

Testimony of
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*Are We Prepared? Assessing Earthquake Risk Reduction in the
United States*

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Introduction

Chairman Quayle, Ranking Member Wu and Members of the Subcommittee, on behalf of Secretary of Commerce Gary Locke and the Department of Commerce, thank you for inviting me to testify on the current activities of the National Earthquake Hazards Reduction Program (NEHRP) today. Before I start, I wanted to share with you that all of us at the Department share in the grief felt by people around the world for the people of Japan. On behalf of the Department of Commerce, Secretary Locke expressed his condolences at the Embassy of Japan on March 23rd.

My testimony provides an overview of the statutory four-agency NEHRP partnership that includes the Federal Emergency Management Agency (FEMA), the National Institute of Standards and Technology (NIST) – my home agency, the National Science Foundation (NSF), and the U.S. Geological Survey (USGS). This partnership also extends far beyond these Federal agencies to include other Federal agencies, state and local governments, non-governmental professional organizations, model building code and standards organizations, and earthquake professionals in the private sector and academia. Without this extended “family” of dedicated earthquake professionals, the NEHRP agencies simply could not fulfill their statutory responsibilities effectively.

In the almost-two years since I last testified before this Subcommittee, the U.S. has fortunately continued to experience a relatively quiet period of seismic activity. However, worldwide seismic events during that time, particularly those around the Pacific “Ring of Fire” that borders the West Coast of the U.S., have been devastating, taking many lives, disrupting many other lives, and costing billions in direct and indirect impacts on infrastructure and economic activity. Since the beginning of 2010, we have witnessed horrific losses of life in Haiti (over 230,000) and Japan (toll still unknown but numbering in the tens of thousands) due to the combined earthquake and tsunami impacts, and lesser, but nevertheless significant, losses of life in Chile and New Zealand. The toll in terms of human life is overwhelming, and we all offer our heartfelt sympathy to those nations and their citizens.

The NEHRP agencies have begun analyzing lessons-learned from all of these tragic events. Some preliminary “big picture” lessons are already clear. The 2010 Haiti and Chile earthquakes provided a stark contrast in the effectiveness of modern building codes and sound construction practices. In Haiti, where such standards were minimal or non-existent, many thousands were killed in the collapses of homes and other buildings. In Chile, with much more modern building codes and engineering practices, the loss of life, while still tragic, was far smaller, about 500, despite the fact that the Chile earthquake had a significantly higher magnitude of 8.8 (M8.8) than the Haiti earthquake (M7.0). The fault rupture that caused the Chile earthquake released approximately 500 times the energy released in the Haiti earthquake. The Chilean building code provisions had been based in large part on U.S. model building codes that have been developed by researchers and practitioners who have been associated with and supported by NEHRP.

Scientists and engineers have not yet had enough time since the 2011 earthquakes in New Zealand (M6.3) and Japan (M9.0) to draw detailed conclusions. We do know that Japan and New Zealand are international leaders in seismology and earthquake engineering – we in the U.S. partner with our counterparts in both countries, because we have much to learn from one another. Despite their technical prowess, leaders in both countries have been taken aback by the amount of damage that has occurred. One lesson we take from this before we even begin detailed studies is that we still have much to learn about the earthquake hazards we face and the engineering measures needed to minimize the risks from those hazards. Assuming that we already know everything we need to know is the surest strategy for catastrophe. The other broad lesson that has already become clear from both of these events is that local, and indeed national, *resilience* --to recover in a timely manner from the occurrence of an earthquake or other hazard event -- is vital, going far beyond the essential, but narrowly focused, issue of ensuring life safety in buildings and other locations when an earthquake occurs. In Christchurch, NZ, the central

business district has been largely closed since the February 21 earthquake, severely impacting the local economy. Some reports indicate as many as 50,000 people are out of work as a result of this closure. In Japan, the impact of the March 11 earthquake and resulting tsunami have been far worse on the national economy, with energy, agriculture, and commercial disruptions of monumental proportions. Some estimates already put the economic losses over \$300 billion, and economic disruption is certain to continue for years and extend far beyond Japan's shores.

