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The National Earthquake Hazards Reduction Program (NEHRP): Issues in Brief

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Summary

Under the National Earthquake Hazards Reduction Program (NEHRP), four federal agencies have responsibility for long-term earthquake risk reduction: the U.S. Geological Survey (USGS), the National Science Foundation (NSF), the Federal Emergency Management Agency (FEMA), and the National Institute of Standards and Technology (NIST). These agencies assess U.S. earthquake hazards, deliver notifications of seismic events, develop measures to reduce earthquake hazards, and conduct research to help reduce overall U.S. vulnerability to earthquakes. Congressional oversight of the NEHRP program encompasses how well the four agencies coordinate their activities to address the earthquake hazard. Better coordination was a concern that led to changes to the program in legislation enacted in 2004 (the National Earthquake Hazards Reduction Program Reauthorization Act of 2004; P.L. 108-360).

P.L. 108-360 authorized appropriations for NEHRP through FY2009. Total funding enacted from reauthorization through FY2009 was $613.2 million, approximately 68% of the total amount of $902.4 million authorized by P.L. 108-360. Although authorization for appropriations expired in 2009, Congress has continued to appropriate funds for NEHRP activities. Congress made available $133.6 million for program activities in FY2016 appropriations, slightly more than FY2015 spending of $128.0 million. The budget request for FY2017 reflects another small increase, for a total of $136.1 million.

It is difficult to assess what effect funding at the levels enacted through FY2014 under NEHRP has had on the U.S. capability to detect earthquakes and minimize losses after an earthquake occurs. The NEHRP program's effectiveness is a perennial issue for Congress; the effectiveness of mitigation measures taken before an earthquake occurs is inherently difficult to capture precisely, in terms of dollars saved or fatalities prevented. A major earthquake in a populated urban area within the United States would cause damage, and in question is how much damage would be prevented by mitigation strategies underpinned by the NEHRP program. A 2015 report issued by the Advisory Committee on Earthquake Hazards Reduction, created by P.L. 108-360, calls for congressional reauthorization of NEHRP, in part to reinvigorate the federal investment and interest in NEHRP and to ensure that earthquake hazard reduction remains a federal priority.

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Introduction

Portions of all 50 states and the District of Columbia are vulnerable to earthquake hazards, although risks vary greatly across the country and within individual states. Seismic hazards are greatest in the western United States, particularly in California, Washington, Oregon, Alaska, and Hawaii. Alaska is the most earthquake-prone state, experiencing a magnitude-7 earthquake almost every year and a magnitude-8 earthquake every 14 years, on average. Because of its low population and infrastructure density, Alaska has a relatively low risk for large economic losses from an earthquake. In contrast, California has more citizens and infrastructure at risk than any other state because of its frequent seismic activity, large population, and extensive infrastructure.

The federal government has supported efforts to assess and monitor earthquake hazards and risk in the United States under the National Earthquake Hazards Reduction Program (NEHRP) since 1977. Four federal agencies responsible for long-term earthquake risk reduction coordinate their activities under NEHRP:

- U.S. Geological Survey (USGS);
- National Science Foundation (NSF);
- Federal Emergency Management Agency (FEMA); and
- National Institute of Standards and Technology (NIST).

Congress last made changes to NEHRP under the National Earthquake Hazards Reduction Program Reauthorization Act of 2004 (P.L. 108-360), which authorized appropriations through FY2009 for a total of $902.4 million over five years. Congress has continued to appropriate funds for NEHRP activities since authorization for appropriations expired in FY2009. (See **Table 1**.)

Changes to NEHRP Since Its Inception

In 1977, Congress passed the Earthquake Hazards Reduction Act (P.L. 95-124), establishing NEHRP as a long-term earthquake risk reduction program for the United States. The program, led by USGS and NSF, initially focused on research toward understanding and ultimately predicting earthquakes. However, earthquake prediction has proved intractable thus far, and NEHRP shifted its focus in 1990 to minimizing losses from earthquakes after they occur.

Agency leadership of NEHRP has also changed since the program's inception. FEMA was created in 1979, and President Carter designated it as the lead agency for NEHRP. In 1980, Congress passed amendments to the Earthquake Hazards Reduction Act (P.L. 96-472) that defined FEMA as the lead agency for NEHRP and authorized additional funding for earthquake hazard preparedness and mitigation for FEMA and the National Bureau of Standards (now NIST). Later, NIST became the lead agency for NEHRP.

