

National Earthquake Hazards Reduction Program Advisory Committee on Earthquake Hazards Reduction

National Institute of Standards and Technology

Building 81, Room 1A116

Boulder, CO

November 9–10, 2016

Meeting Summary

Meeting Attendance

Advisory Committee Members:

Laurie Johnson, Chair	Laurie Johnson Consulting
Jane Bullock**	Bullock & Haddow LLC
Craig Davis	Los Angeles Department of Water & Power
Gregory Deierlein	Stanford University
John Gillengerten	Consulting Structural Engineer
James Goltz	Advisor on Natural Hazards
Nathan Gould	ABS Consulting
Lisa Grant-Ludwig	University of California, Irvine
Robert Herrmann	Saint Louis University
Ryan Kersting	Buehler & Buehler Structural Engineers
Ronald Lynn*	Nevada State Contractors Board
Peter May	University of Washington
Lori Peek	Colorado State University
Glenn Rix	Geosyntec Consultants
David Simpson	IRIS Consortium
Ralph Archuleta	University of California, Santa Barbara; Ex-officio member of ACEHR as Chair of the U.S. Geological Survey (USGS) Scientific Earthquake Studies Advisory Committee (SESAC)

**Participated via teleconference*

***Not in attendance*

NEHRP ICC Member-Agency Representatives and NIST Support:

Howard Harary	NIST, Engineering Laboratory Director and ACEHR Designated Federal Officer
Jason Averill	NIST, Chief, Materials and Structural Systems Division, Engineering Laboratory
Jack Hayes	NIST, NEHRP Director, Materials and Structural Systems Division, Engineering Laboratory
Steven McCabe	NIST, Leader, Earthquake Engineering Group, Materials and Structural Systems Division, Engineering Laboratory
Edward Laatsch	FEMA, Director, Safety, Planning and Building Science Division, Risk Management Directorate
Ryan Rockabrand	FEMA, Federal Disaster Recovery Coordinator, FEMA Region

	VIII
Joy Pauschke	NSF, Program Director, Engineering for Natural Hazards and Natural Hazards Engineering Research Infrastructure
William Leith	USGS, Senior Science Advisor for Earthquake and Geologic Hazards
Tina Faecke	NIST, Program and Management Analyst, Materials and Structural Systems Division, Engineering Laboratory
Brian Garrett	NIST Support Consultant

Summary of Discussions

I. Opening Remarks

Howard Harary called to order this meeting of the National Earthquake Hazards Reduction Program (NEHRP) Advisory Committee on Earthquake Hazards Reduction (ACEHR) at 8:30 a.m. He welcomed attendees to the Boulder campus of the National Institute of Standards and Technology (NIST), briefly describing the history of the facility, the new building in which the meeting was held, and the person to whom this building was dedicated, Katharine Blodgett Gebbie. Harary asked whether the ACEHR members in attendance had any questions about the U.S. Department of Commerce (DOC) ethics rules for Federal advisory committees that had been sent to the members in advance of the meeting. Hearing no questions, he turned the floor over to NEHRP Director Jack Hayes.

Hayes explained, in relation to the DOC ethics rules, that whenever an ACEHR member perceives that they may have a conflict of interest involving something being discussed by ACEHR, the member should recuse himself or herself from the relevant discussion. DOC recognizes that such conflicts are likely to be unavoidable given members' leading roles in the earthquake community. Hayes then presented logistical information related to this two-day meeting.

ACEHR Chair, Laurie Johnson, welcomed the attendees and reviewed the agenda and goals for the meeting. She thanked NIST for alerting her last summer that funds were available for a second face-to-face ACEHR meeting in 2016 (the first meeting was held in March). She welcomed four new members to the Committee: Gregory Deierlein, Ryan Kersting, Glenn Rix, and David Simpson. She also noted the impending retirement of Jack Hayes, but thanked NIST for ensuring program continuity by naming Steven McCabe as the Acting Director of NEHRP following Hayes's departure. Johnson closed by asking attendees to introduce themselves.

II. Agency Overviews and Updates

A. USGS Earthquake Program Update

Bill Leith spoke to the Committee about the recent activities of the U.S. Geological Survey (USGS) Earthquake Hazards Program (EHP). He began by reviewing the recommendations sent to USGS in 2015 by ACEHR and by the USGS Scientific Earthquake Studies Advisory Committee (SESAC). He then discussed the fiscal year (FY) 2016 and 2017 budgets for the EHP and for the USGS contribution to the Global Seismographic Network (GSN); the EHP's new one-year seismic hazard forecast for the Central and Eastern United States (CEUS); and the program's internal planning efforts, external research and monitoring activities, and current challenges. Leith's presentation slides are available on the NEHRP

website at http://www.nehrp.gov/pdf/ACEHRNov2016_USGS.pdf.

Leith noted that although the EHP budget has been increasing since FY 2013, budget growth since 2010 has not kept pace with inflation (as measured by the Consumer Price Index). The biggest change in the budget has been related to earthquake early warning (EEW) systems. In recent years, Congress and the Obama administration have devoted more attention and funding to EEW. As a result, EEW now comprises 13 percent of the EHP budget, and all monitoring activities (i.e., seismic and geodetic networks and EEW combined) now account for about half of the budget, compared to 40 percent in years past. In contrast, funding for EHP components other than EEW has remained at FY 2012 levels.

Leith reviewed the progress being made in the development of EEW in California and the Pacific Northwest. A production prototype of the new "ShakeAlert" EEW system is being installed and tested in 2016 and 2017, with a limited public rollout of the final system anticipated in 2018. Full west-coast operations will begin sometime after that, depending on the availability of funding. USGS estimates that the cost of constructing the systems will total about \$38.3 million, and that operations and maintenance (O&M) costs for full operations will total about \$16.1 million annually. A source of full O&M funding remains uncertain, however.

According to Leith, the EHP's first one-year seismic hazard forecast for induced seismicity in the CEUS has proven to be quite accurate. The forecast was published earlier this year and focused on induced seismicity. Leith described some of the induced seismicity that has occurred this year in Oklahoma, and how the forecast has been used by state regulators there. An ACEHR member remarked that the forecast has been well received and asked whether another will be produced. Leith responded that another one-year forecast will be forthcoming in 2017.

