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

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Summary

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. Alaska is the most earthquake-prone state, experiencing a magnitude 7 earthquake almost every year and a magnitude 8 earthquake every 13 years, on average, since 1900. On November 30, 2018, a magnitude 7.0 earthquake struck north of Anchorage at 8:29 AM local time, causing extensive damage.

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; 42 U.S.C. 7704).

P.L. 108-360 authorized appropriations for NEHRP through FY2009. Although authorization for appropriations expired in 2009, Congress continued to appropriate funds for NEHRP activities during the nine intervening years. In FY2018, Congress appropriated $169.5 million for program activities, $30.6 million more than FY2017 spending of $138.9 million. The budget request for FY2019 would reduce total funding for NEHRP activities, primarily at the USGS and NSF, by $35.1 million and $13.7 million, respectively, compared to their FY2018 enacted amounts.

On November 27, 2018, Congress passed the National Earthquake Hazards Reduction Program Reauthorization Act of 2018, and President Trump signed the bill into law on December 11 (P.L. 115-307). The new act largely leaves the current four-agency NEHRP program intact, while providing some new areas of emphasis. For example, the act emphasizes activities to promote greater resilience to earthquakes. Resilience would include, for example, designing and building structures that not only protect human lives during an earthquake but also continue to be functional structures after an earthquake. Those structures then could be reoccupied instead of being total losses.

The 2018 NEHRP reauthorization act removes statutory language referring to seeking a capability to predict earthquakes. Earthquake prediction thus far has proven to be virtually impossible, and in its 1990 reauthorization (P.L. 101-614), Congress shifted the NEHRP program emphasis from prediction to hazard reduction. P.L. 115-307 continues that emphasis, along with a new focus on activities that would enhance the effectiveness of an earthquake early warning system, among other changes to the program. An earthquake early warning system would automatically send an alert to areas in danger of potential shaking after the earthquake is initially triggered. The alert would notify electric utilities, railway systems, and even hospital operating rooms to cease activities before the earthquake-triggered shaking begins.

The 2018 NEHRP reauthorization act authorizes appropriations for NEHRP activities from FY2019 to FY2023, for a total amount of about $760 million over the five-year span, or approximately $152 million annually. That annual amount is slightly higher than enacted appropriations for the program in FY2017, but slightly lower than the amount enacted in FY2018.

One persistent question has been how to assess more precisely the relationship between NEHRP activities and reduced earthquake risk and actual losses from earthquakes. P.L. 115-307 appears to

address that question by requiring the Comptroller General of the United States to review the program's activities and produce a report for Congress that addresses earthquake risks and hazards. The review and report would look at how states, tribes, and local governments are using NEHRP-generated information and implementing measures to reduce their earthquake risk.

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Portions of all 50 states and the District of Columbia are vulnerable to earthquake hazards,[1] although risks vary greatly across the country and within individual states.[2] 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 13 years, on average, since 1900.[3] Because of its low population and low infrastructure density, most of the state of Alaska has a relatively low risk for large economic losses from an earthquake. In contrast, a larger portion of California has more earthquake risk than any other state because of its frequent seismic activity, large population, and extensive infrastructure. However, on November 30, 2018, a magnitude 7.0 earthquake struck just north of Anchorage, AK, causing extensive damage.[4]

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).

On November 27, 2018, Congress passed the National Earthquake Hazards Reduction Program Reauthorization Act of 2018, and President Trump signed the bill into law on December 11 as P.L. 115-307. The new act combined two nearly identical bills, S. 1768 and H.R. 6650, introduced by Senator Feinstein and Representative Rohrabacher, respectively. Prior to passage of P.L. 115-307, Congress last made changes to NEHRP under the National Earthquake Hazards Reduction Program Reauthorization Act of 2004 (P.L. 108-360; 42 U.S.C. 7704).

The 2018 NEHRP reauthorization act largely leaves the overall program structure in place, but modifies some of the intents and purposes of the original legislation, such as removing references to the goal of earthquake prediction, and substituting instead the goal of issuing early warnings and earthquake alerts. The new law also authorizes appropriations for NEHRP activities for each of the four NEHRP agencies through FY2023. Authorization for appropriations under P.L. 108-360 expired in 2009; however, Congress continued to appropriate funds for NEHRP activities during the intervening nine years until enactment of P.L. 115-307.