The 2010 and 2011 events followed decades or even centuries of quiescence on the faults where they struck and are sobering reminders of the unexpected tragedies that can occur. The USGS has recently issued updated assessments of earthquake hazards in the U.S. that provide appropriate perspectives for us. For example, in 2008, the USGS, the Southern California Earthquake Center (SCEC), and the California Geological Survey (CGS), with support from the California Earthquake Authority (CEA), jointly forecast a greater than 99% certainty of California's experiencing a M6.7 or greater earthquake within the next 30 years. The recent New Zealand earthquake, at M6.3, is slightly less severe than that which is postulated for California. The recent Chile and Japan earthquakes, at M8.8-M9.0, occurred in tectonic plate collision zones where one plate overrides another; that characteristic is closely comparable to those which generated 1964 Alaska earthquake and more ancient earthquakes off the coasts of Oregon and Washington, in the Cascadia Subduction Zone. Seismologists thus believe that what we have recently observed in Chile and Japan should serve as clear indication to us for what may likely occur again someday off the Alaska, Oregon, and Washington coasts.

While concern for future earthquake activity is always great along our West Coast, the National Research Council has noted in its publications that 39 states in the U.S. have some degree of earthquake risk, with 18 of those having high or very high seismicity. In 2011 and 2012, earthquake practitioners and state and local leaders in Memphis, St. Louis, and other Midwestern locales will participate in events that will commemorate the bicentennial anniversary of the New Madrid sequence of earthquakes, which included at least four earthquakes with magnitudes estimated at 7.0 or greater.

NEHRP is predicated on the reality that earthquakes are inevitable and will occur without warning, but that there is much the nation can do to minimize their consequences. The NEHRP agencies strive to perform the needed research and then translate the research results into actions that ensure that U.S. citizens are less threatened by devastating earthquakes. As described briefly in this testimony, the NEHRP agencies work in partnership, with each agency fulfilling its unique role, to perform a national service that simply cannot be duplicated by others. The studies and monitoring of the earthquake hazard cuts across both governmental and commercial boundaries. The research and implementation in both science and engineering by the NEHRP agencies is made possible by the "critical mass" they provide, which would not otherwise be possible if all responsibilities were left to the many states and (for the most part) small corporate entities that work in this field.

NEHRP Organization, Leadership, and Reporting

NEHRP is authorized through the Natural Hazards Risk Reduction Act of 2004. The Senate Committee on Science, Commerce, and Transportation has introduced S. 646, the Natural Hazards Risk Reduction Act of 2011, to reauthorize these program. A similar bill was passed through the House of Representatives in the last session of Congress. We and the other agencies involved look forward to working with both chambers of Congress in the 112th Congress on this important legislation.

The NEHRP Interagency Coordinating Committee (ICC) and the external Advisory Committee on Earthquake Hazard Reduction (ACEHR) continue to provide leadership to the program.

Interagency Coordinating Committee

Since 2006, the ICC has been very actively engaged in NEHRP leadership, meeting formally and conducting informal exchanges of information. This has resulted in a significant increase in program visibility in each agency and in the Executive Office of the President and has elevated key interagency decisions directly to the agency leader level. The direct involvement of, and interactions between the agency leaders has greatly improved program coordination and efficiency.

The ICC has actively overseen the development of NEHRP's annual reports and, most importantly, the development of the new NEHRP Strategic Plan that was released in October 2008. The ICC members viewed the significance of the Strategic Plan to be so great that they remained fully engaged with its development throughout its preparation.

Advisory Committee on Earthquake Hazards Reduction

The ACEHR advises the NEHRP program on trends and developments in the science and engineering of earthquake hazards reduction; Program effectiveness in carrying out Program activities; Program management, coordination, implementation and activities; and any need for Program revision. The ACEHR first met in 2007 and consists today of 16 leading earthquake professionals from across the U.S., from all walks of the non-Federal earthquake practitioner sector.

Lead Agency

The 2004 reauthorization designated NIST as the NEHRP Lead Agency with primary responsibility for planning and coordinating the Program.

While NIST "leads" NEHRP activities it is only with the outstanding teamwork of all the agencies working together under well defined roles and responsibilities that NEHRP accomplishments occur. There is a genuine camaraderie, sense of common purpose, and dedication to improving earthquake safety and resilience among the agency representatives.

NEHRP Strategic Plan

Vision

The 2008 Strategic Plan presents a new NEHRP vision for our nation¹:

A nation that is earthquake-resilient in public safety, economic strength, and national security.