In addition to the uncertainty over future funding for EEW, Leith identified several other challenges facing the EHP. One concerns the funding needed to maintain seismic monitoring stations that were installed in the CEUS, and are being installed in Alaska, and as part of the EarthScope Transportable Array (TA). These stations were originally intended to be temporary, and the funding currently available to maintain them will end in 2017 (CEUS) and 2019 (Alaska). USGS is looking for a way to support their permanent adoption into the Advanced National Seismic System (ANSS).

Other challenges identified by Leith include the "brain drain" being experienced at USGS science centers, where resources are sufficient to replace only one of every two scientists lost to retirement; the relocation of the Menlo Park (CA) Science Center to the NASA Ames Research Center, which will generate unknown costs for the EHP in coming years; the need for more funding for EHP's applied research and hazard assessment components; and relatively weak support in Congress for the ongoing needs of the USGS program.

B. USGS Scientific Earthquake Studies Advisory Committee (SESAC) Update

Ralph Archuleta informed the attendees that SESAC last met just the two days before this ACEHR meeting. He displayed a roster of SESAC's members and described the main issues discussed at their meeting. Regarding the ShakeAlert EEW systems being developed on the west coast, Archuleta echoed the concern expressed by Leith about the substantial long-term funding needed for the system. He noted that although the State of California recently provided \$10 million for EEW

implementation, that is a one-time allocation. There is still no long-term funding available for ShakeAlert's projected annual O&M costs. Archuleta's presentation slides are available on the NEHRP website at http://www.nehrp.gov/pdf/ACEHRNov2016_SESAC.pdf.

Archuleta stated that SESAC is eager to review the ANSS Strategic Plan, which is soon to be released by the Agency. The original plan, USGS Circular 1188, issued in 1999, assessed seismic monitoring in the United States and laid the groundwork for the development of ANSS. The new version will present the vision that will guide future development of the system. SESAC also expressed concern about the uncertain availability of the funding that ANSS will need to adopt and maintain the EarthScope monitoring stations that may otherwise be lost in the CEUS.

Regarding the upcoming relocation of the USGS Menlo Park Science Center, Archuleta acknowledged the associated costs that may have to come out of the EHP budget, but also noted that the center's new location will facilitate potentially fruitful collaboration between the EHP and the National Aeronautics and Space Administration (NASA).

USGS has given SESAC initial estimates of the funding that would be needed to enable the EHP to fully carry out its mission of monitoring seismic activity and mitigating its effects. Archuleta noted that these estimates, which are being developed in response to a SESAC recommendation, are comparable to the corresponding estimates developed by the National Research Council for its 2011 report entitled *National Earthquake Resilience: Research, Implementation, and Outreach*. This data corroborates the accuracy of these estimates and indicates that the EHP will need much greater budget increases than it has received to date to fulfill its mission.

Archuleta explained that SESAC will soon prepare brief recommendations to USGS, following its most recent discussions. SESAC will provide more complete recommendations next year that will relate to EHP's activities over the coming three to five years. SESAC members currently feel, however, that EHP's budget is no longer commensurate with the amount of work that the program is expected to accomplish. It is getting to the point where existing activities may have to be cut whenever new activities are added.

Archuleta was asked whether SESAC has advised USGS on the priorities of existing and potential EHP activities. He responded that although SESAC has not yet taken a comprehensive look at the EHP's priorities, it has advised that monitoring activities (seismic and geodetic networks and EEW) should not take up more than half of the EHP budget. He also noted that Leith has asked SESAC to consider what strategies the EHP should employ to deal with the ongoing imbalance between its workload and budget.

C. NSF Earthquake Program Update

Joy Pauschke briefed ACEHR on the role of the National Science Foundation (NSF) in NEHRP, the organizational components of NSF whose work relates to NEHRP, and the major NEHRP-related research programs currently active at NSF. The Agency's role in NEHRP is to support fundamental research related to earthquakes, in the earth sciences, in earthquake engineering, in the social, behavioral, and economic sciences, and in cross-cutting combinations of these and other disciplines. Pauschke provided links to par.nsf.gov and research.gov that highlight specific information about

each NSF-supported project, current and expired, including project outcomes. Using the word “earthquake,” a search in research.gov showed that NSF currently supports/has supported over 700 research projects during FY 2014 – FY 2016 across the Foundation, ranging in topics from earth sciences to engineering to social, behavioral, and economic sciences.

NSF provides this support through a variety of programs that fund research infrastructure and facilities as well as research projects selected from among solicited and unsolicited proposals.

NSF research programs relevant to NEHRP are housed primarily within the Agency's Engineering (ENG) and Geosciences (GEO) directorates, but also include programs that cut across these and other directorates. Within ENG, Pauschke focused on three programs organized under the Division of Civil, Mechanical and Manufacturing Innovation: Engineering for Natural Hazards (ENH), Infrastructure Management and Extreme Events (IMEE), and Natural Hazards Engineering Research Infrastructure (NHERI). Pauschke serves as program director for the ENH and NHERI programs.

The ENH and IMEE programs support numerous research projects related to natural hazards and extreme events, some of which relate to earthquakes. Pauschke provided sample lists of recent grants that ENH and IMEE have awarded for projects focused either on earthquakes or on earthquakes and other natural hazards. The NHERI program supports a network of university facilities that provide the specialized equipment, tools, and infrastructure needed for engineering research projects related to earthquakes and windstorms. NSF recently completed a two-year competition to select these facilities, and information about the network is available at www.designsafe-ci.org. While many of the facilities are already established, Pauschke noted that the Post-Disaster, Rapid Response Research Facility headquartered at the University of Washington is under development and expects to begin field reconnaissance deployments in the fall of 2018.

