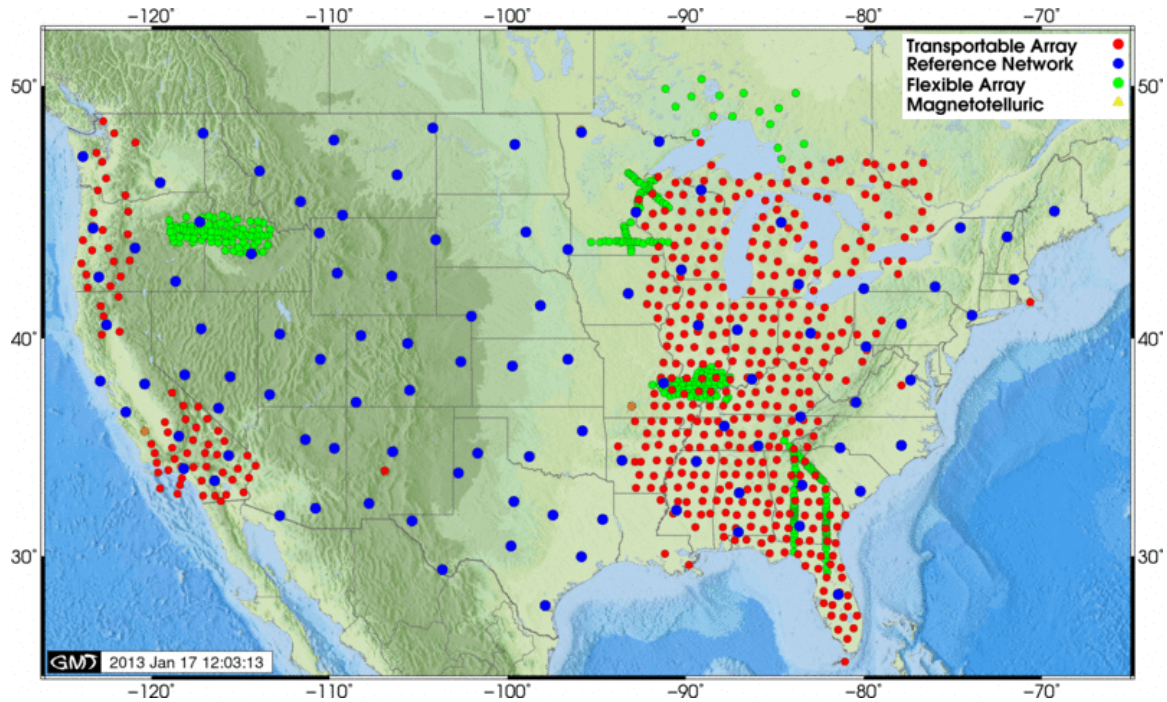


Figure 1. Configuration of the Earthscope transportable array on January 17, 2013. The 400 stations were first installed in the western U.S. in August 2007. The array has been “rolling” across the lower 48 states since then.

Recommendations

The committee recommends the following:

- 1) NSF should begin sponsoring the conversion of EarthScope Transportable Array stations to permanent seismic stations maintained and operated by the USGS as soon as possible.
- 2) The ICC should assist the USGS in engaging DOE to create a partnership that will assure access to CO₂ sequestration sites in order to monitor induced seismicity both near and far from the sites, thereby addressing local seismic risks related to injection as well as providing new ground motion data to constrain attenuation models.
- 3) The USGS should evaluate the impact of induced seismicity on seismicity rate models.
- 4) The USGS should partner with private industry to provide additional funding for the installation of temporary seismic instrumentation in dense arrays near injection sites to collect ground motion data in the near-source region.

Endorse the Continuation of NEES

Large-scale, multi-user experimental facilities are essential to increasing the seismic resilience of the United States by supporting the development of better seismic hazard estimates, by building knowledge about the vulnerability of the natural and built environments, and by developing standards and innovative construction technologies. NEES facilities are designed to study the performance of natural and built environments subjected to earthquake effects. Networked facilities linked with a dedicated and focused cyberinfrastructure enhance efficiency and access, thereby increasing and accelerating learning.

ACEHR notes that NEES operations have enabled giant advances in understanding the vulnerability of older systems; in developing new, highly resistant systems; in modeling nonlinear systems in the natural environment; and in advancing simulation capabilities. These advances are reflected in standards widely used by engineers nationally, and thereby are having substantial impacts on enhancing the safety and resilience of our communities.

NEES is approaching the final year of NSF's original 10-year plan of support for the network. NSF is in the process of implementing the "NEES2" plan for supporting the operation and management of earthquake engineering research infrastructure during fiscal years 2015–2019. ACEHR urges continued support for those elements of the NEES infrastructure and collaboratory that have demonstrated their effectiveness during the past eight and one-half years of multi-user research.

Recommendation

The committee recommends continued support of the NEES infrastructure and collaboratory and of the associated research that uses these facilities, at current or increased levels.

Closure

We appreciate the opportunity to communicate our findings and recommendations to you and stand ready to respond to any questions or comments that may arise.

Sincerely,

(Signed by Chris Poland 3/15/2013)

Chris D. Poland, PE, SE, NAE
Chair
Advisory Committee on Earthquake Hazards Reduction
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