This vision sets a fresh course for NEHRP, recognizing the importance of not only improving public safety in future earthquakes but also enhancing national economic strength and security. For example, if a southern California earthquake severely damaged the ports of Los Angeles and Long Beach, as happened to the port of Kobe, Japan, in 1995, there would be national economic implications. Similarly, if a major earthquake occurred in the Central U.S., one or more Mississippi River transcontinental rail or highway crossings in the Saint Louis to Memphis region, as well as oil and natural gas transmission lines could be severely disrupted. Working with its partners in both the Federal and non-Federal sectors, NEHRP can and should provide tools to assist the government and private sector entities who address those challenges.

More significantly, the vision also recognizes the need for improving our national *resilience* in the face of future damaging earthquakes. Achieving *resilience* requires coordinated application of mitigation, redundancy, robustness, and response and recovery activities and is a vital issue for the nation.

NEHRP does play a role in providing the means for improving response and recovery capacity. For example, led by FEMA and USGS, the NEHRP agencies are engaging in scenario demonstration projects, such as the 2008 *Great Southern California Shakeout*² and subsequent similar activities. These projects serve to catalyze both pre-earthquake mitigation measures and post-earthquake response and recovery activities for state and local leaders.

Plan Structure

The Strategic Plan sets three overarching program goals that involve synergies among the agencies: improve understanding of earthquake processes and impacts (basic research); develop cost-effective measures to reduce earthquake impacts on individuals, the built environment, and society-at-large (applied research and development); and, improve the earthquake resilience of communities nationwide (knowledge transfer and implementation).

The Plan also sets out nine areas of strategic priority for the program, areas of great importance to the nation that will be emphasized more prominently as resources become available to address them: fully implement the Advanced National Seismic System (ANSS); improve techniques for evaluating and rehabilitating existing buildings; further develop performance-based seismic design (PBSD); increase consideration of socioeconomic issues related to hazard mitigation implementation; develop a national post-earthquake information management system; develop advanced earthquake risk mitigation technologies and practices; develop guidelines for earthquake-resilient lifeline components and systems; develop and conduct earthquake scenarios for effective earthquake risk reduction and response and recovery planning; and, facilitate improved earthquake mitigation at state and local levels.

² [Http://www.shakeout.org/](http://www.shakeout.org/)