Pauschke described several NEHRP-related programs within the Directorate for Geosciences. These include: (1) Seismological Facilities for the Advancement of Geoscience and EarthScope (SAGE), a seismic and magnetotelluric facility supporting continuous observing networks including the SAGE Transportable Array (TA), former TA stations converted to long-term operations in the CEUS, and about one third of the GSN; portable instruments for individual investigator research, data management, and education and outreach activities; (2) Geodesy Advancing Geosciences and EarthScope (GAGE), a geodetic and seismic facility supporting continuous observing networks including the GAGE Plate Boundary Observatory (PBO) and Global Geodetic Network (GGN), portable instruments for researcher use, data management, and education and outreach activities; (3) Geophysical Observatory for Geoscience (NGEO), a network of facilities that will, if funded beginning in 2018, provide seismic, geodetic, and related geophysical instrumentation and services for the research community and partner agencies; and (4) Prediction of and Resilience against Extreme Events (PREEVENTS), a new program supporting conferences and research projects focused on understanding, modeling, and forecasting natural hazards and extreme events. SAGE and GAGE data support USGS earthquake monitoring and warning missions, hazard mapping, and potentially EEW systems; NASA global earth observing missions; and tsunami warning and related activities carried out by the National Oceanic and Atmospheric Administration (NOAA).

Pauschke identified many examples of cross-cutting programs that are supported by multiple

directorates; and provided examples of the kinds of collaborative and multidisciplinary research projects that these programs are supporting. NSF is also strengthening the nation's pool of earthquake research talent through a number of funding mechanisms targeted to early career faculty and to graduate and undergraduate students. Pauschke reviewed several of these mechanisms. She closed by mentioning some of the major research topics and processes that NSF is planning to explore in coming years, and by reminding attendees that NSF will be moving to a new building in Alexandria, VA in September 2017. Pauschke also explained how to obtain information on NSF funding awards and opportunities related to NEHRP. Her presentation slides are available at http://www.nehrp.gov/pdf/ACEHRNov2016_NSF.pdf.

D. Q&A/Open Discussion about First Set of NEHRP Agency Updates

An ACEHR member asked whether the NCEO program mentioned by Pauschke is related to the EarthScope facilities whose funding is coming to an end in the next few years. Leith responded that there are connections between the two and that at least some of these EarthScope facilities should be able to continue operating with NCEO funding. However, he noted that NSF plans to award flat funding over 10 years for NCEO and that not all EarthScope resources may be able to be maintained within this budget.

Another member expressed concern about the downward pressure on the USGS EHP's support for external research, particularly that which could be conducted by next-generation earthquake scientists. Leith responded that, although EHP's budget for external research is diminished, the EHP is committed to maintaining a strong external research component. While the program has not tracked the types and numbers of young researchers involved in funded projects, Leith's impression is that the external projects have continued to involve post-doctoral fellows and graduate students. In addition, the USGS Mendenhall Research Fellowship Program continues to serve as an important source of hiring for the EHP.

Leith was asked to say more about the Subduction Zone Science Plan that he had mentioned in discussing the EHP's internal planning efforts. He explained that interest in subduction zone science began building, both inside and outside of USGS, several years ago, and has since grown through various workshops and meetings. The plan Leith mentioned earlier was put together at USGS with no funding support; it examines the subduction zone science that USGS would like to be explored over the next five years. Leith anticipates that a budget request to fund this research will be forthcoming. He also noted that NSF's community has begun to discuss a large-scale focus in this area, including through an NSF-sponsored workshop in September 2016.

Pauschke was asked whether NSF could provide a breakdown of its NEHRP support similar to that presented in a pie chart for USGS. Such a breakdown could help ACEHR distill the variety of programs and projects that are contributing to NSF's total NEHRP-related financial support, and evaluate whether there may be any gaps in what is being funded. Pauschke indicated that a breakdown of NEHRP-related support would be challenging given the number of NSF programs that support earthquake-related research, as these programs support many other topics than disaster-related and earthquake-related. A possible funding breakdown will be investigated. The earthquake community should be resourceful to take advantage of the many NSF funding opportunities that can support the many facets of earthquake-related research.

An ACEHR member took note of some of the new seismic hazard information being released, such as the recent one-year seismic hazard forecast for the CEUS produced by USGS, and the information about increased seismic activity in California released by USGS and the State of California in September. The member wondered how people are using such information, whether there are guidelines about how it should be used, and whether USGS or NSF have any programs that could support the development of such guidelines. Leith said that USGS issued the first CEUS forecast to see whether and how people might use it, and that so far the Agency has only anecdotal data about its use. Regarding the information recently released in California, he noted that communications surrounding that were the responsibility of the state's emergency services Agency. Pauschke advised that within NSF, ENG's IMEE program might support fundamental research related to the development of such guidelines, but not the development of the guidelines themselves.

Concern was expressed about whether the lack of recent, damaging earthquakes in the United States might be reducing students' interest in earthquake science. Leith stated that, while USGS has observed a continuing lack of diversity among interested students, it has not seen lessening interest among students. Pauschke added that NSF has not encountered lessening interest, either.

Leith was asked whether USGS plans to integrate induced seismicity into its national seismic hazard maps. He said that the agency plans to keep information about induced seismicity separate from its seismic hazard maps. An ACEHR member expressed concern about the turnover among IMEE program officers at NSF. Pauschke said that the position of IMEE program officer is currently advertised as an Intergovernmental Personnel Act (IPA) position rather than a permanent position, and IPAs serve one to four years. Pauschke was asked how NEHRP could further engage with NSF in planning future activities. She responded that NSF remains open to partnering with the other NEHRP agencies and has made that known to the other agencies, but that NSF must also focus on seeding as-yet-unknown research.

E. NIST Earthquake Program Update

Steven McCabe described the recent activities of NIST's Earthquake Engineering Group (EEG). He reviewed the EEG's current and planned research projects, including the internal projects carried out by EEG staff and the external projects conducted by a contractor (the Applied Technology Council). McCabe described the EEG staff, their involvement in internal and external projects, and their outreach to the nation's earthquake engineering codes and standards community. He also spoke about the EEG's future plans in regard to internal staffing and testing facilities, and the EEG's involvement in NIST's community resilience initiatives. McCabe's presentation slides are available at http://www.nehrp.gov/pdf/ACEHRNov2016_NIST.pdf.

