Craig Burkhardt
Deputy Under Secretary of Commerce for Standards and Technology
Deputy Director, National Institute of Standards and Technology (NIST)
Chair, Interagency Coordinating Committee on Earthquake Hazards Reduction (ICC)
100 Bureau Drive, Gaithersburg, MD 20899

Dear Mr. Burkhardt,

The Advisory Committee on Earthquake Hazards Reduction (ACEHR) is authorized by Section 103 of the National Earthquake Hazards Reduction Program (NEHRP) Reauthorization Act of 2004 (Public Law 108-360), codified at 42 U.S.C. § 7704(a)(5), and was established pursuant to the Federal Advisory Committee Act, as amended (5 U.S.C. App.). ACEHR members are non-Federal volunteers serving three-year terms and represent a broad cross-section of research and academic institutions, earthquake-related professions, and state and local governments. The Committee is charged with assessing (1) trends and developments in the science and engineering of earthquake hazards reduction; (2) the effectiveness of NEHRP; (3) any need to revise NEHRP; and (4) the management, coordination, implementation, and activities of NEHRP.

We are pleased to submit our FY24–25 biennial report to you in your capacity as Deputy Director of NIST and Chair of the ICC. This report is also directed to the NEHRP Office within NIST and to the four NEHRP agencies—FEMA, NIST, NSF, and USGS. The report includes two recommendations:

1. **The development and implementation of a NEHRP Management Plan**; and
2. **A comprehensive review of ACEHR recommendations issued since 2008 to support the establishment of a systematic process for evaluating past recommendations and facilitating more targeted agency action and reporting**.

ACEHR appreciates the sustained commitment and responsiveness of the NEHRP agencies over the past two years. We extend our sincere thanks to the Acting NEHRP Director and the agency representatives for their collegial engagement and for providing timely, transparent updates on agency activities. We are encouraged by continued momentum related to the FY22–29 NEHRP Strategic Plan (NEHRP, 2023). ACEHR fully supports the Plan's goals and objectives and strongly affirms the value of developing an accompanying Management Plan. Such a plan is essential for translating strategic priorities into operational actions, promoting cross-agency accountability, and addressing the 2022 Government Accountability Office (GAO) recommendations concerning performance metrics and strategic alignment of resources.

We recognize that recent and potential changes in staffing levels, funding, and institutional knowledge may substantially affect the

ACEHR supports the passage of S.320, the National Earthquake Hazards Reduction Program (NEHRP) Reauthorization Bill. Its enactment would signal continued national commitment to NEHRP's vital mission and reauthorize program funding through FY28—ensuring the ongoing development of the tools, research, and capabilities necessary to enhance the Nation's earthquake resilience.

implementation of our recommendations and the goals, objectives, and focus areas of the Strategic Plan. Their success is **contingent on sustained staffing** and **adequate resource support**.

Finally, we acknowledge with deep appreciation Ms. Tina Faecke, whose decades of service to NIST and NEHRP culminated in her impactful tenure as ACEHR's Designated Federal Officer (DFO). Her institutional knowledge, integrity, and unwavering support to the Committee were extraordinary, and her legacy of public service stands as a model of excellence.

As always, ACEHR stands ready to support NEHRP and the ICC in advancing the goals of national earthquake resilience. We respectfully submit this report with the full endorsement of the Committee and hope it proves a useful resource in your continuing leadership of NEHRP.

Dr. Lucy A. Arendt, Chair of ACEHR (Donald J. Schneider School of Business & Economics, St. Norbert College, De Pere, WI)

Members, Advisory Committee on Earthquake Hazards Reduction (ACEHR)

1. Dr. Laurie Baise (Department of Civil and Environmental Engineering, Tufts University, Medford, MA)
2. Dr. Ann Bostrom (Daniel J. Evans School of Public Policy & Governance, University of Washington, Seattle, WA)
3. Mr. Jeff Briggs (Missouri State Emergency Management Agency, Jefferson City, MO)
4. Mr. Robert Carey (Utah Division of Emergency Management, Salt Lake City, UT)
5. Mr. David W. Cocke (Structural Focus, Gardena, CA)
6. Dr. Rachel A. Davidson (Department of Civil, Construction, and Environmental Engineering, University of Delaware, Newark, DE)
7. Dr. Michael W. Hamburger, ex-officio, Chair of SESAC (Earth and Atmospheric Sciences, Indiana University, Bloomington, IN)
8. Mr. Thomas F. Heausler (Consulting Structural Engineer, Bay Saint Louis, MS)
9. Dr. Tara Hutchinson (Department of Structural Engineering, University of California, San Diego, CA)
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12. Dr. Jonathan P. Stewart (Civil and Environmental Engineering, University of California, Los Angeles, CA)
13. Dr. Douglas Wiens (Dept of Earth, Environmental & Planetary Sciences, Washington University, St. Louis, MO)

Enclosure

Advisory Committee on Earthquake Hazards Reduction (ACEHR)

Biennial Report | FY24-25 | June 4, 2025

National Earthquake Hazards Reduction Program (NEHRP)

Advancing earthquake science
Developing practices for earthquake risk reduction
Promoting resilience strategies
Leveraging post-earthquake insights

Photo Sources: L. A. Arendt, T. C. Hutchinson

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ACKNOWLEDGEMENTS

The members of ACEHR are fortunate to collaborate closely with many exceptional individuals. We appreciate their passionate commitment to NEHRP and their tireless efforts to educate the members of ACEHR about NEHRP and the work of their agencies. These individuals, members of the Program Coordination Working Group (PCWG), are true public servants, dedicated to ensuring the achievement of NEHRP's mission.

1. John (Jay) L. Harris, Acting NEHRP Director, NIST
2. Siamak Sattar, NIST
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11. Jonathon Foster, FEMA
12. Andrew Herseth, FEMA
13. Bill R. Blanton, FEMA (retired)

ACEHR wishes to highlight the outstanding support provided by Ms. Tina Faecke, a long-time NIST employee and recently retired Designated Federal Officer (DFO) for ACEHR. We are grateful to Tina for her willingness to share her vast institutional knowledge, her sharp insights, and her logistical expertise. We are also grateful for Tina's authentic leadership, her generosity of spirit, her genuine care for everyone in her orbit, including all members of the public, and her remarkable loyalty and commitment to selfless service.

EXECUTIVE SUMMARY

Earthquake mitigation is not a discretionary investment. It is a societal and economic imperative. Every dollar spent today prevents exponentially greater losses tomorrow—measured not only in property, but in lives and livelihoods. NEHRP represents one of the best returns on federal investment, and its continued strength is essential to a safer, more resilient United States. To sustain its effectiveness, the NEHRP agencies (FEMA, NIST, NSF, USGS[1]) must have adequate staffing, funding continuity, and active leadership support. Recent changes and proposed actions to reduce funding, staff support, and freeze new hiring slow the pace of learning and innovation and threaten NEHRP's ability to deliver on its mission to protect the Nation.

Earthquakes are among the most complex and consequential natural hazards. Their sudden onset, often without meaningful warning, can cause cascading damage—destroying homes, disrupting lifeline infrastructure[2], compromising critical services, and inflicting deep psychological and economic trauma. Events such as the 2023 Türkiye earthquake and the 2024 New Jersey earthquake are stark reminders that both tectonic complexity and societal vulnerability drive the impacts of earthquake events. The United States, one of the most earthquake-prone nations on Earth, faces widespread risk: over 75% of the population lives in areas vulnerable to damaging ground shaking (National Seismic Hazard Model, 2023).

In the U.S., earthquakes do not discriminate by geography, as they occur all over the nation. From subduction zones in Alaska and the Pacific Northwest to intraplate faults in the Central and Eastern U.S. (CEUS), from the San Andreas Fault to the Wasatch, from Los Angeles to Memphis to Salt Lake City—earthquake threats are national in scope. Understanding them also spans multiple domains of expertise. Addressing these risks requires collaboration among engineers, architects, earth scientists, emergency managers, public officials, economists, and other social scientists. The human and financial stakes demand it.

Since 1977, the National Earthquake Hazards Reduction Program (NEHRP) has been the federal government's coordinated strategy to confront earthquake risk throughout the Nation. NEHRP's strength lies in its interagency structure—uniting FEMA, NIST, NSF, and USGS—and in its enduring commitment to science-based, cost-effective solutions. Through NEHRP, Americans have benefitted from improved seismic monitoring, stronger building codes, early warning systems, functional recovery guidelines, and evidence-informed planning tools such as HAZUS (2023). These achievements are not theoretical. They are

[1] FEMA: Federal Emergency Management Agency, NIST: National Institute of Standards & Technology, NSF: National Science Foundation, USGS: United States Geological Survey

[2] Lifeline infrastructure typically includes electric power systems; water supply and wastewater systems; natural gas and liquid fuel systems; transportation systems; telecommunications; and emergency services

lifesaving. For example, communities adopting modern codes supported by NEHRP are avoiding an estimated $1.6 billion in annual damages, with projected savings of $132 billion through 2040. NEHRP's leadership at the federal level makes possible the success of earthquake risk reduction efforts at the local, state, Tribal, and territorial levels. NEHRP plays a vital role in advancing national earthquake resilience by uniting the scientific expertise, financial resources, and institutional coordination that local, state, Tribal, and territorial governments alone cannot marshal. Its unique federal mandate enables it to address the most complex seismic challenges at a scale and depth beyond the reach of individual jurisdictions.

Despite this progress, the work is far from finished. Earthquake risk continues to evolve due to population growth, aging infrastructure, induced seismicity linked to energy development, and new scientific insights into previously unrecognized hazards. For instance, over 600 earthquakes have occurred in Texas in just the past three years, six of which exceeded magnitude 5. New studies also reveal a 70% chance of a major earthquake in the San Francisco Bay Area in the next 30 years, and a nearly 50% chance along the Wasatch Fault in Idaho and Utah.

