Appendix B: Agency Efforts in the Current NEHRP

B

Four agencies—the National Science Foundation (NSF), the U.S. Geological Survey (USGS), the Federal Emergency Management Agency (FEMA), and the National Institute of Standards and Technology (NIST)—have specific responsibilities within the National Earthquake Hazards Reduction Program (NEHRP). Figure B-1 shows the division of NEHRP funding among the principal agencies. This appendix describes each agency's current NEHRP efforts and outlines earthquake-related activities by other federal agencies that are outside the formal NEHRP framework.

U.S. GEOLOGICAL SURVEY

USGS receives the largest share of NEHRP funds—about $50 million in FY 1994, accounting for more than half of all NEHRP spending. In recent years, USGS has used its NEHRP funds to pursue four goals:

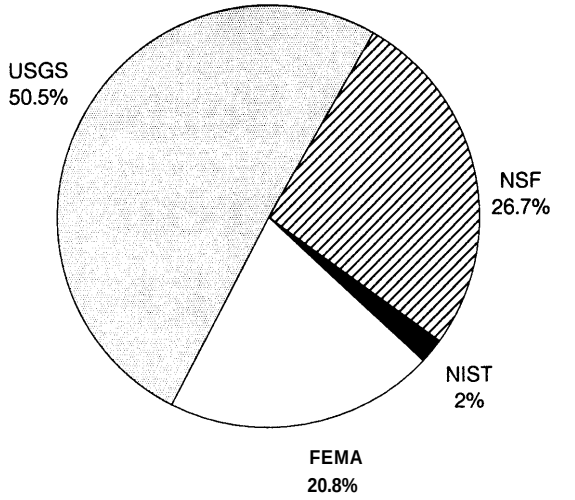
- understanding what happens at the earthquake source,
- determining the potential for future earthquakes,
- predicting the effects of earthquakes, and
- developing applications for research results.[1]

Supporting efforts span a wide range of activities, from research into basic earthquake processes to mapping expected ground motions for use in building design codes. More than two-thirds of NEHRP funding is used internally—to support USGS scientists in regional programs, laboratory and field activities, national hazards assessment projects, and seismic network operation. The remainder is spent as grants to outside researchers for specific projects. In general, the internal work focuses on applying knowledge to describe hazards, while the external program emphasizes expanding and strengthening the base of scientific knowledge.

Three specific aspects of U.S. Geological Survey's NEHRP-related work are discussed below: the geographic focus of the work, efforts made at

[1] Robert A. Page et al., *Goals, Opportunities, and Priorities for the USGS Earthquake Hazards Reduction Program*, U.S. Geological Survey Circular 1079 (Washington, DC: US Government Printing Office, 1992), pp. 1-2.

FIGURE B-1: NEHRP Spending by Agency, FY 1994



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

SOURCE: Office of Technology Assessment, 1995, based on NEHRP budget data.

improving technology transfer, and the post-earthquake investigation program.

■ Geographic Focus

Concentrated for years primarily in California, USGS research and hazard assessment activities expanded in the mid- 1980s to include a multiyear effort to fully characterize seismic hazards along the Wasatch fault zone in Utah. Beginning in 1991, USGS divided a substantial portion of its resources among four regions where the earthquake hazard is most severe: southern California, northern California, the Pacific Northwest, and the central United States[2] (see table B-l). A regional coordinator is responsible for coordinating all aspects of the program with state and local agencies, engineering groups, county emergency managers, and planners.[3] Although California still receives the bulk of the funding set aside for regional studies, USGS has shifted toward a more national program. The most noticeable remaining gap in coverage is metropolitan areas in the Northeast that have significant seismic risk (e.g., Boston and New York City).