Among the research work highlighted by McCabe was an internal project, concluding now, that examined the seismic performance of a set of archetype steel and reinforced concrete buildings. These structures were designed using the latest prescriptive standards (as specified in ASCE/SEI 7, *Minimum Design Loads for Buildings and Other Structures*) and seismically evaluated using the latest performance-based procedures for existing buildings (as specified in ASCE/SEI 41, *Seismic Evaluation and Retrofit of Existing Buildings*). The earthquake engineering community has expressed significant interest in the results of this study; interested parties include the American Society of Civil Engineers

(ASCE) committee responsible for updating ASCE/SEI 41. In a new internal project, the EEG will examine the collapse probabilities for these archetype buildings to evaluate whether there are issues of concern with ASCE/SEI 7 or ASCE/SEI 41.

McCabe noted that EEG staff engineers have been heavily involved, both technically and administratively, in the EEG's external projects. While many of these projects have conducted new research to address specific applied issues encountered by the earthquake engineering community, others have synthesized the results of recent applied research to produce up-to-date guidance for practicing engineers in the form of NIST TechBriefs. In recent months, NIST has published its twelfth TechBrief and has produced updated versions of its first three TechBriefs.

Congress recently (FY 2016) provided additional funding to NIST aimed at strengthening community resilience. The funding has been targeted for earthquakes, wildfires, windstorms, and disaster and failure studies. The EEG has solicited and received external research proposals, which are now under review. The primary focus of the earthquake-related research will be on older existing buildings—improved tools for evaluating their vulnerabilities and cost-effective solutions for mitigating these vulnerabilities. Other foci include improved tools for assessing lifeline resilience and modeling soil liquefaction effects. The EEG is also working with NIST's Community Resilience Group and collaborating with NIST's Community Resilience Center of Excellence.

The EEG is planning to add several engineers to its staff so that in the future, it can shift more of its research from external to internal projects. NIST and the EEG are purchasing several new pieces of equipment for the Division's structural testing laboratory. The intent is to enable the EEG and others within the Materials and Structural Systems Division to conduct smaller-scale testing in-house.

A member of ACEHR wondered why, at a time when USGS has been struggling to secure sufficient funding support from Congress, NIST has been receiving additional funding for work on resilience. Harary responded that the President's budget request to Congress emphasized support for resilience, and that emphasis seemed to resonate with the committee overseeing funding for NIST. It can be difficult to know why certain topics resonate with some committees and not others. McCabe noted that resilience encompasses multiple hazards and that at NIST, at least, it has included earthquakes. In addition, the FY 2016 NIST funding increase, while significant for NIST, is relatively modest in comparison with the USGS NEHRP budget.

F. FEMA Earthquake Program Update

Edward Laatsch updated the Committee on FEMA's NEHRP activities. Including Laatsch, there are now eight FEMA headquarters personnel working on the earthquake program. When FEMA reorganized about nine months ago, Laatsch was made director of the Safety, Planning and Building Science Division within the Risk Management Directorate of FEMA's Federal Insurance and Mitigation Administration (FIMA). Among the areas he now oversees is the Building Science Branch, where the NEHRP personnel are located. The chief of the Building Science Branch, Bill Blanton, is now the first-line supervisor for the earthquake group. Laatsch stated that as Blanton becomes more familiar with the earthquake program, he will be attending more of the NEHRP and ACEHR meetings. In addition to the headquarters staff, FEMA's earthquake program still includes 10 regional earthquake program managers, five of whom are currently serving in an acting capacity.

FEMA NEHRP staff have recently worked with NIST NEHRP personnel on the implementation guidelines for Executive Order 13717. Laatsch said that Jack Hayes would be speaking to the Committee about that work in his NEHRP overview presentation.

Laatsch reported that over the last six months, FEMA has issued and begun implementing two important agency-wide policies related to building codes. These policies require that all FEMA programs adopt regulations, policies, and funding requirements, as appropriate, that encourage state and local adoption and enforcement of the latest hazard-resistant provisions of the nation's model building codes. This means that to obtain pre- or post-disaster public assistance funds from FEMA, recipients will be required to retrofit or rebuild to a level that is compliant with the latest model code provisions relating to hazard resistance. Laatsch and the FEMA earthquake program have advocated for this policy shift for more than a decade.

FEMA NEHRP staff participated in the latest I-Code¹ hearings in October. In these hearings, which concerned the forthcoming, 2018 editions of the I-Codes, four earthquake-related code changes proposed by FEMA were accepted pending final online voting (joining three previously approved changes related to earthquakes), and FEMA testified for or against a total of 34 proposed code changes. Laatsch noted that the latest data generated through FEMA's partnership with the Insurance Services Office (ISO) shows that progress continues to be made in the adoption of disaster-resistant building codes at state and local levels. According to data from ISO's Building Code Effectiveness Grading Schedule (BCEGS) program, 68 percent of all jurisdictions subject to one or more natural hazards (earthquakes, hurricanes, or floods) are using the IBC and IRC without any weakening of the disaster-resistant provisions in these codes.

Laatsch also provided an update on the efforts, initiated about a year ago by the National Institute of Building Sciences (NIBS), to update the landmark 2005 study *Mitigation Saves*. NIBS is working to significantly expand as well as update the 2005 study. The final study report, which is scheduled to be completed by September 2017, will include the results of a rigorous, defensible benefit-cost analysis of enhanced structural design requirements for facilities to resist earthquakes, floods, windstorms, and wildfires. Laatsch's presentation slides are available at http://www.nehrp.gov/pdf/ACEHRNov2016_FEMA.pdf.

G. NEHRP Overview

Jack Hayes provided an update on the governance and administration of NEHRP, including the activities of the NEHRP Secretariat at NIST. He acknowledged and thanked the four new members that have joined ACEHR since the Committee last met in March 2016, and noted that Jack Moehle, who has been a key member of ACEHR, left the Committee a few days prior to this meeting. Hayes stated that he will retire on December 30, 2016, and that Steven McCabe will then become the acting director of NEHRP.