[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). Large population centers would therefore be at a higher risk than small population centers for the same degree of earthquake hazard, in general. The original NEHRP legislation, arguably, mistakenly conflated the terms hazard and risk. More recently, the term *resilience* has been introduced in discussions regarding reducing earthquake risk (i.e., indicating improving resilience to earthquake hazards).

[2] The U.S. territories are not included in this assessment.

[3] State of Alaska, Alaska Seismic Hazards Safety Commission, "Earthquake Risk in Alaska," at http://seismic.alaska.gov/earthquake_risk.html.

[4] U.S. Geological Survey, *2018 Anchorage Earthquake*, https://www.usgs.gov/news/2018-anchorage-earthquake.

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 hazard 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 insoluble over time,[5] and NEHRP shifted its focus in 1990 to minimizing losses from earthquakes.

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

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 all existing federal buildings that were designed and constructed without adequate seismic design and construction standards.

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 an interagency coordinating committee and an advisory committee, both focused on earthquake hazard reduction.

Following enactment of P.L. 108-360, program activities focused on several broad areas:

- Developing effective measures to reduce earthquake hazards.
- Promoting the adoption of earthquake hazard reduction activities by federal, state, and local governments; by national building standards and model building code organizations; and by engineers, architects, building owners, and others who play a role in planning and constructing buildings, bridges, structures, and critical infrastructure or lifelines.[6]
- 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.
- Developing and maintaining the Advanced National Seismic System (ANSS) and the Global Seismic Network (GSN).[7]

[5] See, for example, U.S. Geological Survey (USGS), "Can You Predict Earthquakes?" at https://www.usgs.gov/faqs/can-you-predict-earthquakes?qt-news_science_products=0#qt-news_science_products.

[6] *Lifelines* are essential utility and transportation systems. Within the earthquake community, the term *lifelines* has generally given way to the term *lifeline infrastructure*. See the Earthquake Engineering Research Institute white paper, "Improve Reliability of Lifeline Infrastructure Systems," April 5, 2016, at https://www.eeri.org/wp-content/uploads/eeri-policy-lifelines.pdf.

[7] The Advanced National Seismic System is a nationwide network of seismographic stations operated by USGS. The

From FY2004 through FY2014, program activities also included the NSF-supported George E. Brown Jr. Network for Earthquake Engineering Simulation (NEES) that consisted 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. Prior to enactment of P.L. 115-307, NSF supported the successor to NEES, the Natural Hazards Engineering Research Infrastructure (NEHRI).[8]

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.[9] 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 for NEHRP. 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, with primary responsibility for NEHRP planning and coordination. NIST supports the development of performance-based seismic engineering tools, working with FEMA and other groups to promote the commercial application of the tools through building codes, standards, and construction practices.[10]
- FEMA assists other agencies and private-sector groups to prepare and disseminate building codes and practices for structures and lifeline infrastructure. FEMA also 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

Global Seismic Network is a global network of stations coordinated by the Incorporated Research Institutions for Seismology, a nonprofit organization.

[8] The Natural Hazards Engineering Research Infrastructure (NEHRI) is a distributed, multiuser, national facility that provides research infrastructure for the natural hazards research community, including earthquake and wind engineering experimental facilities, cyber infrastructure, computational modeling and simulation tools, and research data. Personal communication from Karen Pearce, senior legislative affairs specialist, NEHRI, October 6, 2017.