A Shift in Program Emphasis to Hazard Reduction

Congress changed NEHRP's original focus on research to predict earthquakes in the National Earthquake Hazards Reduction Program Reauthorization Act of 1990 (P.L. 101-614). The law decreased the program's emphasis on earthquake prediction, clarified the role of FEMA, clarified and expanded the program objectives, and required federal agencies to adopt seismic safety standards for new and existing federal buildings.

In 2004, Congress enacted P.L. 108-360 and adjusted NEHRP again by shifting primary responsibility for planning and coordinating the program from FEMA to NIST. P.L. 108-360 also

established a new interagency coordinating committee and a new advisory committee, both focused on earthquake hazard reduction.

Current program activities are focused on four broad areas:

1. Developing effective measures to reduce earthquake hazards.[1]
2. Promoting the adoption of earthquake hazard reduction activities by federal, state, and local governments; national building standards and model building code organizations; and engineers, architects, building owners, and others who play a role in planning and constructing buildings, bridges, structures, and critical infrastructure or lifelines.[2]
3. Improving the basic understanding of earthquakes and their effects on people and infrastructure through interdisciplinary research involving engineering; natural sciences; and social, economic, and decision sciences.
4. Developing and maintaining the Advanced National Seismic System (ANSS), the George E. Brown Jr. Network for Earthquake Engineering Simulation (NEES), and the Global Seismic Network (GSN).[3]

Responsibilities of NEHRP Agencies Under P.L. 108-360

The House Science Committee report in the 108th Congress on H.R. 2608 (P.L. 108-360) noted that NEHRP has produced a wealth of useful information since 1977, but it also stated that the program's potential has been limited by the inability of the NEHRP agencies to coordinate their efforts.[4] The committee asserted that restructuring the program with NIST as the lead agency, directing funding toward appropriate priorities, and implementing NEHRP as a true interagency program would lead to improvement.

The 2004 law made the director of NIST chair of the Interagency Coordinating Committee. Other members of the committee include the directors of FEMA, USGS, NSF, the Office of Science and Technology Policy, and the Office of Management and Budget. The Interagency Coordinating Committee is charged with overseeing the planning, management, and coordination of the program. Primary responsibilities for the NEHRP agencies break down as follows (see also **Figure 1**):

- NIST is the lead NEHRP agency and has primary responsibility for NEHRP planning and coordination. NIST supports the development of performance-based seismic engineering tools and works with FEMA and other groups to promote the

[1] Hazard is not the same as risk. Earthquake *hazard* is related to the probability of a certain level of a shaking event caused by an earthquake within a certain time frame. *Risk* could be described as the combination of the hazard and the affected population (which includes the infrastructure supporting that population). High population centers would therefore be at a higher risk than low population centers for the same degree of earthquake hazard, in general.

[2] Lifelines are essential utility and transportation systems.