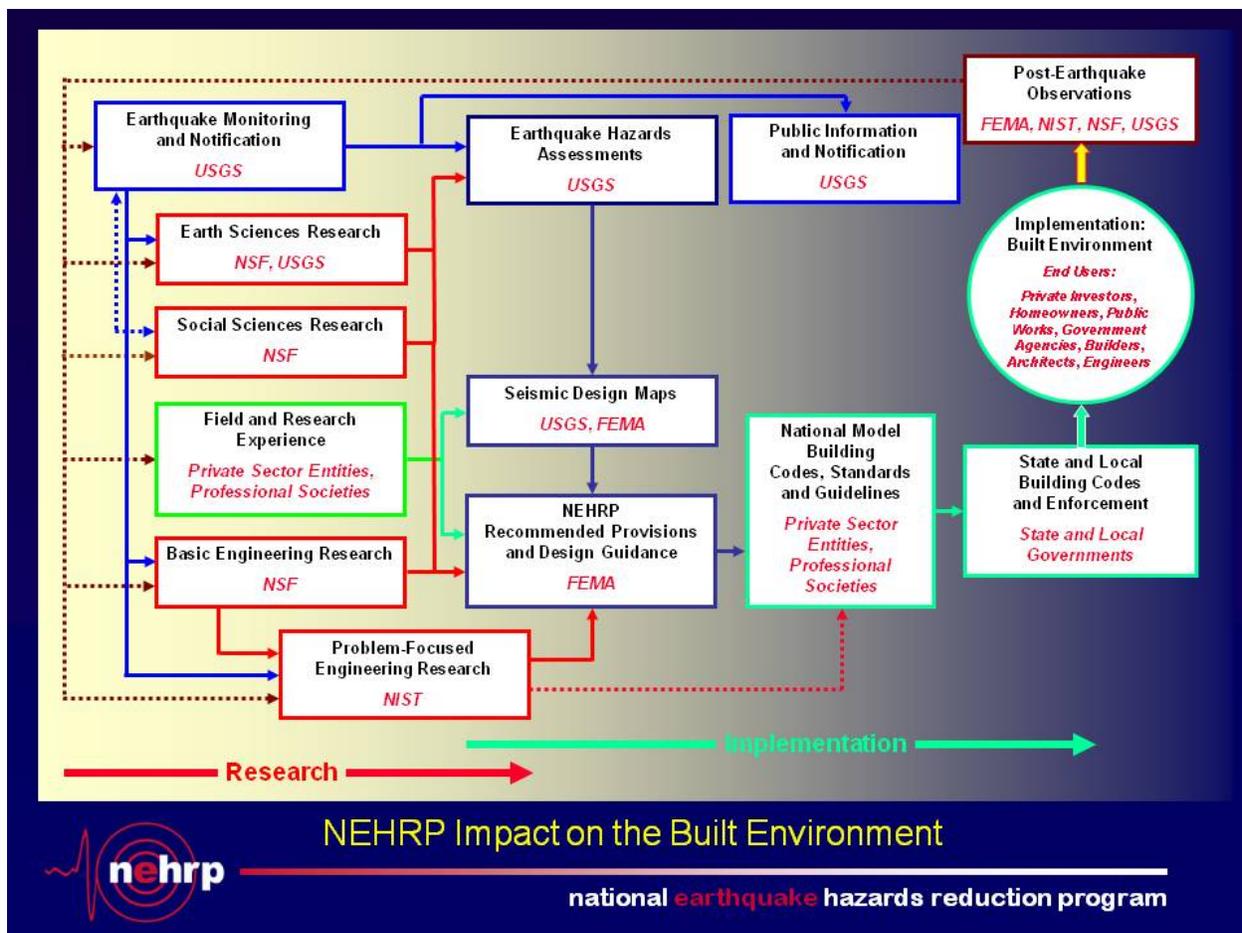


Figure 1. Primary NEHRP Activity Areas

The slide above shows the primary roles of the four agencies and further emphasizes that NEHRP is incomplete without the significant contributions made by those outside the four agencies – in fact, that non-Federal community is a major factor in the historic success of NEHRP.

In addition to the strong principles of ensuring synergy without duplication, the NEHRP agencies will seek, within their designated mission areas, closer ties to the international community. Not only can NEHRP-developed technologies be applied to help others, but the U.S. can learn from advances that are being made abroad.

NEHRP agencies seek to foster synergies among disciplines as well as with those who work with other hazards, such as wind, flood, and fire. The NEHRP agencies are aware of the similarities, differences, and linkages that exist among the hazards. Most of the technical issues that are tied to monitoring hazard occurrence, assessing the resulting risks, and developing tools, standards, and guidelines for design and construction differ substantially from hazard to hazard, making direct interactions at that level difficult. However, there are opportunities for the coordination of some NEHRP activities with those that have parallels for other hazards: *e.g.*, similarities in disaster response that can and should be shared with professionals in other hazard areas and similarities in structural response analysis for earthquakes and for blast or impact situations. Some key linkages provide excellent opportunities for multi-hazard cooperation, *e.g.*, tsunami warnings for such events that are caused by earthquakes (USGS-provided data used by the National Weather Service) and structural fire effects from any source (NIST).

The NEHRP agencies are also aware of the 30+ year history of organized NEHRP interaction with the earthquake professional community and state and local governments. This provides much organizational experience that can be shared with those working in other hazards-related fields, which typically have not enjoyed long histories of such cooperation.

Recent NEHRP Activities-Fostering Technology and Knowledge Transfer

The NEHRP agencies have worked both individually and collectively in recent years to improve the nation's earthquake resilience. Annual reports on the Program activities can be found at www.nehrp.gov. The following are brief descriptions of agency roles and accounts of some of their more prominent recent activities, as reported at the March 2011 ACEHR meeting.

USGS

The USGS is the applied earth science component of NEHRP. USGS delivers rapid characterization of earthquake size, location, and impacts; develops seismic hazard assessment maps and related mapping products; builds public awareness of earthquake hazards; and supports targeted research to improve monitoring and assessment capabilities. Noteworthy in 2011 is the USGS role in the U.S.-Japan Natural Resources Panel for Earthquake Research; this panel will be actively engaged in analysis of the recent Japan earthquake and its impacts on U.S. practice.