Recognizing the enduring danger and opportunity for action, NEHRP released its FY22–29 Strategic Plan in 2023, outlining four key goals:

1. Advance understanding of earthquake processes and consequences
2. Develop tools and practices for risk reduction
3. Promote implementation of resilience strategies
4. Leverage lessons from post-earthquake investigations

The Advisory Committee on Earthquake Hazards Reduction (ACEHR), an independent body established by Congress, offers this FY24-25 Biennial Report as an assessment of NEHRP's progress and a call to action.

Besides highlighting agency achievements in research, development, and implementation for FY24-25, this report emphasizes that the NEHRP Strategic Plan's promise depends on its implementation. A well-constructed **Management Plan** is urgently needed to operationalize strategic goals, track outcomes, and allocate agency responsibilities. ACEHR calls on the Interagency Coordinating Committee (ICC) to provide the sustained support and resources required to develop and execute this Management Plan. ACEHR also recommends that NEHRP Program Leadership and the Program Coordination Working Group (PCWG) continue to support and prioritize the **review, and as appropriate, implementation of ACEHR's recommendations** from 2008 through FY22–23, and work to establish an ongoing, systematic process for evaluating these recommendations moving forward.

Summary of Recommendations

What follows is a "shorthand" list of the two new recommendations provided in this report. The rationale for each recommendation is presented in the **ACEHR Recommendations to NEHRP** section, with recommendations numbered as follows. Fulfilling these recommendations will necessitate adequate staffing, sufficient funding, and strong leadership support.

Recommendation 1: Develop and implement the **NEHRP Management Plan** in support of the FY22-29 NEHRP Strategic Plan.

Recommendation 2: That the NEHRP Program Leadership and Program Coordination Working Group (PCWG) work with ACEHR to continue its **review of previous recommendations** (2008-2023) for those that should be "re-implemented," "fully implemented," or set aside, and to create a systematic process for conducting such reviews in the future.

INTRODUCTION

> *"When you're talking about earthquake mitigation you're talking about lives you're saving. That's where the real value is:* ***You're protecting lives****."*
>
> *— Kit Miyamoto, Global CEO, Miyamoto International*

The National Earthquake Hazards Reduction Program (NEHRP, the Program), created in 1977 and reauthorized in 2018, represents a smart, efficient, and forward-thinking investment in national safety. By supporting science-based research, risk reduction strategies, and public education, NEHRP helps communities avoid catastrophic losses during earthquakes. As members of ACEHR (the Committee), we know that this federal program has already saved billions of dollars in avoided losses, and continuing to support it is a matter of national resilience and security. While local, state, Tribal, and territorial governments each have a role to play with respect to earthquake risk reduction, NEHRP's research-to-practice pipeline and leadership is the foundation upon which rests the effectiveness of these other levels of government.

The Role of Artificial Intelligence in Advancing NEHRP's Mission

As artificial intelligence (AI) technologies rapidly evolve, they present powerful opportunities to continue strengthening NEHRP's capabilities across science, engineering, and implementation domains. AI can enhance seismic hazard modeling by identifying complex patterns in geophysical data. Machine learning algorithms can optimize structural design and retrofitting strategies by simulating thousands of earthquake scenarios and rapidly analyzing building performance. AI also has the potential to streamline post-earthquake damage assessments through drone imagery and automated image recognition, accelerating recovery efforts and informing future mitigation policies. In the social sciences, AI tools can uncover behavioral and demographic patterns that inform more effective public education and risk communication strategies. To fully leverage these advances, NEHRP agencies need to invest in technical capacity, cross-disciplinary collaboration, and responsible data governance to ensure that AI tools are transparent, equitable, and grounded in scientific rigor.

In accordance with its charter, ACEHR members "reflect the wide diversity of technical disciplines, competencies, and communities involved in earthquake hazards reduction. Members are drawn from industry and other communities having an interest in the Program, such as, but not limited research and academic institutions, industry standards development organizations, state and local governments, and financial communities who are qualified to provide advice on earthquake hazards reduction, and represent all related scientific, architectural, and engineering disciplines" (2018, p.2). ACEHR's members are volunteer subject matter experts, independent of NEHRP.

In its advisory role, ACEHR provides a biennial assessment of NEHRP. Specifically, ACEHR assesses (1) the effectiveness of NEHRP in performing its statutory activities; (2) its management, coordination, implementation, and activities; and (3) developments in the science and engineering of earthquake risk reduction. This is the ACEHR Report for FY24-25. While one more quarter remains in FY24–25, and additional agency achievements are likely, this report reflects our confidence that it captures the spirit and substance of NEHRP's accomplishments during the biennium. The report conveys the overarching progress, priorities, and impact of the Program across its core mission areas.

Mitigation Pays Dividends

The NEHRP Reauthorization Act of 2018 (PL 115-307 or the Act) was an important milestone for the nation. Since NEHRP was enacted in 1977, there has been significant progress by each of the four NEHRP agencies (FEMA, NIST, NSF, and USGS) toward advancing the objectives of NEHRP. The agencies work together to improve the Nation's understanding of earthquake hazards and to **mitigate** their effects. The missions of the four agencies are **complementary.** The agencies **work together** to improve our understanding and

characterization of hazards and vulnerabilities; "improve model building codes and land use practices; reduce risks through post-earthquake investigations and education; improve design and construction techniques; improve the capacity of government at all levels and the private sector to reduce and manage earthquake risk; and accelerate the application of research results" (NEHRP About Us, 2021). NEHRP's research-to-practice pipeline is a model for inter-agency collaboration.

The Program's four strategic goals are described in its FY22-29 Strategic Plan. They include (1) **advancing** our understanding of earthquake processes and their consequences; (2) **enhancing** existing and developing new information, tools, and practices for protecting the nation from earthquake consequences; (3) **promoting** the dissemination of knowledge and implementation of tools, practices, and policies that enhance strategies to withstand, respond to, and recover from earthquakes; and (4) **learning** from post-earthquake investigations to enhance the effectiveness of available information, tools, practices, and policies to improve earthquake resilience. Together, the agencies have made and continue to make consistent strides toward achieving these goals.

Despite the progress made in the U.S., earthquakes still pose a substantial threat. All 50 states and five inhabited U.S. territories are vulnerable to earthquakes. In 2015, the United States Geological Survey (USGS) estimated that nearly half of all Americans were exposed to potentially damaging earthquakes (Jaiswal et al., 2015). However, the scope of risk is even more widespread than commonly understood (Fig. 1).

According to the USGS description of the latest (2023) National Seismic Hazard Model,

- *Risk to People*: With approximately 75% of U.S. land potentially endangered by damaging earthquakes, more than half of the U.S. population is at risk.

- *Widespread Hazard*: Historical data indicate that 37 U.S. states have experienced earthquakes of magnitude 5 or greater over the past two centuries, highlighting the extensive earthquake activity nationwide.

Enabling effective **mitigation** through research and practice is a major element of what NEHRP does. While we cannot prevent earthquakes from occurring, we can mitigate their effects.

For example, we know from previous earthquakes in the United States and elsewhere that a large earthquake in a major urban center could cause thousands of casualties, widespread population displacement and social disruption, and economic upheaval that would cascade across the country. In regions with lower earthquake activity, it may be easier to ignore this risk, but the long-term, **real costs** of inaction—lost lives, devastated infrastructure, and prolonged economic recovery—far exceed the investments required for preparedness.

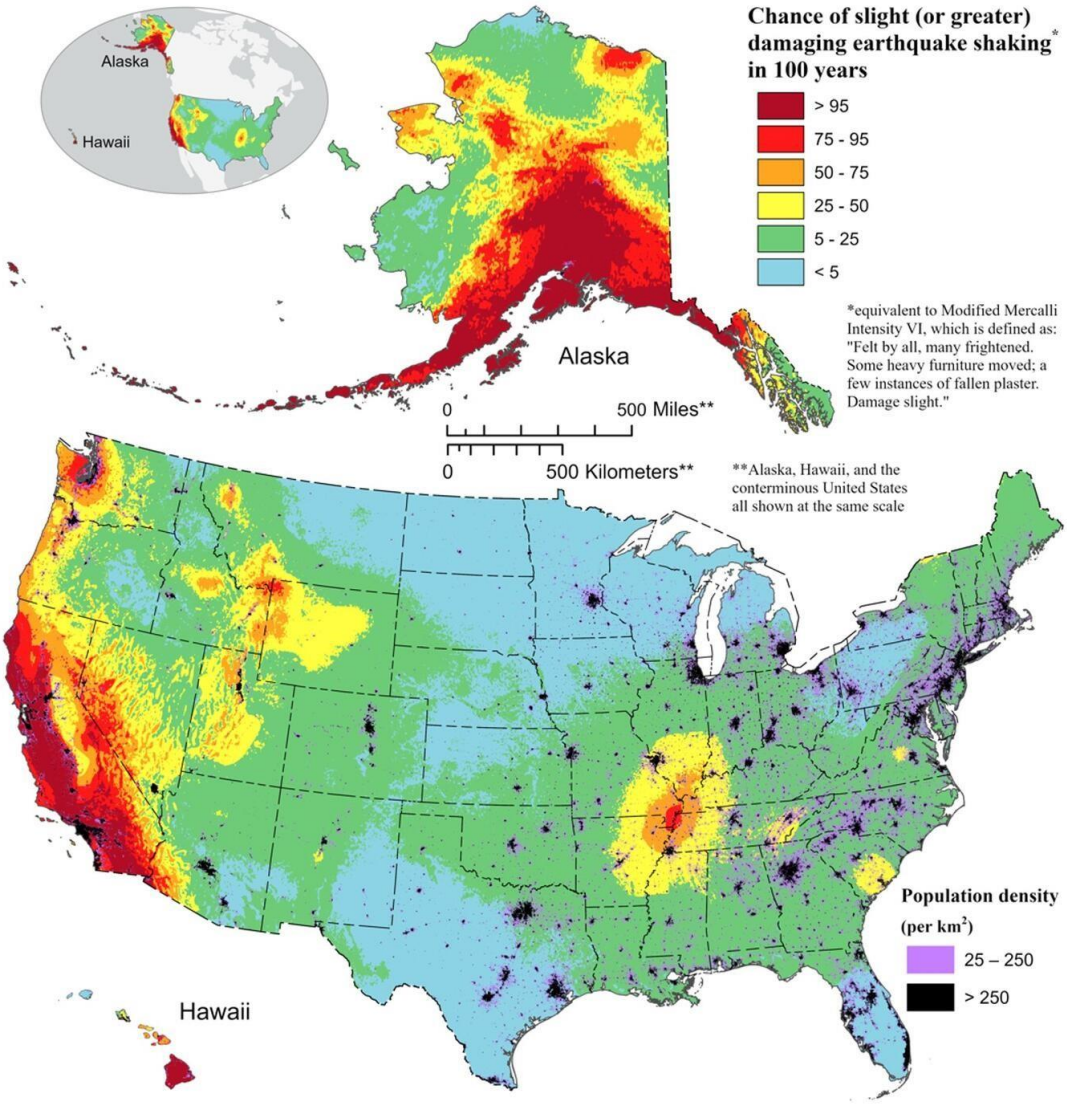

Fig. 1. National Seismic Hazard Model (NSHM, 2023). Map displays the likelihood of damaging earthquake shaking in the United States over the next 100 years.
(Source: https://www.usgs.gov/news/national-news-release/new-usgs-map-shows-where-damaging-earthquakes-are-most-likely-occur-us)