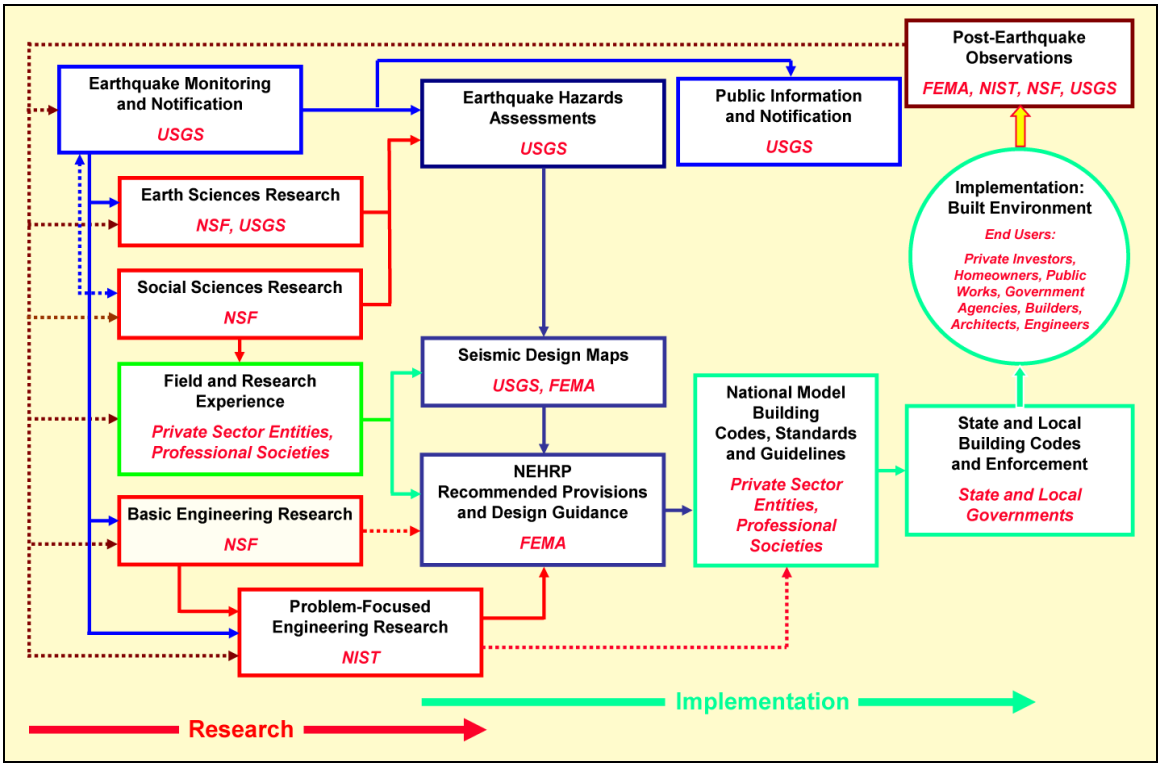
[3] The Advanced National Seismic System is a nationwide network of seismographic stations operated by the U.S. Geological Survey. The Global Seismic Network is a global network of stations coordinated by the Incorporated Research Institutions for Seismology, a nonprofit organization. The George E. Brown Jr. Network for Earthquake Engineering Simulation is a National Science Foundation-funded project that consists of 15 experimental facilities and an information-technology infrastructure with a goal of mitigating earthquake damage by the use of improved materials, designs, construction techniques, and monitoring tools.

[4] U.S. House of Representatives, Committee on Science, *National Earthquake Hazards Reduction Program Reauthorization Act of 2003*, 108th Cong., 1st sess., H.Rept. 108-246 (August 14, 2003), p. 13.

commercial application of the tools through building codes, standards, and construction practices.

- FEMA assists other agencies and private-sector groups to prepare and disseminate building codes and practices for structures and lifelines, and it aids development of performance-based codes for buildings and other structures.
- USGS conducts research and other activities to characterize and assess earthquake risks. The agency (1) operates a forum, using the National Earthquake Information Center (NEIC), for the international exchange of earthquake information; (2) works with other NEHRP agencies to coordinate activities with earthquake-reduction efforts in other countries; and (3) maintains seismic-hazard maps in support of building codes for structures and lifelines and other maps needed for performance-based design approaches.
- NSF supports research to improve safety and performance of buildings, structures, and lifelines using the large-scale experimental and computational facilities of NEES and other institutions engaged in the research and implementation of NEHRP.

Figure 1. NEHRP Agency Responsibilities and End Users of NEHRP Outcomes



Source: National Earthquake Hazards Reduction Program (NEHRP) program office at http://www.nehrp.gov/pdf/ppt_sdr.pdf (modified by CRS).

Notes: FEMA = Federal Emergency Management Agency; NIST = National Institute of Standards and Technology; NSF = National Science Foundation; USGS = U.S. Geological Survey.

Table 1 shows the enacted budgets for NEHRP agencies from FY2005 through FY2016. The total enacted amount for FY2005-FY2009 was $613.2 million, or 68% of the $902.4 million total amount authorized in P.L. 108-360 over the five-year span (see **Table 1**). Authorization of

appropriations for the program under P.L. 108-360 expired at the end of FY2009. Congress has continued to appropriate funds for NEHRP program activities.