■ Technology Transfer

USGS has several programs intended to promote the use of agency-produced knowledge and tools. Examples include the following:

- USGS works with the California Division of Mines and Geology (a state agency) to develop geographical information systems for use in studying high seismic risk regions of the state.
- USGS supports the Southern California Earthquake Center (SCEC). SCEC is a multidisciplinary effort to catalog and quantify regional earthquake hazards and to transfer this information to the mitigation community. It is described further under NSF activities.
- With FEMA, USGS has assisted in establishing the Coordinating Organization for Northern California Earthquake Research and Technology (CONCERT). With members from government agencies and private sector organizations, CONCERT provides a framework for members to exchange ideas and hold public workshops. Their objective is more effective transfer of new technologies and research results to the region's engineering community.
- USGS encourages the exchange of ideas and expertise between "sister cities" with similar seismic risks. One of the first such exchanges

[2] The Pacific Northwest refers to northernmost California, Oregon, Washington, and Alaska; the central United States include Indiana, Illinois, Missouri, Kentucky, Tennessee, Arkansas, and Mississippi. Craig Weaver, Acting USGS NEHRP Coordinator, personal communication, May 9, 1995.

3 Along with three discipline coordinators (who oversee geographically based studies outside the four primary regions, laboratory and theoretical studies, and the national seismic network system), the four regional coordinators oversee peer review panels that advise USGS on funding priorities. Ibid.

TABLE B-1: USGS Spending Under NEHRP, FY 1995

Program element	FY 1995 spending (million dollars)		
	Internal	External	Total
Northern California	7,096.7	1,830.0	8,926.7
Southern California	5,385.2	1,900,0	7,285.2
Pacific Northwest	2,434.2	1,316,1	3,750.3
Central United States	1,853.6	1,000.5	2,854.1
National and international	2,772.1	1,067.2	3,839.3
Seismic networks	**5,040.0**	2,620.0	7,660.0
Earthquake process and theory	**2,491.3**	919.8	3,411.1
Southern California Earthquake Center		1,200.0	1,200.0
Other	7,870.0	2,118.4	9,988.4
Total	34,943.1	13,972.0	48,915.1

NOTE Other includes miscellaneous administration and program assessments.

SOURCE: Office of Technology Assessment, 1995, based on detailed U.S. Geological Survey budget data

involved hazard planners and engineers from Watsonville, California, and their counterparts in Anchorage, Alaska. Other sister-city meetings are planned.

- USGS operates the National Earthquake Information Center (NEIC) in Golden, Colorado. NEIC has three main missions: 1) to determine, as accurately and rapidly as possible, the location and magnitude of damaging earthquakes; 2) to collect and distribute seismic data for use in research; and 3) to pursue research into locating and understanding earthquakes. In support of these missions, NEIC distributes a number of products (see table B-2).

  USGS makes earth science data and maps available over the Internet. For example, data centers in northern and southern California provide maps of recent regional earthquakes, the location of and data from geodetic and seismic monitoring stations, and links to other Internet sites with related data or topics. Other information is becoming increasingly available for use by researchers, educators, and the public.

Future Directions

NEHRP achievements in recent years include increased awareness on the part of state and local officials, engineering associations, and other private sector organizations of earthquake hazards and risks. According to USGS, these groups have become more sophisticated as to what they need next from NEHRP. To better serve their needs, USGS has redesigned the major elements of its FY 1996 NEHRP effort as follows:

- assessing national and regional earthquake hazard and risk,
- assessing major urban area earthquake hazard and risk,
- understanding earthquake processes,
- providing national real-time earthquake hazard and risk assessment, and
- providing national geologic hazards information services.[4]

[4] Ibid.

TABLE B-2: National Earthquake Information Center Products

Title	Description
Quick Epicenter Determinations	Very preliminary list of significant quakes, compiled daily and available for computer access by telephone line.
Preliminary Determination of Epicenters	Initial locations prepared and distributed weekly to those contributing data to the NEIC; also published in a monthly listing available via the Superintendent of Documents in Washington, DC.
Earthquake Data Report	Monthly publication that provides additional, more detailed Information for seismologists on a data exchange basis.
Other products	CD-ROMs, maps, and an annual book of U.S. earthquakes.

SOURCE U S Geological Survey, National Earthquake Information Center, 1994 *Guide to Products and Services* (Golden, CO 1994)

Post-Earthquake Investigations

The 1990 NEHRP reauthorization[5] directed USGS to establish a post-earthquake investigation program, to study and learn lessons from major earthquakes. USGS has supported post-quake work for both U.S. and non-U. S., major earthquakes. This work has allowed USGS to collect perishable data on aftershocks and earthquake-induced damage.