Knowing we can reduce the costs associated with earthquakes means we must do everything in our power to achieve this end. We are fortunate to have NEHRP bridging the gap between knowledge and action. The groundbreaking research and implementation of knowledge into practice conducted or facilitated by the NEHRP agencies enables federal, state, local, Tribal, and territorial agencies and organizations to prioritize **proactive** rather than reactive measures. One of NEHRP "superpowers" is effectively engaging and collaborating with the broader community, beyond the federal government, to achieve its goals.

A 2019 study by the National Institute of Building Sciences (NIBS) found that every $1 spent on earthquake mitigation saves society roughly $3 (Multi-Hazard Mitigation Council, 2019). Specifically, federally funded earthquake hazard mitigation grants between 1993 and 2016 saved society $5.73 billion at a cost of only $2.2 billion—a benefit-cost ratio of approximately 3 to 1. These returns are from avoided damage (26%), reduced casualties (19%), and fewer business disruptions and loss of services (55%). Importantly, this data comes from a period with relatively moderate earthquake activity—indicating that benefits could be significantly higher when major earthquakes strike the United States in the future.

We know that risk mitigation, enabled by advances in earthquake science and engineering, can save the lives and livelihoods of men, women, and children—whether asleep in their homes, at work, in school, or wherever they find themselves during an earthquake. Video and still photos from recent earthquakes, such as the 2023 earthquake in Türkiye, make clear the devastation and overwhelming sorrow that accompany the collapse of buildings and the lack of basic intended function that impedes continued use of buildings, sending people into temporary shelters that provide little in the way of the security offered by their own homes, workplaces, and schools. This perspective highlights a **societal imperative** to study and learn from earthquakes, and to develop and share tools that empower people to mitigate their risks from earthquakes.

MITIGATION PAYS DIVIDENDS!

Recent global earthquakes—like those in Mandalay, Burma (Myanmar), Türkiye, Syria, Morocco, and Taiwan—illustrate the tragic cost of unpreparedness. The U.S. must continue to learn from these events—especially where similarly vulnerable building types exist in seismically active areas here at home. Given the long intervals between major domestic earthquakes, it is essential to have the staffing and resources needed to conduct in-person post-earthquake reconnaissance, thereby ensuring that both the science and practice of earthquake resilience continue to evolve. This is the prerequisite to being prepared as a Nation. While this was possible with the Türkiye earthquake, it was not with the 2025 earthquake in Mandalay, Burma (Myanmar) due to a Level 4 (Do Not Travel) advisory negatively affecting the deployment of federal resources as well as uncertainty around the availability of needed resources in the field. This is unfortunate in that it we were not able to further advance our understanding of earthquakes and mitigation practices.

Earthquakes in the U.S. affect all citizens, directly or indirectly. Earthquake preparedness is not only about safety; it's also about ensuring citizens can return to their homes, jobs, and schools after disaster. Learning that is acquired and coordinated at the federal level and distributed and implemented at the local, state, Tribal, and territorial levels is essential to ensuring mitigation's effectiveness and efficiency.

Managing NEHRP in Uncertain Times

While the future of any enterprise is inherently uncertain, much of organizational life typically follows relatively stable and predictable patterns. Occasionally, however, these patterns are disrupted by periods of instability and change that must be navigated with care and resilience. What follows is ACEHR's assessment of NEHRP's current state and its aspirations for the Program's future.

Since early 2025, NEHRP has experienced an unprecedented level of administrative and organizational uncertainty, driven by the speed and scope of numerous changes. This turbulence has inevitably slowed innovation and delayed the completion of some critical agency activities. Some grant deadlines have been postponed or canceled, and ongoing position restructurings have compelled staff to continually shift responsibilities. Hiring freezes have impeded the recruitment of essential personnel needed to carry out both current and planned projects. The voluntary and involuntary departures of key staff have resulted in significant losses of institutional knowledge, while leadership transitions have further delayed decision-making. Persistent funding uncertainty has hampered long-term planning efforts. For NEHRP to continue fulfilling its vital mission of reducing the Nation's vulnerability to earthquake hazards, greater stability and clarity are urgently needed.

Amid these challenges, NEHRP staff remain deeply committed to the Program's goals. They are pragmatic with respect to the challenges they are facing and are maintaining a positive, can-do approach to their work. While ACEHR affirms this dedication, we also must emphasize that **the current level of uncertainty is unsustainable**. The Committee remains hopeful that a more stable and supportive environment will soon emerge, enabling NEHRP to regain its momentum and continue advancing national resilience.

NEHRP ACHIEVEMENTS (FY24-25)

Despite recent challenges, the NEHRP agencies continue to put in their best work. While ACEHR is confident that the agencies will achieve more in the last quarter of FY24-25 than is reported here, the highlights on the next 17 pages capture the outstanding work ethic and commitment of NEHRP and its four agencies to its mission and goals.

Collaboration between and among the four NEHRP agencies is their *modus operandi*. While all four agencies can boast plenty of accomplishments for the past two years, the overarching focus on understanding and mitigating the effects of earthquake hazards is their collective *raison d'etre*. This formal collaboration allows for resource sharing and optimization, which is important to both the development and implementation of innovative solutions with positive benefit-cost ratios. Continuing efforts to collaborate and learn from each other are expected to best serve the nation as the NEHRP agencies tackle

complex problems, all of which require multi-faceted solutions developed by multidisciplinary teams of subject matter experts. One critical mechanism for maintaining and enhancing the agencies' collaborative focus is the FY22-29 NEHRP Strategic Plan (NEHRP, 2023). Another mechanism enabling collaboration is the PCWG and its monthly meetings.

Events in the last several years have challenged the NEHRP agencies to retain their collaborative ethos and continue producing their best work. The COVID-19 pandemic, coupled with the increasing frequency and severity of other natural hazards such as tornadoes and wildfires, has shifted national attention away from earthquake risk. This shift is further reinforced by the passage of time since the last major, high-casualty U.S. earthquake—the 1994 Northridge event—now more than three decades in the past. At the same time, persistent competition for limited human and financial resources has strained the capacity of the NEHRP agencies.

Despite these difficulties, NEHRP agencies have responded with resilience—demonstrating innovation, deepening interagency collaboration, and making difficult but strategic resource allocation decisions to continue advancing the mission.

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Each of the NEHRP agencies makes unique contributions to NEHRP as part of its research-to-practice pipeline. NSF drives the scientific and academic foundation of NEHRP by supporting long-term research and training the next generation of earthquake professionals. USGS supports applied research in earthquake science and engineering and is NEHRP's source for authoritative seismic hazard data and monitoring, supplying the scientific information that underpins risk assessments and mitigation planning. NIST serves as NEHRP's technical backbone and leader, advancing engineering knowledge and ensuring that codes and standards evolve based on scientific evidence. FEMA brings NEHRP into action at the community level by helping jurisdictions reduce risk and build resilience through practical implementation and capacity-building.

While there are numerous examples of outstanding collaboration between these four NEHRP agencies, this report calls out three of these. In each case, the research-to-practice pipeline is evident.

One especially impactful example of full agency collaboration is the process that leads to the *NEHRP Recommended Seismic Provisions for New Buildings and Other Structures* (FEMA P-2082-1, 2020), which is the **preeminent seismic guidelines** document in the US, serving (among other applications) as the basis for periodic updates to building codes. The *Provisions* are drafted by a Provisions Update Committee (PUC) that has historically been supported by FEMA through a contract with the National Institute for Building Sciences. The PUC consists of national experts on a range of topics who work at essentially no cost. One of the key issues addressed in each cycle is the onboarding of new structural systems, which

requires demonstrations of performance using procedures in FEMA P-58, an effort supported by FEMA via the Applied Technology Council (ATC).

Another critical issue addressed in each cycle by the PUC is the generation of maps used to set design ground motions, which are based on the USGS NSHM. NIST provides in-kind support for a wide range of topics considered by the PUC, with their research results often forming the basis for change proposals including contributions to functional recovery (discussed next). NSF supports basic science and engineering research at universities, which facilitates the practical work advances from USGS and NIST. NSF also provides critical support for NHERI (Natural Hazards Engineering Research Infrastructure) cyber infrastructure and post-earthquake reconnaissance that enables the collection of perishable data.

A second example of collaboration is the continuing **functional recovery** work supported by both NIST and FEMA. Life safety alone is no longer considered sufficient by many involved in developing building codes; likewise, citizens expect better performance from their buildings, especially new ones. The two agencies were originally tasked in the 2018 NEHRP reauthorization language with jointly convening a Committee of Experts to develop the "Recommended Options for Improving the Built Environment for Post-Earthquake Reoccupancy and Functional Recovery Time" (FEMA P-2090/NIST SP-1254, 2021) report to Congress. The agencies played complementary roles in establishing the Project Technical Committee, which developed the report, and the Project Review Committee which vetted it.