Monitoring

The USGS has significantly advanced its delivery of comprehensive earthquake information from monitoring systems, in the U.S. and internationally. In the U.S., monitoring is accomplished via the developing *Advanced National Seismic System (ANSS)*, which is now deployed at about 25% of its planned capacity. Internationally, USGS works in partnership with NSF and the Incorporated Research Institutions for Seismology (IRIS) to maintain the *Global Seismographic Network* as a tool for earthquake monitoring and research. The USGS National Earthquake Information Center (NEIC) assimilates all monitoring data on a 24/7 basis and issues rapid reports of potentially damaging earthquakes to key Federal, state, and local institutions, and to an electronic mailing list of over 250,000 users. USGS has implemented full on-site 24/7 operations at the NEIC and developed products such as the Prompt Assessment of Global Earthquakes for Response (PAGER) system that provides rapid (within minutes of earthquake detection) estimates of population exposure to strong shaking in earthquakes worldwide and delivers that to aid agencies, emergency managers, and others who use it to prioritize response activities. The most recent version of PAGER provides order-of-magnitude estimates of fatalities and economic losses. The USGS is also working with the Department of Veterans Affairs (VA) to install seismic instrumentation at 27 VA medical centers around the country – this will provide valuable information on actual building responses in future earthquakes.

Mapping

In 2008, the USGS released new U.S. national seismic hazard maps based on the most recent field observations and research results. The maps show that earthquakes are serious threats to 75 million people in 39 states. The USGS used these updated hazard maps to develop new “risk-targeted earthquake” (RTE) design maps for national model building codes that focus on the likelihood over time of building collapse due to earthquake ground motions instead of simply focusing on the likelihood of earthquake ground motions themselves. This has resulted in a lowering of earthquake design forces for many types of buildings in the Central and Eastern U.S. The USGS is also developing more detailed urban hazard maps for various areas; such maps have been released recently for Memphis and Seattle and are currently underway for St. Louis and Evansville, Indiana.

Scenario-Based Exercises

In 2008, the USGS, California Geological Survey, and Southern California Earthquake Center produced a plausible scenario of a rupture of the southern end of the San Andreas fault that could result in about 1,800 deaths, 50,000 injuries, and economic losses exceeding \$200 billion in the greater Los Angeles area. This scenario formed the basis for the 2008 *Great Southern California Shakeout* earthquake preparedness and response exercise. Over five million Southern California residents participated in the *Shakeout*, making it the largest public preparedness event ever held in the U.S. The state of California has begun annual renditions of the *Shakeout* exercise across the state. Along with FEMA, the USGS is supporting similar activities for the *Great Central U.S. Shakeout* that will be staged in April 2011.

Central U.S. Activities

The Central U.S. has been a major focus of the USGS and its partners in the past year, with the approach of the bicentennial of the 1811-12 New Madrid earthquake sequence there, which still ranks among the most severe earthquakes ever experienced in the U.S. In addition to its work in support of upcoming *Great Central U.S. Shakeout*, the USGS is working to support the FEMA National Level Exercise (NLE) 2011. In response to recommendations made by the NEHRP ACEHR, the USGS is working through its National Earthquake Prediction Evaluation Council (NEPEC) to support an independent evaluation of the hazard posed by the New Madrid Seismic Zone (NMSZ). The Arkansas Geological Survey and Center for Earthquake Research and Information at the University of Memphis, a regional network in the USGS Advanced National Seismic System, has been actively monitoring the recent swarm of low-magnitude earthquakes in north-central Arkansas.

NSF

NSF is NEHRP's primary basic research arm, supporting research that addresses earth science, geotechnical and structural engineering, lifeline engineering, and the social sciences, and integrating those disciplines. Following the devastating 2010 earthquakes in Haiti and Chile, NSF convened workshops to develop consensus reports on research needs.

Earth Science

NSF supports fundamental research related to seismology, geodesy, soil and rock mechanics, paleoseismology – the geologic studies of prehistoric earthquakes -- structural geology, and relevant theoretical, modeling, and laboratory projects. Recent outcomes from these programs range from explanatory mechanisms for episodic tremor and slip observed along plate boundaries around the world to insight into the slip differential across the southern San Andreas Fault. This work has substantially improved the description and understanding of strain buildup along major plate boundary faults such as the southern San Andreas Fault and the southern California San Jacinto Fault.

Following the 2010 earthquake in Haiti, NSF awarded grants supporting a five year project that installed and maintains 100 field stations around the Caribbean basin to provide continuous GPS (ground deformation) and weather monitoring. This new network is known as COCONet (Continuously Operating Caribbean GPS Observational Network).

NEES

Established in 2004, the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) provides world-class experimental facilities at 14 academic institutions across the U.S. The facilities include seismic shake tables, geotechnical centrifuges, a tsunami wave basin, large strong-floor and reaction-wall facilities with unique testing equipment, and mobile and permanently installed field equipment. The network's cyberinfrastructure technology links the facilities via the *Internet2* grid,

forming the world's first prototype of a distributed “virtual instrument,” and includes a national repository for experimental data, as well as numerical simulation and collaborative tools.

