Advisory Committee on Earthquake Hazards Reduction
National Earthquake Hazards Reduction Program

Draft as of February 27, 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, 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 the 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 headquarters on November 19 and 20. 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 workshop included the development of a list of high impact items that are included in Appendix A. The briefings included a comprehensive summary of the NEHRP Consultants

Comment [TF1]: Sentence inserted by C. Poland.

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 only on four specific 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 preserve the National Science Foundation (NSF)-funded George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES), to reinvigorate the implementation component of NEHRP, to develop a building performance rating system that can stimulate mitigation activities, and to assess the implications of recently published findings about induced seismicity.

Future 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 safety and resilience of our communities.

NEES is approaching the final year of NSF's original ten-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 (FY) 2015–

2019. ACEHR urges continued support for those elements of the NEES infrastructure and collaboratory that have demonstrated their effectiveness during the past eight years of multi-user research.

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

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 ~~S~~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 ~~S~~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 evident in 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 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

[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*

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 increased losses and financial burden to the federal government in future disasters. Unless and until FEMA's support can be strengthened, NEHRP is in urgent need of a supplementary source of support for its vital implementation function.

RECOMMENDATION: We recommend 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.

Building Performance Rating System

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 Systems (is a reference needed?). 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.

Comment [TF2]: Question from Ken Stokoe.

Over the past ten 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.

RECOMMENDATION: We recommend the development and implementation of a building performance rating system. NIST make development of tools and standards a first priority, and FEMA make implementation a first priority.

Implications 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 injection of waste water generated by this (and other industrial) activity. Furthermore, work is beginning on pilot projects investigating large-scale underground injection and permanent storage (sequestration) of CO_2.

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

1) Quantify the seismic and environmental risks to neighboring communities posed by injection induced seismicity
2) Determine whether induced seismicity has or potentially could skew seismicity rate models used as input into the US National seismic hazard maps
3) Take advantage of injection sites as opportunities to better understand subsurface fluid migration and collect new ground motion data to better constrain seismic attenuation in the central and eastern United States, the largest uncertainty in producing seismic hazard maps for these regions

The USGS is the federal agency responsible for monitoring and reporting on earthquake occurrence throughout the nation. At the recent face-to-face ACEHR meeting in November 2012, the Advisory Committee learned of a new partnership between the USGS and NSF, a sister NEHRP agency, to directly increase the number and distribution of seismic stations in the central and eastern U. S.

Presently, there are approximately 200 modern, broadband seismic stations temporarily recording in the central and eastern U.S. as part of the "Transportable Array" of NSF's EarthScope, a Major Research Equipment (MRE) initiative 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, its current configuration is shown in Figure 1. Through a USGS-NSF partnership, 150-200 of these stations would be incorporated into the USGS' earthquake monitoring network. USGS would take over operation and maintenance of the stations, while NSF would purchase replacement stations for 2014 deployment of the EarthScope transportable array to roll across Alaska, where challenging surface conditions require different seismic station design for optimal scientific value.

The cost to carry out this effective doubling of high-quality seismic instrumentation in the central and eastern U.S. is very modest, $3M per year for five years, and was included in the President's 2013 budget request for NSF. However, because of the ongoing budget uncertainties, no action has been taken yet to initiate the conversion of the stations to permanent. This partnership is time-critical. As the portable array continues to roll across the central and eastern U. S. a number of these portable stations are being removed every month from the backside of the array and moved to the front of the array.

The additional seismic instrumentation is not sufficient to investigate injection induced seismicity if there is no access to conduct field studies at injection sites. Unfortunately, DOE has declined USGS requests to engage in seismic monitoring at CO_2 sequestration sites such as near Decatur, Illinois. 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 more regional seismicity monitoring.

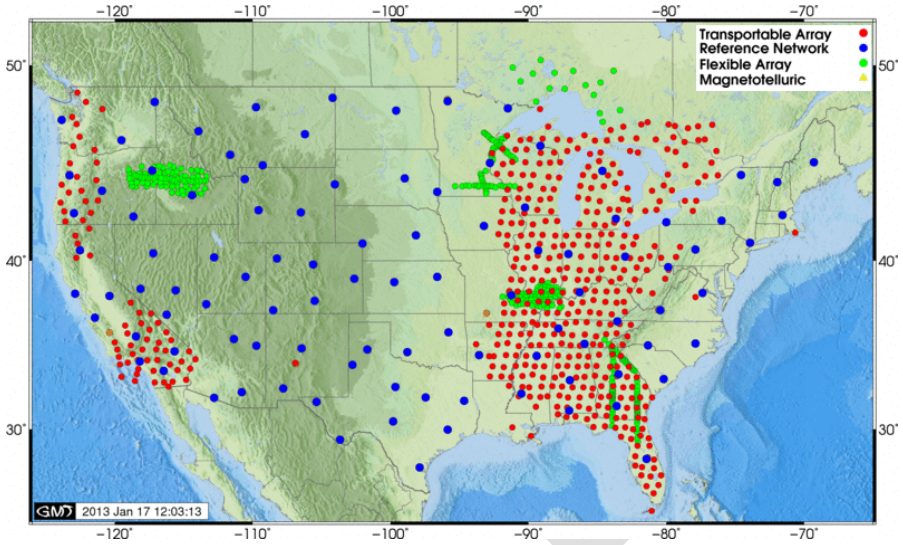

Figure 1. Configuration of the transportable array on January 17, 2013. The 400 instruments were first installed in the western U.S. in August 2007. The array has been 'rolling' across the lower 48 since then with a subset being planned for Alaska beginning in 2014.

RECOMMENDATIONS:

1) NSF begin the conversion of EarthScope Transportable Array stations to permanent as soon as possible.
2) NEHRP leadership engage DOE in creating a partnership to assure access to sites in order to monitor induced seismicity both near and far from the site, addressing both local seismic and environmental risks related to injection as well as providing new ground motion data to constrain attenuation models.
3) USGS evaluate the impact of induced seismicity on seismicity rate models.

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,

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