Both agencies continue to support this critical topic, through leadership and participation in the Provisions Update Committee's (PUC) Functional Recovery Task Committee and its six Topic Subcommittees. The agencies' ongoing work on functional recovery, including basic research, stakeholder workshops, and involvement in the provisions and code development process, is essential to community resilience throughout the nation. The development of a functional recovery methodology was initially developed under a NIST-funded grant to researchers at the University of Colorado Boulder and Texas A&M University, based on the FEMA P-58 computational platform and underlying data. This initial method has since been vetted and further developed under the ATC-138 Project and is currently being incorporated into the FEMA P-58 (Performance Based Design) methodology.

A third example of collaboration involves **post-earthquake investigations**. A recent product of this collaboration is USGS Circular 1542, "Plan To Coordinate Post-Earthquake Investigations Supported by the National Earthquake Hazards Reduction Program" (USGS, 2024), which supersedes USGS Circular 1242, published in 2003. The second-generation Plan was developed with the assistance of ATC. A 17-member Project Review Panel provided guidance on plan development, and input was solicited from subject matter experts representing key stakeholder groups and from participants at a public workshop. While all four NEHRP agencies participated in the development and vetting of the Plan and all four are engaged in the execution of the Plan, USGS is the lead NEHRP Agency for

activating and coordinating NEHRP pre-event and post-earthquake investigations and for implementing Circular 1542.

As described on the USGS website, "Post-earthquake scientific and engineering investigations are undertaken to capture critical information to understand the causes and impacts of the event, lessons from which can substantially improve the Nation's resilience after future earthquakes … The Plan describes coordination between NEHRP Agencies and other organizations that may participate in pre-event and post-earthquake investigations. The Plan delineates the coordination of NEHRP post-earthquake scientific and engineering investigations to document the direct, indirect, and cascading physical and societal impacts from fault rupture and ground shaking hazards and from secondary hazards such as landslides, liquefaction, and tsunamis."

Notably, the report also serves as a guide for NEHRP agencies' involvement in international post-earthquake investigations. Because large domestic earthquakes occur infrequently, there is significant value in learning from earthquakes around the world. The devastating M7.8 Türkiye-Syria earthquake, for example, is considered comparable to potential compound strike-slip earthquake sequences that could occur in the western United States. Collaboration between U.S.-based organizations and researchers from Türkiye and elsewhere provided prodigious data on complex surface rupture, strong ground motions, aftershock occurrence and secondary effects [EERI, GEER, 2023].

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These three examples of collaboration among the four NEHRP agencies speak to the value of this inter-agency partnership. When faced with complex issues, the agencies bring to bear their professional expertise and resources, along with the expertise of practicing engineers and earthquake experts at universities, thereby enabling both efficiency and effectiveness in discharging the NEHRP mission and goals. A final example of this collaborative ethos is the production of the NSHM, last updated in 2023. A steering committee of volunteer earthquake experts from the private sector and universities worked with USGS to ensure the incorporation of the most current available science. As noted in Stewart and Arendt (2025), "It is in large part because of the National Seismic Hazard Model and regularly updated building codes that U.S. buildings designed to meet modern code requirements are considered among the safest in the world, despite substantial seismic hazards in several states."

This collaboration is possible because the NEHRP staff members have high degrees of technical expertise, relevant and longstanding field experience, and because they avoid displaying any political agendas. This professionalism is likely a major contributor to non-government experts (i.e., industry practitioners, university faculty) being willing to donate their time and talents to these complex efforts (Stewart & Arendt, 2025).

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In addition to their collaborative efforts, each NEHRP agency has specific responsibilities that connect them to the overall NEHRP mission and goals. What follows next are highlights from each of the NEHRP agencies for FY24-25, beginning with the NEHRP Program Leadership, housed in NIST.

NEHRP Program Leadership

In its capacity as the NEHRP Program Leadership, NIST oversaw the development of the FY22-29 NEHRP Strategic Plan and will do the same for the NEHRP Management Plan. The latter is expected to articulate how the goals, objectives, and focus areas of the strategic plan will be operationalized, its outcomes assessed, and those outcomes communicated to stakeholders.

Members of ACEHR, both current and past, contributed to the development of the FY22-29 NEHRP Strategic Plan (NEHRP, 2023) as subject matter experts who shared their input and feedback on drafts of the plan. ACEHR fully supports the FY22-29 NEHRP Strategic Plan and recognizes its importance in guiding the efforts of all its agencies going forward.

ACEHR believes that developing an actionable Management Plan in support of the strategic plan is a critical step toward enabling the NEHRP agencies to achieve their overarching goals while also responding to GAO (Government Accountability Office) Recommendations 5 and 6 (GAO-22-105016, 2022) as well as those from ACEHR.

For the past several years, the Acting NEHRP Director has taken the lead in communicating progress made on recommendations made by ACEHR in its reports as well as by the GAO in its reports (e.g., GAO Report to Congressional Committees, 2022). ACEHR continues to appreciate the Acting Director's willingness to field questions from and provide responses to ACEHR's members on these and other topics relevant to ACEHR's work. We look forward to receiving regular updates on the NEHRP Strategic and Management Plans, the GAO assessment reports, and the agencies' responses to ACEHR's recommendations.

The Acting NEHRP Director also shares with ACEHR the schedule and outcomes associated with meetings of the Interagency Coordinating Committee (ICC). As established by PL 108-360, the ICC includes the directors of the four primary program agencies, the White House Office of Science and Technology Policy (OSTP), and the Office of Management and Budget (OMB). The NIST Director chairs the ICC. The ICC oversees NEHRP planning, management, and coordination—including the development of NEHRP's Strategic and Management Plans. The ICC also develops and submits a coordinated interagency NEHRP budget and an annual report to Congress that ensures appropriate balance among NEHRP activities.

Having a group of top leaders who support NEHRP's overarching goals, objectives, and focus areas is critical to NEHRP's long-term success and ability to serve the nation. Ensuring that

the NEHRP agencies have the resources needed to achieve their missions in the context of the FY22-29 NEHRP Strategic Plan is a task the ICC is best positioned to achieve. ACEHR hopes that the ICC will maintain a regular meeting schedule in order to prioritize and signal the effectiveness and importance of NEHRP, while also enabling collaborative efforts among the NEHRP agencies.

ACEHR remains impressed with the overall responsiveness and thoroughness of the Acting Director, members of the PCWG, and all agency members who help the agencies' representatives to prepare for and attend the ACEHR meetings. ACEHR appreciates the professionalism, time, and effort that go into maintaining a positive working relationship with the NEHRP agencies. One consistent theme communicated during the updates provided to ACEHR, whether from the Acting NEHRP Director or the agency representatives, is the value associated with the agencies' commitment to collaborating with each other to achieve the overarching aims of NEHRP and serve the nation in doing so. Besides the vast number of collaborations yielding tangible outputs, the degree of willing cooperation and creativity in joint problem-solving is evident from positive interactions of the agency representatives during ACEHR's meetings. This is no small achievement, given the different missions, tasks, and types of expertise for each agency.

As shown in Fig. 2, the NEHRP agencies are jointly responsible for research, development, and implementation activities (NEHRP, 2025). The Program's **research** helps to advance our understanding of where and at what rates earthquakes occur, the hazards they generate, and their impacts on natural and built environments. The Program **develops** strategies, tools, techniques, and other measures that can reduce the adverse effects of earthquakes. Finally, the Program facilitates and promotes **implementation** of these measures. Together, these activities form the research-to-practice pipeline so critical to the resilience of our nation's at-risk communities.

Research

NEHRP supports basic research that expands knowledge of earthquakes and their impacts (NEHRP, 2021, 2025). **NSF** funds earthquake-related research in the earth sciences, social sciences, and engineering. Both **USGS** and **NIST** conduct or provide support for applied research, which uses the knowledge generated through research to produce the problem-focused findings needed to support the Program's development activities. USGS conducts and sponsors research related to assessing, monitoring, and reporting on earthquake hazards. NIST's research produces the technical information needed to reduce seismic vulnerability in the built environment. All three agencies support post-earthquake reconnaissance research on earthquake impacts, the performance of the built environment, and response and recovery efforts. The following sections provide further details on the roles and activities of the four agencies.

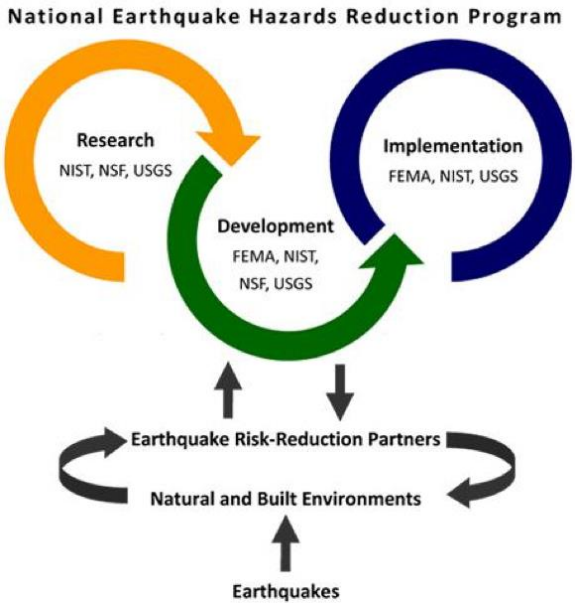

Fig. 2. Depiction of the four coordinating agencies' roles in NEHRP (Source: fema.gov)

NSF

Role: Foundational Research and Academic Capacity-Building

1. Funds basic research in the earth sciences, engineering, and social sciences related to earthquake processes and impacts.
2. Supports large research facilities, such as NHERI, enabling innovative experimentation.
3. Invests in workforce development, graduate education, and interdisciplinary research to grow the nation's expertise in earthquake science and engineering.
4. Encourages innovation and discovery that expands the scientific understanding of earthquakes and risk.