NEES plays a unique role among NEHRP agency investments for basic earthquake engineering research, providing diverse experimental capabilities, substantial user support, emphasis on education and outreach, and a university environment characterized by openness for academic, industry, and government use. NEES has promoted change in the earthquake engineering research culture through open access to unprecedented experimental capabilities, collaboration with experimental facility staff to develop formal testing protocols, archival of all experimental data in a community data repository for reuse by other investigators, and a new generation of students trained in advanced experimentation techniques and analytical modeling. NEHRP agency partners FEMA and NIST, and other Federal agencies, support projects to transfer NEES research findings into technical briefs for practitioners, performance-based seismic design (PBSD) guidelines, and seismic provisions in model building codes.

NSF’s Memorandum Concerning Cooperation in the Area of Disaster Prevention Research with the Japanese Ministry of Education, Culture, Sports, Science, and Technology enables U.S. researchers to use both NEES and Japan’s Earth Defense (*E-Defense*) shake table, the world’s largest shake table, to simulate seismic performance on large- to full- scale models with geotechnical and structural innovations. U.S. and Japanese researchers meet at least annually to discuss topics of mutual research interest and have a close collaborative relationship; as a result, several joint U.S.-Japan projects have now been performed using the *E-Defense* facility.

NSF continues to support, along with other Federal agencies, the Natural Hazards Center at the University of Colorado, Boulder. The Center’s annual July workshop assembles leading U.S. natural hazards researchers, policy makers, and practitioners. This is the major national forum for linking the producers of research with appropriate user communities.

NIST

NIST has devoted significant attention to establishing the NEHRP program. The Secretariat has established the NEHRP web site (www.nehrp.gov) that contains much information about the Program, links to all of the NEHRP agency sites, links to other organizations that are involved with earthquake-related research and implementation issues, and an electronic clearinghouse of documents produced by NEHRP activities.

Through the NEHRP Secretariat, NIST has sponsored a NEHRP-wide study by the National Research Council (NRC) that will provide a broad 20-year roadmap for the NEHRP agencies to consider as they implement the NEHRP Strategic Plan. The NRC study assembled a broad panel of national experts in earthquake risk reduction to identify and prioritize possible activities that could be considered to achieve the objectives set out in the NEHRP Strategic Plan, and to estimate the costs of those activities. The results of the study were released on March 30, 2011 and are now widely available.

In 2010 and 2011, the NEHRP Secretariat has also worked to support the U.S.-Japan Natural Resources Panel on Wind and Seismic Effects and is currently in frequent communication with Japanese counterparts regarding possible cooperative efforts to survey and analyze the damage that occurred in the recent Japan earthquake. The NEHRP Secretariat is also engaged in leading the Federal Interagency Committee on Seismic Safety in Construction (ICSSC) and currently supports an independent study to develop updated standards for seismic evaluation and rehabilitation of existing Federal buildings.

NIST’s technical role in NEHRP is chiefly one of linking the basic research products that come from NSF-supported university research with the implementation activities that are largely led by FEMA. Commencing in 2007 and continuing now, in a strong commitment to the Program, NIST began

strengthening its capabilities in the earthquake research arena, to bridge the research-to-implementation gap. The NIST earthquake risk mitigation research program supports several key areas: providing technical support for the earthquake engineering practice and building code development process; developing the technical basis for performance-based seismic design; supporting the development of technical resources that improve earthquake engineering practice; and, making developed and evaluated technologies available to practitioners in the design and construction communities. These activities are consistent with the NIST mission of serving the measurement and standards needs of the building and fire safety industries. NIST is a critical source of metrics, models, and knowledge for predicting the extent of damage from natural and man-made hazards, mitigating their impact, and helping to enhance the disaster resilience of communities and the built environment.

NIST performs about half of its earthquake research via a contractual partnership with the NEHRP Consultants Joint Venture, which links NIST with the nation's leading earthquake engineering researchers and practitioners. Several projects have been completed, and additional projects are ongoing. In addition, NIST has been building its in-house capabilities by hiring new earthquake research staff members.

Given the unique nature of the necessary interaction between NIST and FEMA in fulfilling their respective roles, the two agencies have formed a special partnership with their programs that involves complete, frequent exchanges of project information and in some instances actual direct collaboration on projects that involve complementary topic areas.