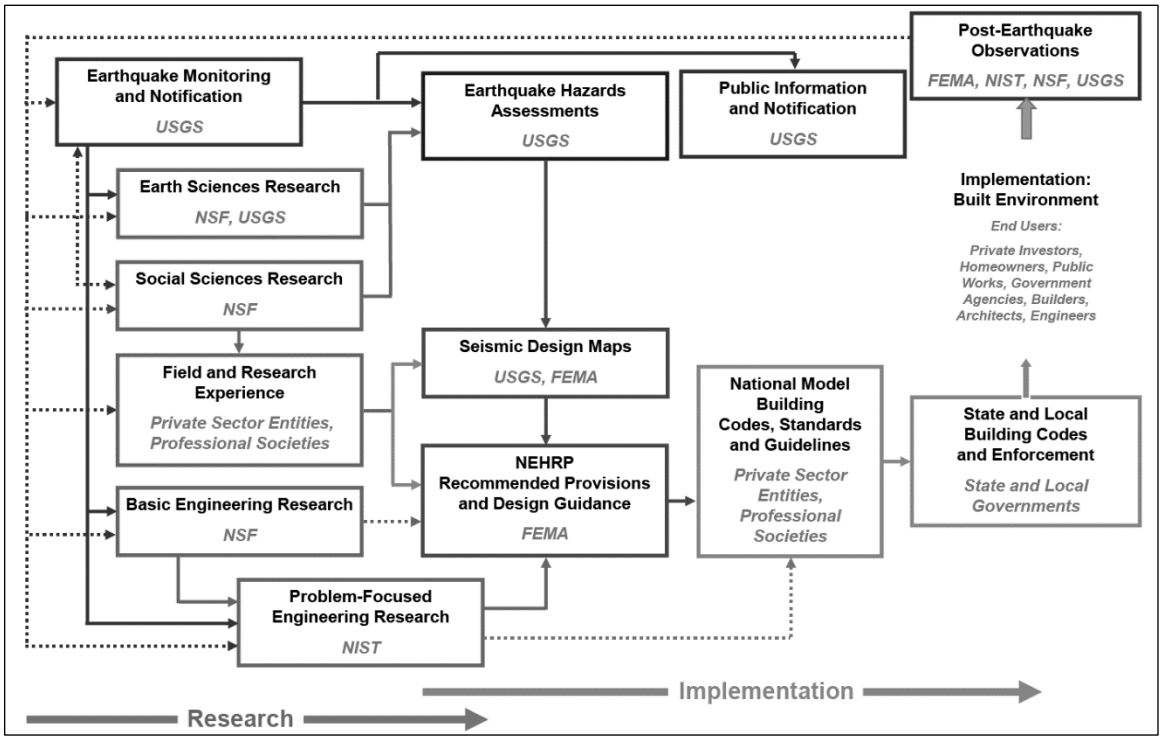
[9] U.S. House of Representatives, Committee on Science, *National Earthquake Hazards Reduction Program Reauthorization Act of 2003*, 108th Cong., 1st sess., H.Rept. 108-246 (August 14, 2003), p. 13.

[10] Building codes typically are developed by independent standards organizations, such as the International Code Council (ICC). According to the ICC, 50 states and the District of Columbia have adopted International Codes© developed by the ICC at the state or jurisdictional level. See https://www.iccsafe.org/about-icc/overview/about-international-code-council/.

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.

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



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 FY2018 (and the budget request for FY2019). Enacted appropriations for FY2005-FY2009 totaled $617.9 million, or 68% of the total amount of $902.4 million authorized in P.L. 108-360 over the five-year span (see **Table 1**). The new NEHRP reauthorization act authorizes a total of $760.3 million for NEHRP activities summed over the five-year span FY2019-FY2023, approximately $142 million less than total amount authorized by P.L. 108-360 (not adjusted for inflation).[11]

[11] In constant (2018) dollars, the difference between total authorized amounts over the five-year periods in P.L. 108-360 and P.L. 115-307 would be at least $330 million (using the U.S. Department of Labor, Bureau of Labor Statistics, CPI Inflation Calculator, https://www.bls.gov/data/inflation_calculator.htm).