What follows are notable NSF activities as reported to ACEHR at its 2024 and 2025 meetings, organized by the four strategic goals in the NEHRP FY22-29 Strategic Plan.

Goal 1: Advance Understanding of Earthquake Processes and Consequences

NSF made significant contributions toward advancing the understanding of earthquake science, with at least 16 awards in support of studies on seismic sources and seismic wave propagation through the Earth's crust. These efforts aimed to enrich foundational knowledge on the behavior of seismic activity and its impact on different geological structures, with a notable emphasis on understanding subduction zone earthquakes. NSF supported work in this area is addressing critical knowledge gaps that will ultimately enhance the accuracy of earthquake hazard assessments and improve risk mitigation strategies.

Additionally, NSF provided funding to support projects focused on characterizing seismic sources, ground motions and other hazards, and their effects in specific regions of the U.S. Through these awards, NSF contributed to enhancing seismic monitoring and advancing national earthquake research, complementing the efforts of the Advanced National Seismic System (ANSS). By investing in studies on earthquake impacts to society and built environments, NSF facilitated a more comprehensive understanding of the socioeconomic and structural consequences of earthquakes.

Goal 2: Develop Information, Tools, and Practices for Earthquake Risk Reduction

Under Goal 2, NSF awarded grants supporting advancements in risk assessment methodologies and seismic performance improvements. Key funded projects included two initiatives aimed at enhancing earthquake scenarios and loss estimation tools, which serve as essential resources for risk assessment across multiple sectors. By funding research on innovative design standards, NSF supported the development of performance-based seismic design procedures that prioritize functional recovery and multi-system coordination.

One notable achievement was NSF's support for infrastructure projects that focus on practical risk reduction applications, particularly in lifeline infrastructure. Such projects underscore NSF's dedication to providing actionable research that informs building codes and supports the implementation of updated resilience standards for both new and existing infrastructure. These advancements ensure that NSF's research portfolio aligns with critical needs in seismic performance and post-earthquake functionality.

The Natural Hazards Engineering Research Infrastructure (NHERI), while not formally part of NEHRP, plays a significant and complementary role in advancing NEHRP's objectives. NHERI, funded by NSF, provides a network of shared research facilities, tools, and data services to support the natural hazards engineering community. While NHERI is not an official NEHRP agency, it contributes to NEHRP's mission by enabling research that informs earthquake risk reduction strategies. For instance, NHERI's cyberinfrastructure platform, *DesignSafe*, facilitates data sharing and computational modeling essential for earthquake engineering research.

Goal 3: Promote Knowledge Dissemination and Implementation of Resilience Strategies

NSF contributed to earthquake resilience education and knowledge dissemination through its support of community engagement and outreach activities. Notably, NSF-funded projects addressed enhancing earthquake information accessibility and providing various user groups with essential tools for preparedness and response. These initiatives included support for activities that promote earthquake awareness, emergency drills, and response planning at local and national levels, reinforcing the importance of public and organizational preparedness for earthquake events.

Through this strategic support, NSF demonstrated its commitment to broadening the reach of earthquake resilience knowledge and facilitating the adoption of preparedness and recovery strategies in communities at risk. NSF's emphasis on integrating social, behavioral, and economic factors into resilience efforts helped tailor these initiatives to meet the needs of high-risk communities.

Goal 4: Leverage Post-Earthquake Insights to Enhance Resilience

NSF's focus on learning from post-earthquake events underscores its commitment to enhancing future resilience strategies based on invaluable field performance data. NSF provided funding for projects that seek to refine post-earthquake data acquisition methods and strengthen frameworks for rapid assessment and recovery. Additionally, NSF's collaborative efforts in developing metrics for evaluating community resilience post-earthquake help ensure that findings from disaster events are effectively translated into actionable insights for policymakers and community leaders.

This work aligns with NSF's goal of fostering a feedback loop in disaster resilience, where observations and data from post-earthquake assessments contribute to iterative improvements in resilience strategies and community preparedness. By funding research that evaluates the efficacy of current resilience practices, NSF aids in building a robust knowledge base that enhances the effectiveness of post-disaster recovery and informs the development of targeted support mechanisms.

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In summary, NSF's FY24-25 achievements reflect a concerted effort to advance seismic research, enhance risk reduction tools, promote resilience education, and integrate learnings from post-earthquake events. NSF contributes to NEHRP's mission to safeguard communities and strengthen resilience against earthquake risks through its targeted funding support of basic research undertaken to explore complex issues by multidisciplinary research teams from multiple institutions.

USGS

Role: Earthquake Monitoring, Hazard Assessment, and Forecasting

1. Operates the National Seismic System and provides real-time earthquake alerts and notifications.
2. Develops and updates the National Seismic Hazard Model that guides risk-informed decision-making and building codes.
3. Conducts geologic and geophysical research to understand fault systems, ground motion, and earthquake probability.
4. Leads Earthquake Early Warning (ShakeAlert®) system development in collaboration with partners.

What follows are notable USGS accomplishments as reported to ACEHR at its 2024 and 2025 meetings, organized by the four strategic goals in the NEHRP FY22-29 Strategic Plan. The publications and products under review and resulting from the agency's activities are listed in USGS (June 2024). They include those summarized in the pages that follow and more.

Goal 1: Advance Understanding of Earthquake Processes and Consequences

The Earthquake Hazards Program (EHP) published a ten-year science strategy, *USGS Circular 1544*: *U.S. Geological Survey Earthquake Hazards Program Decadal Science Strategy, 2024–33* (Hayes et al., 2024), laying out the Program's foundational and aspirational priorities over the next decade. Together, these activities provide the framework to integrate hazard characterization and risk reduction activities across the program. They will allow USGS to advance understanding of location, size, and at what rate earthquakes occur and how we can use improved knowledge to drive short-term and actionable forecasts of seismic activity.

USGS continued to enhance earthquake science and monitoring, with major contributions to research on seismicity, including groundbreaking studies on earthquakes in the Mendocino Triple Junction. This research identified complex multi-source triggering processes, providing insights into fault interactions, and informing seismic hazard models. In partnership with the Statewide California Earthquake Center (SCEC), USGS also supported seismic research aimed at improving regional understanding of earthquake phenomena.

The USGS further advanced seismic monitoring through updates to the ANSS, which revised performance standards and conducted infrastructure upgrades to improve rapid information dissemination. A collaborative subduction zone science workshop was also organized with SZ4D (Subduction Zone in Four Dimensions) researchers to align USGS priorities with the needs of subduction zone research, enhancing preparedness for major subduction-related earthquakes.

Regional Seismic Network cooperative agreements have been awarded, SCEC cooperative agreement has been awarded, and Geodetic Network cooperative agreements have been awarded. In FY25 to date, the U.S. Geological Survey has awarded $1.6 million in a limited first round of earthquake research grants to support advances in the Nation's understanding of earthquake hazard and risk, earthquake causes and effects, and improvements in earthquake monitoring. A second round of funding is planned.

Goal 2: Develop Information, Tools, and Practices for Earthquake Risk Reduction

USGS made significant strides in advancing risk reduction tools and capabilities, focusing on both immediate and long-term earthquake risk mitigation. A major achievement was the release of a Beta version of an earthquake sequence product that maps mainshocks with their associated fore- and aftershocks, providing accessible visualizations of earthquake

sequences. Additionally, USGS introduced an updated Operational Aftershock Forecast Product to enhance aftershock response planning and situational awareness.

USGS continued to expand the ShakeAlert earthquake early warning system with the release of ShakeAlert v3.0.1, which integrates Global Navigation Satellite System (GNSS) data for rapid magnitude estimates and incorporates refined ground motion models for the Los Angeles Basin. The Earthquake Hazards Program (EHP) recently published a Congressionally directed implementation plan for potential expansion of ShakeAlert to Alaska as an Open File Report (Wolfe et al., 2025). The plan was produced in coordination with the State, including the ADGGS and Alaska Earthquake Center. If funded by Congress in future, this plan would be used to extend ShakeAlert to cover the highest-risk portions of the State, surrounding Anchorage, Fairbanks, and Juneau.

The Earthquake Notification System (ENS 2.0) can now deliver messages summarizing USGS PAGER Impact, Aftershock Forecasting, ShakeMap, and ShakeAlert® reports following moderate and large earthquakes. Previously ENS delivered only earthquake location and magnitude information; messages can now summarize the earthquake impact. Users can specify the product(s), the region of interest, a minimum earthquake magnitude, and other values.

Goal 3: Promote Knowledge Dissemination and Implementation of Resilience Strategies

Under Goal 3, USGS enhanced its public outreach and earthquake information systems, particularly following the M4.8 earthquake near Tewksbury, New Jersey. This event highlighted the public's demand for rapid information, as the USGS websites received a record 440 million requests for earthquake data within an eight-hour span. USGS maintained the reliability of its information delivery by investing in information technology (IT) infrastructure improvements, supporting a cloud-based system for robust, scalable data sharing.

The 2023 update to the NSHM represented a milestone for the USGS, as it provided an updated, comprehensive model covering all 50 states. This model incorporates the latest scientific findings, including refined fault models and seismic activity rates, and has been instrumental in guiding state and federal mitigation strategies. USGS also took proactive steps to engage stakeholders by conducting workshops and delivering congressional briefings. The NSHM project is finalizing an update for Puerto Rico and the US Virgin Islands, which is now under review with the NSHM steering committee and associated review sub-committees, and will soon be sent for journal publication, for release by the end of the year. The update process for US Territories has begun and is currently scheduled for completion by the end of 2026. Meanwhile, USGS scientists have been involved with shepherding the 2023 50-state update through the building code transition process to be included in the 2026 NEHRP Provisions. The Earthquake Engineering Research Institute

(EERI) hosted a two-part series webinar in May 2025, on the 2023 NSHM and building code adoption.