Table 1. Enacted Funding for NEHRP Since Enactment of P.L. 108-360 Through FY2016

($ millions)

		USGS	NSF	FEMA	NIST	Total
FY2005	Enacted	58.4	53.1	14.7	0.9	**127.1**
FY2006	Enacted	54.5	53.8	9.5	0.9	**118.7**
FY2007	Enacted	55.1	54.2	7.2	1.7	**118.2**
FY2008	Enacted	58.1	53.6	6.1	1.7	**119.5**
FY2009	Enacted	61.2	56.0	9.1	4.1	**130.4**
FY2010	Enacted	62.8	55.0	9.0	4.1	**130.9**
FY2011	Enacted	61.4	55.3	7.8	4.1	**128.6**
FY2012	Enacted	59.0	53.2	7.8	4.1	**124.1**
FY2013	Enacted	55.6	52.2	`7.8	3.9	**119.5**
FY2014	Enacted	58.7	51.0	7.8	3.9	**121.4**
FY2015	Enacted	64.4	52.2	7.5	3.9	**128.0**
FY2016	Enacted	67.0	54.2	8.5	3.9	**133.6**
FY2017	Request	69.5	54.2	8.5	3.9	**136.1**

Sources: NEHRP program office, 2005-2016 NEHRP Agency Budgets, via personal communication with Jack Hayes, Director, NEHRP, June 20, 2014; and NEHRP, *Program Overview*, presentation to the Advisory Committee on Earthquake Hazards Reduction, March 3-4, 2016, at http://www.nehrp.gov/pdf/ACEHRMar2016_NEHRP.pdf.

Notes: According to the NEHRP program office, American Recovery and Reinvestment Act (ARRA; P.L. 111-5) funds are not included. The USGS-enacted funding reflects the amount appropriated for the USGS; FEMA, NIST, and NSF budgets reflect agency allocations for NEHRP activities from the total agency appropriations.

Congressional Action

In the 113th Congress, the Natural Hazards Risk Reduction Act of 2013 (H.R. 2132) was introduced. The bill would have authorized appropriations for NEHRP through FY2017, retained NIST as the lead NEHRP agency, and authorized total appropriations of about $906 million over five years. Congress did not act on H.R. 2132.

Also in the 113th Congress, on July 29, 2014, the House Science, Space, and Technology Committee, Subcommittee on Research and Technology, held a hearing that reviewed the NEHRP program. According to the charter, the hearing intended to examine strengths, weaknesses, challenges, and accomplishments of NEHRP.[5]

Congress has not introduced legislation to reauthorize appropriations or change the NEHRP program in the 114th Congress.

[5] The hearing charter is available at U.S. House of Representatives, Committee on Science, Space, and Technology, Subcommittee on Research and Technology, *A Review of the National Earthquake Hazards Reduction Program*, hearing charter, 113th Cong., 2nd sess., July 29, 2014, at http://science.house.gov/sites/republicans.science.house.gov/files/documents/7%2029%2014%20NEHRP%20Hearing%20Charter.pdf.

In a 2015 report, the Advisory Committee on Earthquake Hazards Reduction (ACEHR), created by P.L. 108-360, recommended that Congress reauthorize the NEHRP program.[6] The committee stated that "such legislation should address sufficient funding for NEHRP to maintain its foundational emphasis on earthquake hazards and seismic design for the built environment." ACEHR further recommended that

> Prior to or as part of this reauthorization, ACEHR believes a fundamental assessment of the nation's earthquake risk reduction progress to date must be conducted in order to define the next steps and future funding levels needed to improve national earthquake resilience. This assessment should address the extent to which the federal government, states, localities, tribes, and the private sector are already taking steps to address the seismic vulnerabilities of buildings, critical infrastructure and lifeline systems, and the potential social and economic impacts of these vulnerabilities. ACEHR believes a comprehensive assessment of the nation's earthquake resilience progress and the gaps in implementing earthquake hazard reduction measures are necessary to establish adequate funding levels and assign appropriate statutory responsibilities as part of future reauthorization of NEHRP.[7]

NEHRP and Induced Seismicity

ACEHR made several recommendations to the NEHRP program in its March 15, 2013, report to the Director of NIST and to the Interagency Coordinating Committee.[8] One of the recommendations called for increased seismic monitoring to respond to the increased oil and gas exploration and production in the central and eastern United States. Accompanying the increased oil and gas activity has been an increase in deep-well injection and disposal of oilfield brines, produced water, and flowback water from hydraulic fracturing activities.[9] In some instances, the deep-well injection activities reportedly may have triggered earthquakes—some damaging—in regions that are not identified as particularly seismically active on U.S. earthquake hazard maps.[10]

In its 2015 report, ACEHR noted that the USGS had received funding in FY2014 and FY2015 ($1.8 million and $2.5 million, respectively) to study induced seismicity and better understand how best to assess the related seismic hazards.[11] The USGS received $2.5 million for these studies in FY2016 and requested $3.2 million for FY2017.