Table 1. Enacted Funding for NEHRP Since Enactment of P.L. 108-360 Through FY2018 (Including the FY2019 Budget Request)

(in millions of current dollars)

		USGS	NSF	FEMA	NIST	Total
FY2005	Enacted	58.3	53.1	14.7	0.9	**127.0**
FY2006	Enacted	54.5	53.8	9.5	0.9	**118.7**
FY2007	Enacted	55.4	54.8	9.1	1.7	**121.0**
FY2008	Enacted	58.1	55.6	6.1	1.7	**121.5**
FY2009	Enacted	61.2	55.3	9.1	4.1	**129.7**
FY2010	Enacted	62.8	55.3	9.0	4.1	**131.2**
FY2011	Enacted	61.4	53.3	7.8	4.1	**126.6**
FY2012	Enacted	60.4	53.2	7.8	4.1	**125.5**
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	7.4	3.9	**127.9**
FY2016	Enacted	67.0	54.2	8.5	5.2	**134.9**
FY2017	Enacted	71.0	54.2	8.5	5.2	**138.9**
FY2018	Enacted	90.1	65.7	8.5	5.2	**169.5**
FY2019	Request	55.0	52.0	N/A	5.2	**112.2**[a]

Sources: NEHRP program office, 2005-2018 NEHRP Agency Budgets; 2019 Requested Funding for NEHRP Agencies (reported as of June 20, 2018), https://www.nehrp.gov/about/reports.htm.

Notes: According to the NEHRP program office, FEMA and NIST budgets are those agencies' allocations for NEHRP activities from the total agency appropriations through FY2018. The NSF budget is its expenditure for NEHRP activities from total agency appropriations through FY2018. NIST and NSF amounts for FY2019 are those agencies' planned allocations for NEHRP activities from total agency appropriations. The USGS-enacted funding reflects the amount appropriated for USGS NEHRP activities through FY2018, and the USGS amount for FY2019 is what was requested for USGS NEHRP activities. N/A means that the requested amount for FEMA was not available for FY2019 as of November 2018.

a. Total requested amount for FY2019 does not include the amount for FEMA, which is not available as of November 2018.

The NEHRP Reauthorization Act of 2018 (P.L. 115-307)

The 2018 NEHRP reauthorization act largely leaves the current four-agency NEHRP program intact, while providing some new areas of emphasis and specific authorization of appropriations levels for the member agencies. It is the product of two nearly identical bills: S. 1768, introduced by Senator Feinstein on September 6, 2017, with seven original cosponsors; and H.R. 6650, introduced by Representative Rohrabacher on August 3, 2018, with three original cosponsors.

Upon introduction, S. 1768 was referred to the Senate Committee on Commerce, Science, and Transportation, which held a markup on December 13, 2017. An amendment in the nature of a substitute, introduced by Senator Gardner, was accepted by the committee, the bill was reported favorably out of committee, and the Senate passed the bill by unanimous consent on September 27, 2018. Upon introduction, H.R. 6650 was referred to the House Science, Space, and Technology Committee; the House Natural Resources Committee; and the House Transportation

and Infrastructure Committee. The Senate-passed bill in its final form was nearly identical to H.R. 6650, and the House passed S. 1768 by unanimous consent on November 27, 2018. The bill became law on December 11, 2018, as P.L. 115-307).

The sections below discusses changes to the NEHRP program authorized by P.L. 115-307.

Changes to Findings, Purposes, Definitions (Section 2)

As noted above, NEHRP activities shifted long ago from a goal of earthquake prediction to earthquake hazard reduction. The 2018 NEHRP reauthorization act codifies that shift by removing references to earthquake prediction throughout the bill. For example, Section 2 modifies the congressional findings section (42 U.S.C. 7701) by omitting the linkage between seismological research and earthquake prediction, substituting the finding that "a well-funded seismological research program could provide the scientific understanding needed to fully implement an effective earthquake early warning system."[12] An earthquake early warning system would automatically send an alert to areas in danger of potential shaking after the earthquake is initially triggered. The alert would potentially allow components of the lifeline infrastructure,[13] such as electric utilities, railway systems, and even hospital operating rooms, to cease activities that could be impaired by violent shaking before the first earthquake-triggered surface waves reach them.