Goal 4: Learn from Post-Earthquake Investigations to Enhance Resilience

USGS produced its regular suite of products for the recent and devastating M7.7 Mandalay, Burma earthquake of March 28, which generated a PAGER red alert with the expectation of upwards of 10,000 fatalities. Two of the newer products that have been released for this event are: (1) a rapid rupture mapping data release that combines pixel offset correlation analysis to understand the spatial extent of surface rupture, with offset measurements from satellite imagery, and (2) a new geonarrative, published on May 14, 2025, that describes the seismotectonic context of the earthquake in interactive maps that contextualize the earthquake and its impacts.

USGS worked with GEER (Geotechnical Extreme Events Reconnaissance) and EERI on a series of post-earthquake response and research activities following the devastating Türkiye earthquake sequence. USGS collaborated with the EERI Clearinghouse to establish an ad hoc earthquake investigations committee to streamline communication among federal agencies, NGOs (non-government organizations), and NEHRP partners, ensuring a coordinated response. USGS supported surface rupture mapping, aftershock monitoring, and capacity-building efforts in Türkiye, reinforcing international resilience efforts through scientific collaboration.

As discussed previously, USGS undertook updates to USGS Circular 1242 (renumbered to Circular 1542), aimed at coordinating NEHRP's post-earthquake investigations. This initiative helps formalize procedures for gathering and analyzing post-earthquake data, which is essential for improving earthquake resilience. ATC hosted a webinar in mid-May 2025 on the application of USGS Circular 1542. The webinar drew a broad and sizable audience (1,350 registered) of civil and structural engineers, earth scientists, civic leaders, agency representatives, and others interested in participating and learning from post-earthquake investigations.

In addition, USGS initiated a technical partnership with the Global Earthquake Model to enhance global earthquake preparedness and response efforts, exemplifying USGS's role in fostering resilience both domestically and internationally.

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The previous paragraphs highlight USGS's commitment to advancing earthquake science, enhancing public safety tools, and strengthening resilience through coordinated disaster response and knowledge dissemination. The agency's FY24-25 accomplishments reflect a comprehensive approach to earthquake preparedness, underscoring its role in supporting the nation's resilience against earthquake hazards.

Development

NEHRP (2021, 2025) uses research results to develop the earthquake risk-reduction measures that are subsequently put into practice through the Program's implementation efforts. **NIST** combines applied engineering research with the creation of performance-based design tools, guidelines, and standards through its Earthquake Risk Reduction in Buildings and Infrastructure Program. **USGS** leads national seismic monitoring through the ANSS and, with **NSF**, supports global monitoring via the Global Seismographic Network (GSN). USGS develops technologies for rapid earthquake reporting and uses monitoring data to produce nationwide seismic hazard assessments. Its NSHM informs insurance rates, risk planning, and U.S. model building codes. **FEMA** contributes to building safety by helping shape seismic provisions in model codes and standards. It supports consensus-based updates based on the latest research and funds tools like HAZUS to aid in implementing risk-reduction measures.

Implementation | Practice

FEMA, NIST, and USGS lead NEHRP implementation, producing and promoting resources that translate research into practical guidance for diverse audiences (NEHRP, 2021, 2025). **NIST** conducts applied earthquake engineering research to provide the technical basis for building codes, standards, and practices, and works with FEMA and others to implement improved earthquake-resistant design guidance for building codes and standards for new and existing buildings, structures, and lifelines. **FEMA** plays a key role in publishing seismic rehabilitation methods and incorporating consensus-based improvements into national model building codes in collaboration with standards organizations. FEMA also provides training through its National Earthquake Technical Assistance Program (NETAP). Training covers many topics, including the use of HAZUS, which generates loss estimates to support preparedness, response, and mitigation planning. **USGS** enhances preparedness through the development of earthquake scenarios.

NIST

Role: Program Leadership, Engineering Research, and Code Development Support

1. Chairs the Interagency Coordinating Committee (ICC) and leads NEHRP's overall strategic coordination.
2. Conducts applied research in earthquake engineering, especially related to building performance and structural safety.
3. Supports the development of improved building codes and standards, working closely with professional organizations.
4. Leads post-earthquake reconnaissance and technical investigations through the National Construction Safety Team Act.

What follows are notable NIST activities as reported to ACEHR at its 2024 and 2025 meetings, organized by the four strategic goals in the NEHRP FY22-29 Strategic Plan. The

publications and products under review and resulting from the agency's activities are listed in NIST (June 2024). They include those summarized in the pages that follow and more.

Goal 1: Advance Understanding of Earthquake Processes and Consequences

NIST actively pursued collaborative research and field studies to enhance understanding of earthquake effects on infrastructure and society. Notable efforts included a reconnaissance mission to Lahaina, Maui, aimed at identifying barriers to effective emergency response, and collaborative studies on business resilience following the 2023 Kahramanmaraş Earthquake in Türkiye. These efforts provide insights into improving emergency response systems and business recovery in the face of earthquake events. NIST also contributed to disaster research methodology through publications on using social media data in post-disaster contexts.

Goal 2: Develop Information, Tools, and Practices for Earthquake Risk Reduction

NIST's achievements under Goal 2 focused on advancing seismic design, risk assessment, and resilience-enhancing methodologies:

- *Economic Considerations for Functional Recovery Design:* This project addressed the cost-effectiveness of seismic design strategies aimed at achieving functional recovery—ensuring buildings can resume essential functions shortly after an earthquake. Building on NIST Special Publication 1254, the study applies benefit-cost analysis (BCA) to new building designs, comparing various alternatives and quantifying the cost differential. Preliminary findings suggest that while up-front construction costs increase by 1–6%, these are typically offset by avoided losses during seismic events. Future work will extend this analysis to lifeline infrastructure systems.
- *Nonstructural Element Database*: NIST initiated and developed a robust SQL database of nonstructural element experimental tests and seismic fragility models, filling a key knowledge and tech transfer gap for researchers and practitioners. Through an extensive literature review, the project team collected over 2000 experimental data points into the database and explicitly related each point to a set of seismic fragility models. The relational and open-source architecture of the database promotes data transparency, reuse, and scalability, where observations of nonstructural damage can be continuously uploaded to an online repository and directly queried by engineers and researchers to improve understanding of how nonstructural elements influence building performance and functional recovery.

- *Functional Recovery Standards*: NIST made strides in defining functional recovery performance for buildings, including completing a framework to guide decisions for lifeline infrastructure systems, a design guide for reducing structural damage in reinforced concrete buildings based on experimental test data, and a decision support tool that leverages machine learning to map outcomes from performance-based building assessments to prescriptive design requirements. The lifelines framework aids in aligning structural performance with post-earthquake functionality, supporting both physical resilience and operational readiness for crucial utilities such as water, wastewater, and electricity.
- *Performance-Based Seismic Design*: Research on innovative earthquake-resistant structural systems, including controlled rocking designs, aimed to enable rapid functional recovery following earthquakes. NIST collaborated with seismologists and structural engineers to develop reinforced concrete models tailored to withstand seismic stresses effectively.
- *Forward Looking Seismic Standards*: Recognizing the evolving risk landscape, NIST initiated research to integrate life cycle impacts into seismic standards, focusing on enhancing codes for future hazard adaptation and assessing infrastructure resilience for future conditions.

Related to NIST's work on functional recovery, a 2024 NIST Research Brief (RB 4) (Johnson et al., 2024) visually depicts the "improved recovery trajectory between current design practice and the new functional recovery performance objective under development for buildings." Fig. 3 illustrates how implementing functional recovery design is expected to shorten the time needed to reoccupy, repair, and resume a building's basic functions and services as compared to current code design.

Goal 3: Promote Knowledge Dissemination and Implementation of Resilience Strategies

Under Goal 3, NIST facilitated substantial knowledge sharing and professional engagement to encourage resilience practices:

- *Guidelines for Seismic Design and Evaluation of Concrete Members Retrofitted with Fiber Reinforced Polymer (FRP):* In response to a 2018 workshop identifying the lack of standards for seismic retrofitting with fiber-reinforced polymer (FRP), NIST developed a new design guide focused on FRP jacketing of concrete columns. The guide includes a database of retrofitted columns and a new analytical expression for estimating drift capacity, accounting for anchorage and failure modes. Reviewed by subject matter experts and prepared for ACI 369F balloting, the guide is intended for integration into American Concrete Institute (ACI) codes and will be published shortly to support consistent, evidence-based seismic retrofit practices.

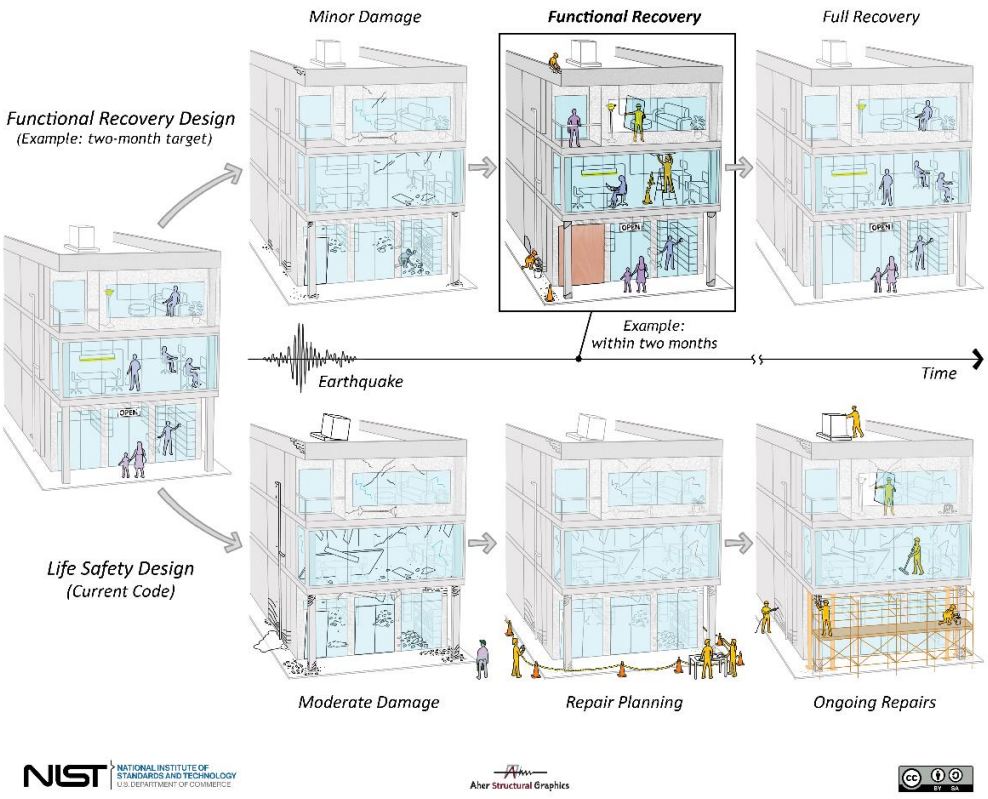

Fig. 3. Functional Recovery Performance Compared to Life Safety Design.
(Source: https://doi.org/10.6028/NIST.RB.4r1)