¹ The International Codes, or I-Codes, are the nation's most widely used model building codes. Developed through a national, consensus-based process by the nonprofit International Code Council, the I-Codes include the International Building Code (IBC), International Residential Code (IRC), and others.

ACEHR's most recent report to the NEHRP Interagency Coordinating Committee (ICC), sent in May 2016 to the ICC Chair, NIST Director Willie May, was discussed at the ICC's latest meeting in August 2016. Hayes stated that Howard Harary would speak to the Committee about the ICC meeting later in the day.

Hayes presented tables showing NEHRP's budget, by agency, from FY 2005 through FY 2016. He noted that USGS is the only agency whose budget for NEHRP is specified by Congress in a line-item appropriation for NEHRP. FEMA, NIST, and NSF decide internally how much to allocate to NEHRP out of their agency's total appropriation from Congress. Hayes remarked that the recent budget increment shown for NIST, from \$3.9 million in FY 2015 to \$5.2 million in FY 2016, has been allocated to the external research grants targeting community resilience (see NIST update, above). He also showed the budget requests for FY 2017, noting that these amounts may be adjusted by Congress when it makes appropriations for the year. Until that time, the NEHRP agencies can continue to support NEHRP at their FY 2016 budget levels.

Hayes directed everyone's attention to the NIST NEHRP "thumb drives" (the size of credit cards) that had been distributed to the meeting attendees. These were developed in response to ACEHR's past recommendations that NIST strengthen its publication outreach. The drives, which have been distributed at conferences and meetings since March, contain all NIST NEHRP publications released since 2006. Hayes thanked the FEMA NEHRP program, which had done this earlier for their publications, for the idea.

Noting that he had covered the topic in depth at ACEHR's last meeting in March, Hayes briefly described the work being done pursuant to Executive Order 13717, which was issued by President Obama on February 2, 2016. The order directed NIST, as the lead agency for NEHRP and for the Interagency Committee on Seismic Safety in Construction (ICSSC), to prepare implementation guidelines for the order and to support the ICSSC in updating its *Standards of Seismic Safety for Existing Federally Owned and Leased Buildings*. NEHRP staff at NIST and FEMA have worked together to prepare the implementation guidelines in cooperation with representatives from about 35 affected agencies. The guidelines, which will encourage federal agencies to go beyond minimum seismic code requirements to achieve resilience, are nearly finished and will soon be released as ICSSC Recommended Practice (RP) 9, *Implementation Guidelines for Executive Order 13717: Establishing a Federal Earthquake Risk Management Standard*. NIST is continuing to help the ICSSC update ICSSC RP 8, *Standards of Seismic Safety for Existing Federally Owned and Leased Buildings*. As part of this work, McCabe will be working with other agencies to establish a common definition of "exceptionally high-risk" buildings. Hayes's presentation slides are available at http://www.nehrp.gov/pdf/ACEHRNov2016_NEHRP.pdf.

H. Q&A/Open Discussion about Second Set of NEHRP Agency Updates

McCabe was asked whether EEG applied research projects are looking at how earthquakes degrade the resiliency of buildings. He stated that EEG projects are including buildings that have been shaken and damaged in various earthquakes that have occurred in places such as California, Chile, New Zealand, and Taiwan. Currently, the primary focus is on examining how well ASCE 41 would have

predicted the damage actually incurred. Another ACEHR member asked whether these studies might include "indicator" buildings (i.e., buildings judged to be representative of a group of affected structures) in New Zealand or elsewhere. McCabe stated that the EEG's research partners in New Zealand may include such buildings.

A member asked Laatsch whether FEMA is involved in getting local governments to enforce their building codes. He noted that the enforcement of codes in individual cases requires authority that FEMA does not have. If requested, however, FEMA can assess how well codes are normally being enforced in a local jurisdiction. The code adoption data that the ISO prepares for FEMA through the BCEGS program is an indicator of how well jurisdictions are handling code enforcement.

McCabe was asked whether there may be funding available for looking at what percentages of buildings are pre- and post-benchmark codes in seismically vulnerable localities. He noted that such work has already been done in Los Angeles, funded by NSF. He added that FEMA is developing triage-level criteria that can be used to identify buildings in Los Angeles whose seismic vulnerability should be assessed more closely. NIST is interested in working on how that closer look should be conducted.

Referencing FEMA's new policies linking disaster-resistant building codes to post-disaster assistance, a member asked whether a recipient of assistance would face any negative consequences if they did not comply with the required codes. Laatsch stated that applicants for assistance will be required to submit statements affirming that they will comply with the hazard-resistant code provisions specified by FEMA. While FEMA is unlikely to check on actual compliance in each instance, there will be ways for the Agency to determine whether these policies are having the desired effect. Another member asked whether the assistance provided will be sufficient to support the required code compliance. Laatsch responded that applicants must add the costs of such compliance into the amount of support they are seeking. It remains to be seen to what extent these costs may cause applicants to replace rather than repair and retrofit damaged buildings.

It was suggested that the retrofit guidance for non-ductile concrete buildings that NEHRP has helped develop over the past 30 years is a success story that may be worthy of study, dissemination, and promotion. The retrofit ordinances that this guidance has so far spawned in California could be in jeopardy under changing political leadership, and timely promotion of this story may help to maintain support for such measures. Laatsch was asked whether FEMA might be able to take this on. He responded that the FEMA earthquake program has always been opportunistic and needs to remain open to such opportunities as circumstances allow.

The ACEHR Chair closed this discussion by noting that if the Committee decides to continue, at future meetings, to withhold members' questions until after the completion of brief oral updates from the agencies, the agencies will need to submit full and accurate presentation slides in advance. This will enable members to prepare questions in advance on matters that will not be covered in the oral presentations, and enable the Committee to get through the updates more expeditiously.

I. NEHRP Interagency Coordinating Committee Update

Harary updated ACEHR on the latest meeting of the NEHRP ICC, held on August 31, 2016 at the White House Complex, the Eisenhower Executive Office Building (EEOB) in Washington, DC. In attendance at

that meeting, which was the first time that the ICC had met in several years, were the directors of the NEHRP agencies (or their designees), the director of the Office of Science and Technology Policy (OSTP), and working-level representatives from the NEHRP agencies, OSTP, and the Office of Management and Budget (OMB).