Section 2 of P.L. 115-307 also introduces the concept of *resilience* to earthquake hazards. For example, Section 2 cites a National Research Council study that includes goals and objectives for achieving national earthquake resilience.[14] Section 2 also amends the congressional statement-of-purpose section (42 U.S.C. 7702) to include the purpose of increasing the resilience of communities to future earthquakes in addition to the purpose of reducing the risks to life and property. The new act defines "community resilience" in the definitions section of the law (42 U.S.C. 7703) to mean "the ability of a community to prepare and plan for, absorb, recover from, and more successfully adapt to seismic events."

Section 2 of P.L. 115-307 also takes note of the aspect of resilience that includes design and construction of buildings so that those structures are built to potentially continue functioning, or to be reoccupied, in spite of earthquake damage. The act notes that the built environment historically has been constructed and maintained to prevent severe injuries or loss of life, but not necessarily to continue functioning or to be reoccupied without a complete reconstruction. Section 2 introduces the language of "re-occupancy, recovery, reconstruction" following an earthquake to capture this trend within the seismic resilience community.

The new act also adds the states of Oregon and Tennessee, together with the Commonwealth of Puerto Rico, to the 39 states previously identified as subject to major or moderate seismic risk (42 U.S.C. 7701).

[12] An early-warning system would send a warning after an earthquake occurred but before the damaging seismic waves reach a community that would be affected by the seismic waves. In contrast, an earthquake prediction would provide a date, time, and location of a future earthquake.

[13] P.L. 115-307 replaces the term *lifelines* with the term *lifeline infrastructure* wherever it appears in the *U.S. Code*.

[14] National Research Council, *National Earthquake Resilience, Research, Implementation, and Outreach*, 2011, http://www.nehrp.gov/pdf/nrc2011.pdf.

Changes to Program Activities and Agency Responsibilities (Section 3)

Within the four broad NEHRP program activities, Section 3 of P.L. 115-307 adds a new component to help promote earthquake hazards reduction. The act adds to the activities listed under 42 U.S.C. 7704(a)(2)(B) the requirement of "publishing a systematic set of maps of active faults and folds, liquefaction susceptibility, susceptibility for earthquake induced landslides, and other seismically induced hazards." If carried out, such a repository of maps could be considered an important tool for reducing earthquake risk by the spectrum of potential users at the federal, state, local, and tribal government level, as well as the developers of national building codes, developers, building owners, and others involved in planning and construction of the structural environment. It is not clear whether this new requirement would involve the compilation and organization of existing maps or the creation of new maps; either could represent a significant undertaking by the NEHRP agencies.

The new act inserts language to "continue the development of the Advanced National Seismic System [ANSS], including earthquake early warning capabilities," as part of 42 U.S.C. 7704(a)(2)(D). In addition, it deletes references to the George E. Brown Jr. Network for Earthquake Engineering Simulation.[15]

Section 3 also adds new duties for the Interagency Coordinating Committee. Under P.L. 115-307, the committee is required to develop a strategic plan for NEHRP, a management plan to implement the strategic plan, and a coordinated interagency budget on a biennial basis. The committee also is required to develop memoranda of understanding with any relevant federal agencies on data sharing and resource commitments in the event of an earthquake disaster. The act identifies the National Aeronautics and Space Administration and the National Oceanic and Atmospheric Administration as two agencies to coordinate with on data sharing and resource allocation "to ensure judicious use of Government resources and the free-flowing exchange of information related to earthquakes."

Further, the committee shall coordinate with the Secretaries of Agriculture and the Interior on the use of federal lands for monitoring, research, and data collection. The committee also is required to coordinate with the Secretaries of Transportation and Housing and Urban Development on the effects of earthquakes on transportation and building stocks (part of the lifeline infrastructure described above).

The new act requires that the NEHRP Interagency Coordinating Committee coordinate with its counterpart committee on Windstorm Impact Reduction, as well as other natural hazards coordination committees as determined appropriate, to share data and best practices.