- *Collaborative Symposia and Educational Leadership*: NIST hosted the 2023 NIST-NSF Disaster Resilience Symposium, bringing together over 50 researchers to present findings and ongoing projects in disaster resilience. Through leadership roles in national and international committees, NIST researchers contributed to diverse initiatives, including functional recovery standards, seismic code updates, and educational outreach on earthquake safety.
- *Development and Deployment of Resilience Tools*: NIST advanced the RESISTANT tool, designed to assist agencies like the Federal Highway Administration and Department of Transportation in planning investments for earthquake resilience in transportation networks. This tool supports infrastructure decision-making by integrating performance and recovery metrics for critical transportation systems.
- *Seismic Safety Evaluations*: NIST led the Interagency Committee on Seismic Safety in Construction's (ICSSC) Spring 2024 meeting, focusing on tools and protocols for evaluating federal buildings and leased spaces, contributing to nationwide standards for building safety evaluations.

Goal 4: Leverage Post-Earthquake Insights to Enhance Resilience

NIST's post-earthquake studies continue to inform strategies for resilience enhancement, providing feedback loops for future disaster preparedness:

- *Field Reconnaissance Missions*: NIST researchers actively participated in reconnaissance missions, including deployments to Türkiye after the 2023 earthquake sequence and to the NY-NJ earthquake zone. These studies investigated ground deformation and structural performance, offering critical data on the physical impacts of earthquakes and informing post-event functional recovery.
- *Publication of Reconnaissance Findings*: NIST shared data-driven insights through publications, including articles in *Earthquake Spectra* on functional recovery and observed damage assessments from the Türkiye earthquake sequence. These publications document challenges and lessons learned, offering a basis for refining resilience practices.
- *Collaboration with Infrastructure and Lifeline Sectors*: NIST's ongoing collaboration with NIBS and other stakeholders is part of a broader effort to integrate resilience into utility and transportation networks, supporting the development of earthquake response protocols across critical infrastructure sectors.

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In summary, NIST's achievements in FY24-25 reflect a deep commitment to improving earthquake resilience through collaborative research, advanced engineering practices, and cross-agency knowledge dissemination. By focusing on functional recovery, performance-based design, and post-disaster learning, NIST's efforts support the NEHRP goals of enhancing national preparedness and infrastructure resilience against earthquake events.

FEMA

Role: Implementation, Preparedness, and Risk Reduction at the State and Local Level

1. Leads efforts to translate research into practice by developing and promoting building codes, design guidance, and mitigation strategies.
2. Supports state, Tribal, territorial, and local governments with tools, technical assistance, and funding for seismic risk reduction.
3. Manages post-disaster mitigation grants and promotes earthquake insurance and public education.
4. Coordinates national preparedness activities, including planning for response and recovery in earthquake-prone areas.

What follows are notable FEMA activities as reported to ACEHR at its 2024 and 2025 meetings, organized by the four strategic goals in the NEHRP FY22-29 Strategic Plan. The publications and products under review and resulting from the agency's activities are listed in FEMA (June 2024). They include those summarized in the pages that follow and more.

Goal 1: Advance Understanding of Earthquake Processes and Consequences

During the FY24-25 period, FEMA focused its resources on different areas from those covered under Goal 1 of the NEHRP Strategic Plan. As a result, no new initiatives or notable achievements were recorded under Goal 1 for this reporting period.

Goal 2: Develop Information, Tools, and Practices for Earthquake Risk Reduction

FEMA made substantial progress toward improving national resilience against earthquake risks by enhancing information, tools, and practices for earthquake preparedness:

- FEMA P-232, *Homebuilders' Guide to Earthquake-Resistant Design and Construction*, recently updated in 2024, offers practical guidance on applying current seismic design requirements to typical residential construction in the U.S. Aimed at homebuilders, tradespeople, and local code officials, the guide explains fundamental principles of earthquake-resistant design and clarifies how these principles underpin requirements in the International Residential Code (IRC). FEMA P-232 also provides above-code recommendations to enhance seismic performance in dwellings and townhouses. It includes estimated cost increases for each upgrade along with expected performance benefits, supporting informed decision-making by builders and homeowners. The updated edition builds on the 2006 version, aligning with the 2024 IRC, adding a new townhouse design example, and expanding benefit-cost insights. It reflects FEMA's continued commitment to promoting resilient construction practices that reduce earthquake-related damage, injury, and disruption.
- FEMA actively contributed to the evolution of seismic building codes. Collaborating with the International Code Council (ICC), FEMA proposed over 50 changes to the seismic components of the 2024 editions of the International Building Code (IBC) and International Residential Code (IRC). This process also included the creation of 100 updated commentaries to enhance seismic provisions.
- FEMA played an influential role in technical standards development by supporting multiple American Society of Civil Engineers committees including the Seismic Evaluation and Retrofit of Existing Buildings Committee. These efforts ensure FEMA's direct input on the standards that guide earthquake-resistant design practices, improving the structural integrity of buildings nationwide.

Goal 3: Promote Knowledge Dissemination and Implementation of Resilience Strategies

Under Goal 3, FEMA took significant actions to increase the availability of earthquake preparedness information and tools:

- FEMA published critical guidance on cordoning earthquake-damaged buildings (FEMA P-2055-2, 2023), addressing the need for safer management of damaged structures post-disaster. This guidance provides local officials with streamlined strategies for

establishing safe zones around earthquake-affected buildings, thus reducing risks from potential collapses and enhancing recovery operations.

- FEMA continued to develop and update guidance for various structural and non-structural aspects of seismic resilience. Publications such as the Seismic Design Category Maps (FEMA P-2192-4) and the guidelines for performance in high seismic regions (FEMA P-2343) underscore FEMA's commitment to delivering technical resources that support advanced seismic performance standards.
- FEMA's emphasis on functional recovery standards is evident in its support for the PUC's Functional Recovery Task Committee, which focuses on developing criteria that guide communities in the aftermath of major earthquakes. The development of resources such as FEMA P-58-8 aims to aid communities in recovering more swiftly while promoting resilience through practical design practices.

Goal 4: Learn from Earthquake Investigations to Improve Resilience

FEMA engaged in various initiatives to translate lessons from past earthquakes into practical resilience strategies:

- In May 2025, FEMA published FEMA P-2335, *Guidelines for Post-Earthquake Repair and Retrofit of Buildings Based on Assessment of Performance-Critical Damage*, which provides updated technical guidance for evaluating and repairing earthquake-damaged reinforced concrete buildings. It helps engineers determine when repairs—or repairs combined with retrofitting to strengthen structures—are needed to address damage that compromises structural performance. The document builds on earlier FEMA guidance for concrete wall buildings, expands its scope to include concrete frame systems, and aligns with current seismic design practices. It defines Performance-Critical Damage as damage that reduces a component's strength or deformation capacity, increasing the risk of collapse in future earthquakes. While FEMA P-2335 does not set policy, it offers procedures that support implementation of post-earthquake repair standards such as those in the International Existing Building Code (IEBC). Intended for experienced structural engineers and building officials, the document is grounded in extensive research and analysis, including experimental data and simulation studies.
- FEMA collaborated with the USGS on Circular 1542, which details procedures for post-earthquake data acquisition, ensuring that FEMA's resources contribute effectively to field research efforts after earthquakes. This collaboration reinforces FEMA's commitment to applying scientific insights to practical earthquake management strategies.

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In summary, FEMA's activities in FY24-25 demonstrate a strong focus on improving earthquake resilience through collaborative standards development, updated guidance publications, and strategic funding programs. These efforts support national preparedness

and aim to enhance both structural resilience and community recovery from earthquake impacts.

ACEHR RECOMMENDATIONS TO NEHRP

ACEHR offers **two** new recommendations in this report. We affirm the recommendations made in previous reports, such as ACEHR (2023), but do not repeat them here. In making these recommendations, ACEHR observes that adequate staffing, sufficient funding, and strong leadership support will be needed to achieve these recommendations. Without these key resources, it is unrealistic that these recommendations can be achieved in a timely manner.

Recommendation 1

Develop and implement the **NEHRP Management Plan** in support of the FY22-29 NEHRP Strategic Plan.

In ACEHR's FY20-21 report (ACEHR, 2021), the authors noted that,

> "Once the FY22-29 NEHRP Strategic Plan is approved and adopted, the focus will change to ensuring the Plan is implemented. Depending on available resources, ACEHR calls upon the Interagency Coordinating Committee to provide the resources required for full implementation of the Plan, including appropriations and budgetary mechanisms that are closely aligned with the Plan at agency and sub-agency levels" (ACEHR, 2021, p. 4).

The FY22-29 NEHRP Strategic Plan was approved and published in 2023. Members of ACEHR, both current and past, contributed to the development of the FY22-29 NEHRP Strategic Plan as subject matter experts who shared their input and feedback on drafts of the plan. ACEHR continues to fully support the FY22-29 NEHRP Strategic Plan and recognizes its importance in guiding the efforts of its collaborating agencies going forward.