The Administration has committed NIST to support post-earthquake investigations for NEHRP. The President's 2012 budget request includes funding to support the formation of a formal Disaster and Failure Studies Program at NIST that would include post-earthquake investigation activities, in addition to field studies in a number of other hazards areas. Following the 2010 Chile earthquake, FEMA, NIST, and USGS staff members joined scientists and engineers sponsored by American Society of Civil Engineers (ASCE) and the NSF-supported Earthquake Engineering Research Institute (EERI) Learning from Earthquakes (LFE) program in surveying the damage to Chilean infrastructure. Following the field work, NIST co-sponsored a Chile research needs meeting with American Society of Civil Engineers and the Pacific Earthquake Engineering Research (PEER) Center that resulted in NIST's making mid-year programming changes to focus key research efforts on lessons learned from the Chile earthquake.

FEMA

While the other agencies contribute to NEHRP implementation efforts, FEMA is NEHRP's primary implementation and outreach arm.

Implementation Activities

FEMA has a prominent NEHRP leadership role in working with the practitioner community, the ASCE, and the International Code Council (ICC) to support the development of model building code provisions. FEMA works with the Building Seismic Safety Council (BSSC) to develop the next generation of the *NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures* (FEMA P-750) that was released in early 2010 for use in future ASCE standards and model building codes. USGS in turn supports the development of the *Recommended Provisions* with its hazards mapping activities.

FEMA works directly with the model building code organizations to assist in the development of new seismic provisions for new editions of the International Codes, or "I-Codes," that are promulgated by the ICC. The I-Codes have been adopted in part or whole by all 50 states, standardizing safe design practices nation-wide. FEMA supports projects to develop earthquake engineering guidelines for designers and works closely with NIST in this activity. This partnership and the resulting development, publication,

dissemination, and promotion of building design and construction materials are signature elements of NEHRP.

FEMA has developed and published over 200 earthquake design guidance publications on all aspects of earthquake risk mitigation, including: seismic design and construction of new buildings; evaluation and cost-effective rehabilitation/retrofit of existing hazardous structures; and other related structural and non-structural issues. FEMA has pioneered developmental work that supports the emergence of Performance-Based Seismic Design of buildings. Basic research supported by NSF has supported this effort, and, in recent years, NIST has initiated several knowledge transfer projects that complement the FEMA activity. PBSD is essential to fostering resilience in the constructed environment, because it helps engineers to work with building owners to enhance building performance beyond the basic life safety that is provided by the prescriptive measures found in model building codes.

FEMA began a significant new public outreach effort in 2008 with its new *QuakeSmart* initiative, which is designed to encourage business leaders and owners in areas that are at risk from earthquakes to take actions that will mitigate damage to their businesses, provide greater safety for customers and employees, and speed recovery if an earthquake occurs. The initiative began with a series of Community Forums in four cities in the Midwest and on the West Coast. Further forums are scheduled and FEMA is working with the Home Depot and ServiceMaster companies to broaden public outreach.

Outreach Activities

To support and increase the adoption of NEHRP earthquake resiliency measures, FEMA leads NEHRP efforts to maintain strong partnerships with other earthquake and hazards-related agencies, state and local governments, academia, the research community, code enforcement officials, design professionals, and the remainder of the private sector.

FEMA provides technical and financial assistance to states to increase awareness of the earthquake hazard and to foster plans to reduce seismic vulnerabilities. To provide state financial assistance, FEMA administers the Earthquake Hazards Reduction State Assistance Program which provides financial support to 33 states and territories.

FEMA also provides grants to support earthquake-related outreach and educational activities that promote earthquake mitigation and awareness to a series of multi-state consortia and organizations, including the Cascadia Regional Earthquake Working Group (CREW), which serves states in the Pacific Northwest affected by the Cascadia Subduction Zone and related faults; the Central United States Earthquake Consortium (CUSEC), which serves the states impacted by the New Madrid seismic zone; the Northeast States Emergency Consortium (NESEC), which serves northeastern states on a multi-hazard basis; and the Western States Seismic Policy Council (WSSPC).

In addition to outreach activities to promote training courses and publications, to improve education and awareness, FEMA has co-sponsored series of informational conferences, including the National Earthquake Conference held in Seattle in April 2008, as well as the 100 Year Anniversary of the 1906 San Francisco Earthquake. Along with USGS, FEMA is providing support for the upcoming National Level Exercise (NLE) 2011 and the *Great Central U.S. Shakeout*. The NLE 2011 will focus on testing the earthquake catastrophic plan and the emergency response capacity of the NMSZ states.