NEHRP Agencies

Under P.L. 115-307, NIST would remain the lead agency for the program, with its duties and responsibilities largely unchanged. FEMA also retains most of its duties and responsibilities, with a few modifications. For example, the previous NEHRP authorization allowed FEMA discretion in entering cooperative agreements or contracts with states, local jurisdictions, or other federal agencies to establish demonstration projects on earthquake hazard modification, linking research and mitigation efforts with emergency management programs, or preparing educational materials for national distribution. Section 3 of P.L. 115-307 requires FEMA to enter cooperative

[15] In Section 8 (Technical Corrections) of P.L. 115-307, the act also deletes references in the U.S. code to the ANSS predecessor—the Advanced National Seismic Research and Monitoring System.

agreements or contracts for these purposes (substituting the word "shall" in the enacted language for the word "may" in preexisting law). Also, states that enter into these agreements would be required to provide a 25% cost share, unless FEMA lowers or waives the cost-share requirement. The act allows FEMA to reduce or waive the requirement for "a small impoverished community," as defined in Section 203 of the Disaster Relief Act of 1974 (42 U.S.C. 5133(a)).[16]

Statutory language requiring USGS to develop procedures for making earthquake predictions is removed under Section 3 and replaced with language for developing procedures for issuing alerts and early warnings. Further, P.L. 115-307 requires the USGS to issue an alert and an earthquake warning, when necessary and feasible, to FEMA, NIST, and state and local officials, in the event of an earthquake.

The new act strikes language in current law that requires NSF to support earthquake-related research using the George E. Brown Jr. Network for Earthquake Engineering Simulation (NEES), and instead refers generically to using "experimental and computational facilities." Also, Section 3 adds a new subsection to current law requiring NSF to identify and track grant funding that is part of the NEHRP program, and to provide a report at least every two years specifying the amount of NSF funding awarded to conduct research that enhances the understanding of earthquake science.

Review of NEHRP (Section 4)

Section 4 of P.L. 115-307 requires the Comptroller General of the United States to complete a review of federal earthquake hazard risk reduction efforts. The review and report from the Comptroller General on its findings must be completed within three years of enactment.[17]

The review requires discussion of the following elements:

- the extent to which the USGS has identified the risks and hazards to the United States posed by earthquakes, including risks and hazards resulting from tsunamis and landslides that are generated by earthquakes;
- the efforts of FEMA and NIST to improve the resilience of the United States to earthquakes and to identify important gaps in the resilience of the United States to earthquakes;
- progress made by NIST and the Interagency Coordinating Committee[18] in advancing the plans and goals of NEHRP and how coordination among the NEHRP agencies may be improved;
- the extent to which the results of research in earthquake risk and hazards reduction supported by NSF during the 40 years of NEHRP have been effectively disseminated to federal, state, local, and private-sector stakeholders; and
- the extent to which the research done under NEHRP has been applied to both public and private earthquake risk and hazards reduction.

[16] Commonly referred to as the Stafford Act.

[17] P.L. 115-307 requires the Comptroller General to submit the report to the Committee on Commerce, Science, and Transportation, the Committee on Energy and Natural Resources, and the Committee on Homeland Security and Governmental Affairs of the Senate; and the Committee on Science, Space, and Technology, the Committee on Natural Resources, and the Committee on Homeland Security of the House of Representatives.

[18] As defined in Section 4 of the Earthquake Hazards Reduction Act of 1977 (42 U.S.C. 7703).

The report also would include recommendations from the Comptroller General to improve NEHRP and the resiliency of the United States to earthquake risks.

Seismic Standards (Section 5)

Section 5 of P.L. 115-307 replaces language in current law (42 U.S.C. 7705b) that called for the adoption of seismic safety standards for buildings constructed or leased by the federal government. The new language requires, instead, an assessment and recommendations for improving the built environment and critical infrastructure specifically "to reflect performance goals stated in terms of post-earthquake reoccupancy and functional recovery time."