The induced seismicity hazard from deep-well injection represents what might be considered a short-term hazard, compared with the perennial seismic hazard from natural tectonic forces, because to some degree the chance of an earthquake caused by deep-well injection depends on the injection activity. In response to the increase in earthquake activity in some locations that

[6] Advisory Committee on Earthquake Hazards Reduction, Effectiveness of the National Earthquake Hazards Reduction Program, A Report from the Advisory Committee on Earthquake Hazards Reduction, September 2015, p. 2, at http://www.nehrp.gov/pdf/2015ACEHRReportFinal.pdf.

[7] Ibid., p. 2.

[8] Letter from Chris D. Poland, Chair of the Advisory Committee on Earthquake Hazards Reduction, National Earthquake Hazards Reduction Program, to Patrick D. Gallagher, Director, National Institute of Standards and Technology, March 15, 2013, at http://www.nehrp.gov/pdf/2013ACEHRReportFinal.pdf.

[9] For more information about induced seismicity and the regulatory framework, see CRS Report R43836, *Human-Induced Earthquakes from Deep-Well Injection: A Brief Overview*, by (name redacted) and (name redacted)

[10] See, for example, National Research Council, "Induced Seismicity Potential in Energy Technologies," Board on Earth Sciences and Resources, 2012, at http://www.nap.edu/catalog.php?record_id=13355.

[11] Advisory Committee on Earthquake Hazards Reduction, *Effectiveness of the National Earthquake Hazards Reduction Program*, p. 30.

appears to be associated with deep-well injection, the USGS recently updated its seismic hazard maps. The updated maps include a one-year seismic forecast for the central and eastern United States that factors in contributions from both natural and induced earthquakes.[12]

Outlook

At present, earthquakes cannot be accurately predicted. In its 1990 reauthorization, NEHRP shifted its program emphasis from prediction to hazard reduction. Since then, the program's focus has been on understanding the earthquake hazard and its risk to populations and infrastructure in the United States, developing effective measures to reduce earthquake hazards, and promoting the adoption of earthquake hazard reduction measures in vulnerable areas.

Legislation to modify NEHRP in the 108th Congress (P.L. 108-360) reflected congressional concerns about how well the four NEHRP agencies coordinated their efforts to maximize the program's potential. As part of its oversight responsibilities, Congress may consider evaluating how effectively the agencies have responded to Congress's direction in P.L. 108-360 to improve coordination since 2004.

The NEHRP program has evolved with the recognition that the program is unlikely to provide information that would allow earthquake prediction. NEHRP has shifted its emphasis toward reducing losses during an earthquake. Establishing a precise relationship between NEHRP activities and reduced losses from an actual earthquake may also be difficult. However, as more accurate seismic hazard maps evolve, as understanding of the relationship between ground motion and building safety improves, and as new tools for issuing warnings and alerts are devised, trends denoting the effectiveness of NEHRP activities may emerge more clearly.

Congress has not introduced legislation in the 114th Congress that addresses the NEHRP program directly. The advisory committee to NEHRP, the ACEHR, called for NEHRP reauthorization in a 2015 report and issued specific recommendations to strengthen the program and help assess its effectiveness. Many of the recommendations are NEHRP-agency specific, but the committee wrote the report, in part, to seek support in Congress "to reinvigorate the federal investment and interest in NEHRP and ensure that earthquake hazard reduction remains a federal priority."[13]

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[12] Mark D. Petersen et al., *2016 One-Year Seismic hazard Forecast for the Central and Eastern United States from Induced and Natural Earthquakes*, U.S. Geological Survey, Open-File Report 2016-1035, March 2016, at http://pubs.usgs.gov/of/2016/1035/ofr20161035.pdf.

[13] Advisory Committee on Earthquake Hazards Reduction, *Effectiveness of the National Earthquake Hazards Reduction Program*, p. 6.