The ICC decided that face-to-face meetings of the ICC principals will be held annually, supported by periodic senior-executive-level meetings. The annual meetings will be held preferably in the Fall to facilitate budget planning discussions. The committee tentatively decided to meet again in December 2016 to discuss FY 2018 budget planning, a new or revised NEHRP strategic plan, and program activities, opportunities, and gaps.

The ICC discussed Senator Dianne Feinstein's July 12, 2016 letter to the NEHRP agencies. Harary reported that, while the agencies would welcome congressional action on the reauthorization of NEHRP, the lack of a timely reauthorization has not harmed program effectiveness. Leith asked for a clarification, noting that the USGS did not agree that the lack of a timely reauthorization has not harmed program effectiveness, and Harary clarified that his statement pertained only to the mechanics of implementing the program. In regard to the statutory requirement for a NEHRP management plan, the committee decided that this requirement can be met by documenting the program's existing management practices. Harary's presentation slides are available at http://www.nehrp.gov/pdf/ACEHRNov2016_ICC.pdf.

Harary was asked how far personnel changes are expected to go at NIST as a result of the forthcoming change in administrations. He responded that NIST has only one political appointee, the NIST Director, and that a change in that position has already been planned for January 2017. He noted that President-elect Trump's transition team will probably soon visit NIST, and NIST will tell them that NEHRP is in need of reauthorization. The ACEHR Chair raised the question of when she should meet with the ICC; Harary stated that, while her attendance at an ICC meeting would be beneficial at some point, the December meeting is not the best time, given that the ICC principals may be changing under the new administration. He added that, depending on how the transition proceeds, the ICC may need to reconsider whether to meet in December. Several members urged that the ICC meet as planned, noting that the transition may provide important opportunities to highlight the NEHRP agencies' commitment to the program and its reauthorization. Leith added that, in regard to NEHRP reauthorization, the USGS position is that reauthorization provides an important opportunity to enhance the visibility of the program within Congress and the administration.

J. NEHRP 40th Anniversary Commemoration Update

McCabe, Leith, and Johnson spoke about the plans that are being made to observe the 40th anniversary of NEHRP in 2017. So far the main events being planned are a pair of west-coast conference sessions and an east-coast congressional briefing in the spring.

Johnson noted that in May 2016, a precursory event was held at the National Earthquake Conference. This was a panel discussion on NEHRP that explained how ASCE and others had collaborated on the last NEHRP reauthorization. The 40th anniversary events will begin in Portland (OR) in March at the 2017 Annual Meeting of the Earthquake Engineering Research Institute (EERI). Two plenary panel discussions are tentatively planned: one on opening day concerning NEHRP's past and present

activities and accomplishments and what remains to be done to achieve an earthquake-resilient nation, and another toward the end of the conference on NEHRP reauthorization.

The other major commemoration event is being planned for Spring 2017 in Washington (DC). Leith explained that USGS normally holds science briefings for congressional staff twice each year, and in 2017, one of these briefings will be focused on NEHRP. He also noted that Senator Feinstein has been invited to speak on NEHRP reauthorization at the 2017 Annual Meeting of the Seismological Society of America in Denver (CO) in April. (The senator has not yet accepted or declined this invitation.) McCabe suggested that the congressional staff who will be invited to the USGS briefing should perhaps also be invited to the EERI sessions. Johnson mentioned that EERI is currently indexing its oral history recordings and that it may be useful to pull together those related to NEHRP, if not this year for the 40th anniversary, then perhaps later on.

An ACEHR member suggested that a document on the 10 greatest things to come out of NEHRP be developed for use in the 40th anniversary events. Johnson noted that the first EERI panel will be speaking about the program's successes and that perhaps that information could be used for such a document. McCabe added that the same information could be used at the USGS congressional briefing, as well.

K. Vision for "Earthquake-Ready Nation"

Harary described the "weather-ready nation" concept that NOAA has developed, and asked ACEHR to consider whether it may be useful to adapt the concept to earthquakes. NOAA has used this concept to promote various activities intended to protect people from severe weather events and to respond effectively when people and property are affected by such events. A common goal across these activities is to provide information to stakeholders in a form that they can use to make better decisions. Harary asked whether the analogous concept of an "earthquake-ready nation" could be a useful brand or communication tool for earthquake risk-reduction efforts, and whether it could bring anything new to these efforts.

An ACEHR member wondered whether the earthquake-ready concept should be pursued as a new and separate program or as a banner under which existing programs could be repackaged. He cautioned that any such program should carefully complement and integrate with existing state and local efforts to avoid confusion and duplication of efforts. Another member observed that for some hazards, such as floods and wildfires, this concept has been applied on the community level and linked with the insurance industry. Perhaps there could be an "earthquake-ready community" designation that could lower rates for earthquake insurance.

In addition to the geographic scope of the earthquake-ready concept (i.e., nation versus community), members discussed its functional scope. That is, should the concept be applied only to earthquake preparedness on the household and community levels, or should it also apply to mitigation, EEW, response, and recovery activities. One member argued that limiting it to preparedness would exclude the many other activities that individuals and families cannot do. Another noted that because the "ready" concept has been linked primarily with preparedness in other hazard contexts, perhaps a different term, such as earthquake-resilient, should be used if it is to apply to all phases of seismic risk reduction. Another member agreed, noting that the term "earthquake-resilient nation" is already in

use (and is consistent with the NEHRP Strategic Plan), and that "earthquake-ready" may imply that only two conditions are possible (ready or not ready), while "earthquake-resilient" accommodates degrees of readiness. It was also suggested that the concept could be used to encompass all of the things that NEHRP has championed (e.g., seismic retrofitting, earthquake drills, code adoption and enforcement), and to measure how well these things have been implemented. There seemed to be general agreement that the concept, regardless of how it is labeled, could be used to encompass all NEHRP activities. Several members pointed out, however, that implementation activities cannot be accomplished at the Federal level alone, and that the concept should encompass state and local efforts as well. Harary thanked the members for their input and said that the concept will continue to be developed.