In its capacity as the lead NEHRP agency, NIST oversaw the development of the FY22-29 NEHRP Strategic Plan. In addition, NEHRP leadership proposed the first-ever development of a **NEHRP Management Plan** to accompany the Strategic Plan. The purpose of the Management Plan is to identify actionable steps and performance measures that may be used to formally evaluate NEHRP's progress on its Strategic Plan as well as gaps and the reasons for them. Whereas the Strategic Plan lays out the strategic goals, objectives, and program-identified focus areas, the newly conceived and created Management Plan is expected to articulate how the goals, objectives, and focus areas of the strategic plan will be operationalized, its outcomes assessed, and those outcomes communicated to critical

stakeholders. The Management Plan will also address a framework for conducting a national risk assessment, in partial response to Recommendation 1 from the U.S. Government Accountability Office (GAO) in its May 2022 Report to Congressional Committees on NEHRP. The GAO report was conducted in response to The National Earthquake Hazards Reduction Program Reauthorization Act of 2018 which included a provision for GAO to assess the program's efforts.

NEHRP Leadership is responsible for overseeing the development of the NEHRP Management Plan. ACEHR agrees that developing an actionable Management Plan is a critical step toward enabling the NEHRP agencies to achieve their overarching goals, while also responding to previous ACEHR recommendations and comments, as well as GAO Recommendations 5 and 7 (GAO-22-105016, 2022). NEHRP is working with a group of subject matter experts contracted through ATC to develop a draft of the Management Plan. Working closely with the subject matter experts are the members of the PCWG. It is expected that a working draft of the Management Plan will be available in early 2026.

While the timing of the Management Plan—anticipated in 2026—may seem late given that the current Strategic Plan covers FY22–29, it offers a valuable opportunity to pilot and evaluate a two-plan approach. This will allow NEHRP to assess whether separating the Strategic and Management Plans leads to more effective goal setting, execution, and evaluation compared to a single integrated document. Moreover, the PCWG and others agreed it was prudent to begin developing the Management Plan while several years remain in the current Strategic Plan, rather than waiting until the next planning cycle for FY30–37.

ACEHR looks forward to updates on the development of the Management Plan along with updates on the goals, objectives, and focus areas of the FY22-29 Strategic Plan that include comprehensible performance measures and metrics. The execution of the Management Plan will better enable ACEHR to perform the evaluative components of its charge. We applaud the development of this innovative addition to the NEHRP strategic planning process.

Recommendation 2

That the NEHRP Program Leadership and Program Coordination Working Group (PCWG) work with ACEHR to continue its **review of previous recommendations** (2008-2023) for those that should be "re-implemented," "fully implemented," or set aside, and to create a systematic process for conducting such reviews in the future.

Starting in January 2025, a subgroup of ACEHR's subject matter experts initiated a review of its entire suite of recommendations going back to 2008 (2008-2023, number of recommendations=124), with the goal of ascertaining the status of the recommendations. Tina Faecke, then-DFO for ACEHR, compiled a spreadsheet of all ACEHR recommendations and their status as reported in line with the Federal Advisory Committee Act (FACA) (Marchsteiner & Stuessy, 2024). While 64 had been "fully implemented" (at least, as they were understood when they were reported thusly), others were "partially implemented"

(17), “under consideration” (10), or “in planning” (7). Eight were deemed to be observations rather than recommendations, five were considered “not applicable” as they related to non-NEHRP activities, and 13 were classified as “out of scope,” typically because they involved funding requests or other actions that the NEHRP agencies were not allowed to undertake by law or precedence.

The initial review of ACEHR’s past recommendations sparked robust discussions, including the potential need to revisit some that had previously been marked as “fully implemented,” as they were now seen as newly relevant in light of evolving contexts. Other recommendations that had not been acted upon—due to resource constraints, competing priorities, or feasibility concerns—were reconsidered and, in some cases, deemed newly viable. The NEHRP Leadership, in collaboration with the PCWG, engaged with ACEHR to explore these questions further, providing greater clarity on the current status and prospects of many recommendations. When this effort was initiated, ACEHR intended for the analyses of past recommendations to be described in this ACEHR report, including bringing forward relevant recommendations. The effort was paused before completion due to staffing and funding challenges at the NEHRP agencies as described earlier in this report.

ACEHR values its strong working relationship with the NEHRP Leadership and PCWG and supports the continuation of this review process in the next biennium. A key priority will be to establish a structured, ongoing process for assessing the relevance, viability, and timing of past recommendations. This includes recognizing when recommendations should be merged, reimagined, deferred, or sunsetted. Such a process will promote shared understanding and alignment on implementation timelines, helping ensure that ACEHR’s guidance remains timely, actionable, and strategically focused.

CONCLUDING THOUGHTS

To continue the needed pace of innovation and effectively safeguard the nation, NEHRP must be fully staffed, adequately funded, and supported by leadership over the long term. Earthquakes are inevitable, but large-scale loss and disruption are not. The science is clear, the economic case is strong, and the moral imperative is undeniable. We must treat earthquake mitigation as a national, state, and local priority—not after the next disaster, but now.

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APPENDICES

APPENDIX A: ACEHR MEMBERS AND AFFILIATIONS

1. Dr. Lucy A. Arendt, Chair of ACEHR (Donald J. Schneider School of Business & Economics, St. Norbert College, De Pere, WI)
2. Dr. Laurie Baise (Department of Civil and Environmental Engineering, Tufts University, Medford, MA)
3. Dr. Ann Bostrom (Daniel J. Evans School of Public Policy & Governance, University of Washington, Seattle, WA)
4. Mr. Jeff Briggs (Missouri State Emergency Management Agency, Jefferson City, MO)
5. Mr. Robert Carey (Utah Division of Emergency Management, Salt Lake City, UT)
6. Mr. David W. Cocke (Structural Focus, Gardena, CA)
7. Dr. Rachel A. Davidson (Department of Civil, Construction, and Environmental Engineering, University of Delaware, Newark, DE)
8. Dr. Michael W. Hamburger, *ex-officio*, Chair of SESAC (Earth and Atmospheric Sciences, Indiana University, Bloomington, IN)
9. Mr. Thomas F. Heausler (Consulting Structural Engineer, Bay Saint Louis, MS)
10. Dr. Tara Hutchinson (Department of Structural Engineering, University of California, San Diego, CA)
11. Dr. Anne Meltzer (Lehigh University, Bethlehem, PA)
12. Ms. Danielle H. Mieler (City of Alameda, CA)
13. Dr. Jonathan P. Stewart (Civil and Environmental Engineering, University of California, Los Angeles, CA)
14. Dr. Douglas Wiens (Dept of Earth, Environmental & Planetary Sciences, Washington University, St. Louis, MO)

APPENDIX B: GUIDING PRINCIPLES & ASSUMPTIONS

1. The NEHRP agencies are committed to aligning their decisions and actions with the expectations outlined in the Earthquake Hazards Reduction Act of 1977 as reauthorized and amended by Public Law 115-307 (December 2018).

2. The NEHRP agencies will pursue the goals, objectives, and focus areas in the *FY22-29 NEHRP Strategic Plan* and will update as needed in accordance with future NEHRP Reauthorization.

3. The resources needed to implement the goals, objectives, and focus areas in the Strategic Plan are authorized and appropriated by Congress. The NEHRP agencies cannot by themselves increase the resources associated with NEHRP.

4. ACEHR is committed to aligning its recommendations and observations with the expectations outlined in the Earthquake Hazards Reduction Act of 1977 as reauthorized and amended by Public Law 115-307 (December 2018) as well as the *FY22-29 NEHRP Strategic Plan*.

5. ACEHR relies upon information shared by the NEHRP agencies as well as other subject matter experts in discharging its responsibilities.

6. Transparency in communication is valued by the members of ACEHR in their interactions with the NEHRP agencies.

7. ACEHR's overarching goal in preparing its biennial reports and other documents is to facilitate the effectiveness of the NEHRP agencies as they work to meet the expectations outlined in the Earthquake Hazards Reduction Act of 1977 as reauthorized and amended by Public Law 115-307 (December 2018).

8. ACEHR recognizes that each of the NEHRP agencies plays a unique role in contributing to the implementation of the *FY22-29 NEHRP Strategic Plan*.

9. ACEHR builds upon prior reports and documents in developing its recommendations.

10. ACEHR recognizes that the recommendations in any one of its biennial reports will most typically require more than two years to fully implement and evaluate.

APPENDIX C. ABBREVIATIONS AND ACRONYMS

ACEHR	Advisory Committee on Earthquake Hazards Reduction
ACI	American Concrete Institute
ATC	Applied Technology Council
AI	Artificial Intelligence
ANSS	Advanced National Seismic System
BRIC	Building Resilient Infrastructure and Communities
CEUS	Central and Eastern United States
DFO	Designated Federal Officer
EERI	Earthquake Engineering Research Institute
FEMA	Federal Emergency Management Agency
FY	Fiscal Year
GAO	U.S. Government Accountability Office
GEER	Geotechnical Extreme Events Reconnaissance
GEM	Global Earthquake Model
GNSS	Global Navigation Satellite System
GSN	Global Seismographic Network
HAZUS-MH	Hazards U.S. Multi-Hazard (FEMA's Loss Estimation Methodology)
IBC	International Building Code
ICC	Interagency Coordinating Committee
ICSSC	Interagency Committee on Seismic Safety in Construction
ICST	Institute for Computer Sciences and Technology
IRC	International Residential Code
IT	Information Technology
M	Magnitude
NEHRP	National Earthquake Hazards Reduction Program
NETAP	National Earthquake Technical Assistance Program
NGO	Non-Governmental Organization
NHERI	Natural Hazards Engineering Research Infrastructure
NIBS	National Institute of Building Sciences
NIST	National Institute of Standards and Technology
NSF	National Science Foundation
NSHM	National Seismic Hazard Model
NWIRP	National Windstorm Impact Reduction Program
OMB	Office of Management and Budget
OSTP	Office of Science and Technology Policy
PCWG	Program Coordination Working Group
PL	Public Law
PUC	Provisions Update Committee
SCEC	Statewide California Earthquake Center
SESAC	Scientific Earthquake Studies Advisory Committee
SZ4D	Subduction Zones in Four Dimensions
USGS	U.S. Geological Survey