This language highlights one of the changes in overall NEHRP program direction to enhance the aspect of earthquake resilience, meaning building structures that would allow for continued use and reoccupancy following an earthquake. The assessment and recommendations would come from a committee of experts, appointed by the Director of NIST and Administrator of FEMA, representing federal agencies, nongovernmental organizations, the private sector, disaster management associations, engineering associations, and construction and homebuilding industry associations. Under P.L. 115-307, the committee is required to submit a report to Congress with recommended options no later than June 30, 2020.[19]

Management Plan for Advanced National Seismic System (ANSS) (Section 6)

The ANSS is a nationwide network of seismographic stations operated by USGS. It consists of a "backbone" network of about 100 seismic stations throughout the United States, the National Earthquake Information Center, the National Strong Motion Project, and 15 regional seismic networks operated by USGS and partner institutions.[20] The new act requires a new five-year management plan for ANSS, which includes the following elements:

- strategies to continue developing an earthquake early warning system;
- a mechanism for securing participation of state and regional earthquake monitoring entities in ANSS, including those defunded by ANSS during the past five years;
- a plan to encourage and support integration of geodetic and geospatial data products into monitoring activities in earthquake-prone regions;
- a plan to identify and evaluate existing data sets available across commercial, civil, and defense entities to determine if there are additional data sources to inform the development and deployment of ANSS and an earthquake early warning system; and
- a plan to ensure a geographically diverse management and advisory structure for ANSS.

The five-year management plan is due within one year of enactment.

[19] For the Senate, the report would go to the Committees on Commerce, Science, and Transportation; Energy and Natural Resources; and Homeland Security and Governmental Affairs. For the House, the report would go to the Committees on Science, Space, and Technology; Natural Resources; and Homeland Security.

[20] For more information, see U.S. Geological Survey, Earthquake Hazards Program, *ANSS—Advanced National Seismic System*, at https://earthquake.usgs.gov/monitoring/anss/.

Authorization of Appropriations (Section 7)

Section 7 of P.L. 115-307 authorizes appropriations for NEHRP activities over a five-year period, FY2019-FY2023. The new act apportions the same authorized amount per agency each year. The total authorization is broken down by agency as follows:

- USGS—$83.4 million per year, $417 million total;[21]
- NSF—$54 million per year, $270 million total;
- FEMA—$8.76 million per year, $43.8 million total;
- NIST—$5.9 million per year, $29.5 million total.

The total five-year NEHRP authorization of appropriations is $760.305 million for FY2019-FY2023, or about $152 million annually. The findings section (Section 2) of P.L. 115-307 recognizes that the National Research Council in 2011 recommended funding of approximately $300 million annually for 20 years (in 2009 dollars).[22] That value is about twice the average annual amount authorized for appropriations in P.L. 115-307.

Outlook

At present, earthquakes cannot be accurately predicted. For example, although historically Alaska has experienced a magnitude 7 earthquake nearly every year, it has proved impossible to predict exactly when and where an earthquake will occur. The November 30, 2018, Anchorage earthquake was no exception, although as the most earthquake-prone state, Alaska has a relatively high probability of experiencing earthquakes every year compared to many other western states.

In its 1990 reauthorization, NEHRP shifted its program emphasis from prediction to hazards 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. The National Earthquake Hazards Reduction Program Reauthorization Act of 2018 (P.L. 115-307) leaves the program largely intact, while emphasizing activities to promote greater resilience to earthquakes and activities that would enhance the effectiveness of an earthquake early warning system, among other changes. The new act authorizes annual appropriations levels for NEHRP at slightly higher levels than the amount of enacted appropriations for the program in FY2017, but slightly lower than the amount enacted in FY2018. P.L. 115-307 also removes statutory language regarding earthquake prediction.

Since NEHRP shifted its emphasis toward reducing losses during an earthquake, one persistent question has been how to establish a more precise relationship between NEHRP activities and reduced earthquake risk and actual losses from earthquakes. Section 4 of P.L. 115-307 appears to address that question by requiring the Comptroller General of the United States to review the

[21] P.L. 115-307 requires that $30 million of the annual authorized amount for the USGS be made available for completion of the ANSS.

[22] National Research Council, *National Earthquake Resilience, Research, Implementation, and Outreach*, 2011, p. 4, http://www.nehrp.gov/pdf/nrc2011.pdf.

activities of the program and produce a report for Congress that addresses the earthquake risks and hazards in the nation. The review and report are to examine how federal activities are

addressing those risks and hazards, including how states, tribes, and local governments are using NEHRP-generated information and implementing measures to reduce their earthquake risk.

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