III. ACEHR Discussions

A. Discussion of Proposed Implementation Assessment

The ACEHR Chair led a discussion about the implementation assessment study recommended by the Committee in its 2015 and 2016 reports to the ICC. In response to this recommendation, the NEHRP agencies asked for more information about what the study would entail. ACEHR Member Peter May drafted a series of potential approaches to the study for consideration by the Committee, and reviewed this document (NEHRP Implementation Assessment Notes, available at http://www.nehrp.gov/pdf/ACEHRNov2016_Charge.pdf) at the meeting. The document posited that the key questions to be answered by the study were (1) How much progress has been made in putting seismic risk-reduction practices in place? and (2) What gaps remain?

With respect to the size and scope of the study, the document presented three alternatives: a "very modest" approach, a "moderate" approach, and an "ideal" approach. The modest version of the study would comprise a review of existing articles and reports and secondary data, yielding at best partial answers to the study questions. The moderate version would incorporate state-level data on adoption and enforcement of seismic provisions in building codes, and on seismic risk-reduction activities related to existing buildings, land-use planning, and lifelines. It could potentially yield a "report card" on state-level seismic risk-reduction efforts as well as methods for tracking future progress. The ideal version of the study would incorporate data from both state and local levels, as well as more extensive data about lifelines.

ACEHR members discussed the purposes and priority of the study, noting that it could potentially draw attention and resources to seismic risk-reduction efforts in general or to the NEHRP agencies or state and local earthquake programming in particular. It could also help to highlight the urgency of NEHRP's reauthorization, or be assigned to NEHRP in the reauthorization. Several members liked the idea of using the study to develop a risk-reduction rating methodology or community rating system that could make a more effective "business case" for seismic risk reduction at federal, state, and local levels. In terms of who should conduct the study, the members agreed that to be considered credible and not self-serving, the study would need to be performed by an objective party outside of the NEHRP agencies. The National Academies were suggested, but members were unsure about their ability to prepare business cases. The NEHRP agency representatives in attendance were asked what they thought of the study concept. Initial reactions were positive and with a three-tiered study, many possible options exist within this broad concept. Funding of such a study would require serious

consideration by the Agencies of the scope of the study along with the current NEHRP responsibilities and funding commitments.

B. Discussion of NEHRP Reauthorization Issues

The Committee briefly discussed the prospective content of the next NEHRP reauthorization legislation, including what the NEHRP agencies have developed to-date and what ACEHR should do in regard to such content. Hayes reported that the NEHRP agencies have collaborated at least twice in years past to develop recommendations regarding the content of the next reauthorization. This was last done around 2009, at the request of the House Science Committee. Since then, Congress has not asked for any more such input. Harary added that NIST included some recommendations about what should be in the reauthorization in the Agency's response to Senator Feinstein's letter of July 12, 2016. ACEHR members seemed to agree that it would be helpful for the Committee to consider what it thinks should be addressed in the reauthorization, and that a section about this could be added to ACEHR's next report on NEHRP effectiveness in 2017.

A member asked Leith whether, given the growing interest in EEW, it might be appropriate to recommend that NASA have some sort of role in a reauthorized NEHRP. He indicated that USGS is already working with NASA on an informal basis, and that it would make sense to link the space agency to NEHRP in some way. Another member cautioned that in making recommendations about the legislation, ACEHR should focus on the program's goals, themes, and directions rather than on specific projects, which could limit the flexibility of the NEHRP agencies.

C. Day 2—Opening Remarks and Public Input Period

The ACEHR Chair reviewed the agenda for the second day of the meeting, then opened the public input period. No members of the public had registered with NEHRP to provide input at this meeting, nor did any members of the public announce their presence or request to speak during the input period or any other part of the meeting. The Chair closed the input period with no input having been received.

IV. Recent Developments and Issues Related to Earthquake Monitoring and Early Warning Systems

Bill Leith spoke about recent developments related to the GSN, ANSS, EEW, and station retention in Alaska. The main activity affecting the GSN is a project to replace 47 failed borehole sensors. New sensors have been designed and tested, and will be installed over the next three to five years. USGS recently finished drafting a new strategic plan for ANSS; pending final reviews, it is expected to be published in January 2017. A major new development in this plan is that USGS will be incorporating geodetic monitoring into ANSS. Leith explained that the addition of GPS will enable more accurate processing of the largest earthquakes. The new plan also identifies the resources that will be needed to maintain ANSS; these include replacements for the current strong-motion sensors, which are no longer being made. Leith's presentation slides are available on the NEHRP website at http://www.nehrp.gov/pdf/ACEHRNov2016_ANSS.pdf.

In February 2016, USGS began operating a "production prototype" EEW system in California. Although some 75 users have signed up to receive EEW alerts through this system, only one, Bay Area Rapid Transit, is so far set up to act on the alerts. USGS is working one-on-one with the remaining users to

help them prepare to use the alerts for their respective purposes. USGS is working toward a geographically limited rollout of the final EEW system in 2018. Although enough funding has been received to support these development activities, there is still no plan for funding the remaining capital costs or ongoing O&M costs. In its talks with Congress, USGS has combined these costs to request a flat \$16.1 million per year to build and operate the west-coast EEW system.

Leith expanded on the information he presented earlier in the meeting about seismic monitoring in Alaska. He noted that with its high seismic hazard and many critical facilities, Alaska needs good seismic monitoring capabilities. There is currently an opportunity to significantly enhance these capabilities, as well as tsunami, volcano, and climatological monitoring in the state, by acquiring and permanently retaining the monitoring stations being maintained temporarily in the state for the SAGE TA and GAGE Plate Boundary Observatory. Congress asked USGS to study the costs and benefits of retaining the TA stations and a report has recently been prepared. If Congress agrees to release the study, USGS will ask SESAC to review it and attempt to prioritize the Alaska work in relation to all of the other work facing the EHP. The stations are presently scheduled to be removed after 2018, so there is some urgency to this issue.