In a project closely related to its other NEHRP efforts, FEMA completed development and publication of its *Guidelines for Design of Structures for Vertical Evacuation from Tsunamis*. This document was jointly funded by FEMA and the National Oceanic and Atmospheric Administration (NOAA). NOAA issues tsunami warnings and leads the TsunamiReady program, a community preparedness and mitigation initiative. Tsunami safety is a critical issue for many coastal communities along the West Coast of the

U.S. that are vulnerable to tsunami. The States of Oregon and Washington have already expressed interest in using this publication. This publication has taken on added significance as a result of the recent Japan earthquake and tsunami.

Conclusion

The earthquakes of the past fourteen months – Haiti, Chile, New Zealand and now Japan – remind us of the persistent nature of the tectonic forces active within the Earth. There is nothing we can do to stop these processes, but the impacts of earthquakes, while not completely avoidable, can be greatly reduced.

Two major lessons from the recent earthquakes can be simply stated:

- Devastating earthquakes strike without warning, often at locations where their size and impacts are not fully expected.
- Earthquake preparedness and resilience measures can greatly reduce losses of lives, property, economic capacity, and societal well being.

These lessons seem obvious. But, we have recently seen nature teach them to us again, at the expense of others less fortunate and incompletely prepared. There is no need or justification for us to be forced to re-learn these lessons at home. Our challenge is to see that the new knowledge and experience gained through NEHRP continues to be developed and applied to domestic practices and policies that foster a more resilient American society.

Chairman Quayle and other Subcommittee members, thank you again for the opportunity to testify on NEHRP activities. This concludes my remarks. I shall be happy to answer any questions you may have.



Dr. John (Jack) R. Hayes, Jr. is the Director of the National Earthquake Hazards Reduction Program (NEHRP) of the Engineering Laboratory (EL) at the Department of Commerce's National Institute of Standards and Technology (NIST). Dr. Hayes joined NIST in early 2006. NEHRP is the Federal government's program to reduce risks to life and property from earthquakes. As director, Dr. Hayes provides overall program management, coordination and technical leadership; strengthens program effectiveness by facilitating implementation of earthquake risk mitigation measures; and builds and maintains effective partnerships with NEHRP program agencies and stakeholders in industry, academia and government. Dr. Hayes also leads in-house NIST efforts to perform earthquake engineering research in support of NEHRP.

Dr. Hayes joined NIST after serving as leader of seismic and structural engineering research at the U.S. Army Engineer Research and Development Center's (ERDC) Construction Engineering Research Laboratory (CERL) in Champaign, IL. At CERL, Dr. Hayes was actively involved in earthquake engineering research for the U.S. Army Corps of Engineers. He also collaborated extensively with the earthquake engineering program at NSF, including work within the Mid-America Earthquake Center, and has been directly involved with a number of significant earthquake mitigation projects for FEMA. Working with key personnel at USGS, Dr. Hayes helped develop the seismic provisions for the American Society of Civil Engineers' ASCE 7-05 standard and a new Department of Defense tri-services seismic design manual.

Prior to his tenure at CERL, Dr. Hayes was Research Civil Engineer and Senior Scientist at the Engineering Research Division of the U.S. Air Force Engineering and Services Laboratory (1984-1988); Structural Engineer at the U.S. Air Force Armament Division (1982-1984); Assistant Professor of Civil Engineering at the Virginia Military Institute (1980-1982); Civil Engineer and NATO Infrastructure Staff Officer at the Headquarters U.S. Air Forces in Europe (1977-1980); and Civil Engineer Officer at Tinker AFB, OK (1975-1977). Dr. Hayes is a retired Lieutenant Colonel in the U.S. Air Force Reserves and is a registered Professional Engineer in Florida and Virginia.

Education: University of Illinois at Urbana-Champaign, Ph.D., Civil Engineering, 1998; University of Virginia, M.E. (Tau Beta Pi), Civil Engineering, 1975; Virginia Military Institute, B.S. (Distinguished Graduate), Civil Engineering, 1973.

Latest Publications: Annual Report of the National Earthquake Hazards Reduction Program (NEHRP); Seismic Design of Reinforced Concrete Special Moment Frames: A Guide for Practicing Engineers.