An ACEHR member observed that USGS seems to be relatively successful at retaining assets that can serve the Agency's mission. According to Leith, USGS has found that there are two main opportunities for strengthening programs—when the program is reauthorized, and when the program can build or retain high-profile assets. Even so, the Agency faces ongoing budgetary challenges that have caused it to cut support for some regional monitoring networks, reduce new building instrumentation activities, and have difficulty hiring sufficient workforce talent.

Several members commented on the need for the NEHRP agencies to take advantage of opportunities to hand off new facilities or technologies to other parties that can maintain or implement them (and conversely, to take advantage of opportunities to acquire existing facilities or technologies that they can maintain or implement). It was also suggested that the NEHRP agencies look into philanthropic support for acquiring and maintaining existing assets. Leith noted that USGS has found philanthropic support for capital investments, but has found little philanthropic interest in funding O&M.

V. New ACEHR Letter to the ICC

The ACEHR Chair presented an initial draft of a proposed letter from ACEHR to the ICC, which conveyed in the form of informal recommendations several conclusions reached by the Committee during the first day of this meeting. The Committee made several revisions to the letter, the final version of which recommended that (1) the ICC meet again in December to help coordinate and shape transition planning related to NEHRP; (2) NEHRP initiate, as a top priority, the implementation gap assessment study that ACEHR previously recommended in its September 2015 and May 2016 reports to the ICC; and (3) a permanent (as opposed to "acting") NEHRP director be appointed as soon as possible following the retirement of the current director. After finalizing its content, the Committee formally adopted the letter and directed the ACEHR Chair to prepare and send the letter to the ICC Chair. The letter is available at <http://nehrp.gov/pdf/2016ACEHRRReportFinal.pdf>.

VI. Initial Planning for ACEHR's 2017 Report on NEHRP Effectiveness

The ACEHR Chair led a discussion about the organization and content of the Committee's next biennial report on NEHRP effectiveness. The legislation governing NEHRP requires that ACEHR produce these reports. The intended audience for the next report, which must be submitted to the ICC by September 30, 2017, includes the NEHRP agencies as well as congressional members and staff.

The Chair showed an outline of the last biennial report, prepared in 2015, which the Committee reviewed and revised for 2017. The report will comprise five main sections: Executive Summary; Overarching Considerations; Program Management, Coordination, and Implementation; Program Effectiveness and Needs; and New Trends and Developments. The ACEHR members who draft these sections can use the corresponding content from the last report as a starting point. In revising the 2015 outline, the Committee tentatively changed the subsections under Overarching Considerations to include the program reauthorization, the implementation assessment study, and NEHRP's relationship to broader resilience concepts. The members also revised the subsections under New Trends and Developments.

The Committee asked for input from the agency representatives in attendance about what they would like to see included in the report. Pauschke said that NSF likes to hear about potential breakthroughs and the research needed to bring them about. Laatsch noted that the current emphases at FEMA are disaster response and the National Flood Insurance Program, and that earthquakes are one of many hazards that must be considered at the Agency. He also said that high-profile initiatives are coming to FEMA that will further squeeze the resources that can be devoted to individual hazards. Consequently, ACEHR should consider how and when earthquake activities can be advanced under the multi-hazard banner, and should consider not only what new efforts are needed, but also what activities may no longer be needed.

After discussing the outline of the 2017 report, ACEHR members broke into small groups to brainstorm tentative content for the program effectiveness subsections on the NEHRP agencies. Later, the full Committee reassembled to hear about what each group had discussed. The group that had discussed NIST effectiveness noted that two of the Committee's 2015 recommendations for NIST have been achieved. Issues tentatively identified for the new report included more emphasis on lifelines vis-a-vis building systems, the current fragmentation of seismic safety criteria for lifelines, and the need for additional earthquake research staffing at NIST.

The group that had discussed FEMA reported that the Agency has not resolved the Committee's 2015 recommendation to increase funding for the earthquake program. In 2017, the Committee may wish to reiterate this recommendation, adding content about FEMA's importance and how the agency could be more creative in seeking funding. Linking the earthquake program to the activities of other FEMA branches and to the support for Presidential Policy Directive 8 may help in this regard. More emphasis could also be placed on modeling success stories and on linking FEMA assistance to model approaches. Other potential topics identified for the 2017 report included the need to further prioritize vulnerable buildings and their occupants, praise for the recent building code policy changes at FEMA, and the use of land-use planning for mitigation in multi-hazard areas.

The group that had focused on NSF found that the Agency's responses to previous recommendations have been somewhat vague, particularly regarding documenting relevant research results and breaking down the Agency's total NEHRP-related financial support. Rather than repeating past recommendations, the group felt that it may be more helpful to ask NSF to prepare a report on what the Agency is doing for NEHRP. Group members felt that NSF is doing many good things for the program, but that these things can be communicated more clearly. Rather than lists of specific research projects, what is needed are higher-level syntheses of how current grant programs are contributing to the goals of NEHRP, and explanations of what is represented within the Agency's NEHRP-related support. Another issue for the 2017 report is the need for both engineering and geosciences representation at ACEHR meetings.

The USGS-focused group recommended that the USGS content from the 2015 report be used as an outline for the new subsection. Many of the prior recommendations are still valid, but final decisions about the 2017 recommendations will need to be informed by how USGS fares in the transition to the new administration, as well as by the next recommendations prepared by SESAC. The group also noted that there are aspects of the EEW work (e.g., education and outreach) that are not being done by USGS, and that perhaps could be done by FEMA.

VII. Adjournment

The Committee agreed that their next face-to-face meeting should probably not occur much earlier than May 2017, so that ACEHR can receive post-transition updates from the NEHRP agencies before completing the biennial report on NEHRP effectiveness. The May meeting will focus on the 2017 report, and may need to be followed by one or more conference-call meetings. The NEHRP Secretariat will check on potential rooms for this meeting at NIST in Gaithersburg (MD). The ACEHR Chair stated that she will send e-mail messages to all Committee members so that they can sign up to work on particular sections of the report.

ACEHR members thanked the Chair for her leadership in guiding this meeting to a successful conclusion. Harary also thanked Hayes for his exemplary leadership of NEHRP. The Chair then adjourned the meeting at 2:00 p.m. on Thursday, November 10, 2016.