After the Northridge earthquake in 1994, Congress passed a supplemental appropriations bill that, in part, funded USGS to install a seismic monitoring system that can better measure strong ground motions. This system will improve the ability to provide real-time information on earthquake size, location, and likely effects.

NATIONAL SCIENCE FOUNDATION

NSF receives about one-quarter of the NEHRP funding. Its NEHRP spending is in two distinct areas: fundamental earth science, and engineering and social science research. The earth science research, overseen by the Earth Sciences Division in the Directorate for Geosciences, accounts for 11.4 percent of NEHRP funds in FY 1994. The engineering and social science research in the Earthquake Hazard Mitigation Program within the Directorate for Engineering accounts for 15.6 percent of NEHRP funds. Figure B-2 provides funding trends in current dollars for both areas.

Earth Science Research

NSF uses NEHRP resources to support earthquake-related earth science research through two main channels: direct grants to researchers and support for various university consortia, including the Incorporated Research Institutions for Seismology (IRIS) and the Southern California Earthquake Center (see table B-3). In addition, using non-NEHRP funds, NSF supports the University Navstar Consortium (UNAVCO) that provides technical assistance and equipment to investigators for geodetic studies and other earth science research.

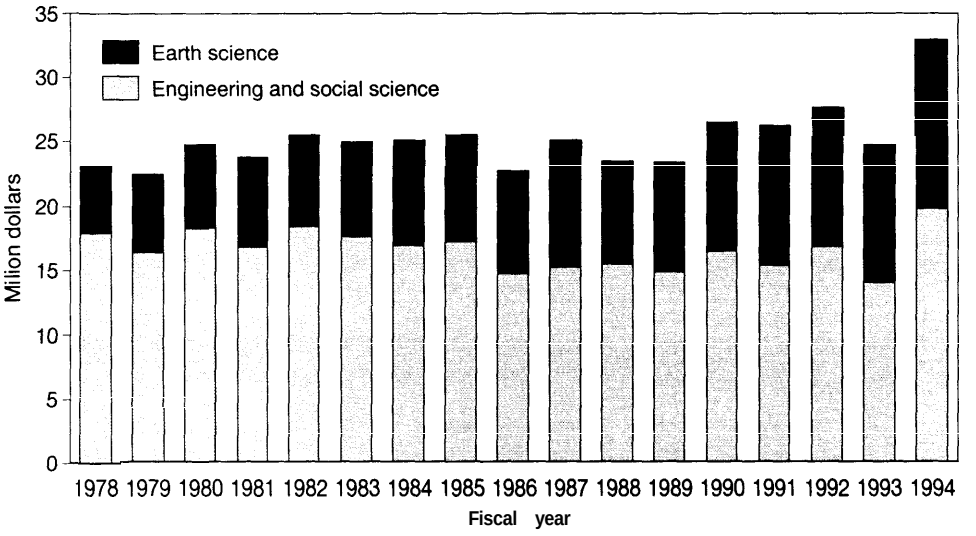
Direct Grants

NSF awards research grants directly to investigators for the study of earthquake sources, active tectonics, earthquake dating and paleoseismology, and shallow crustal seismicity.[6] For FY 1990 to 1994, instrument-based seismology, geodesy, and other tectonics received the bulk of the awards (on

[5] Public Law 101-614, Nov. 16, 1990.

[6] James Whitcomb, Director, Geophysics Program, National Science Foundation, personal communication, Nov. 21, 1994.

FIGURE B-2: NSF Spending Under NEHRP, FY 1978-94



SOURCE Office of Technology Assessment, 1995, based on National Science Foundation budget data

the order of 90 percent); paleoseismology and microzonation efforts, in contrast, comprised about 5 percent of the overall budget for direct grants (see table B-4).

Incorporated Research Institutions for Seismology

IRIS is a university-based consortium that supports research in seismology by providing facilities for instrumentation and for data collection, archiving, and distribution. IRIS is supported by NSF (in part with NEHRP funds) and by the Air Force Office of Scientific Research.

IRIS, in partnership with USGS, is building a multiuse global network of modem, digital seismograph stations. According to IRIS, the Global Seismographic Network supports NEHRP by enabling detailed assessments of the frequency of earthquakes around the world and of their anticipated ground motions. In 1994, 20 new stations were added to the network, bringing the total to 72.[7]

Through PASSCAL (Program for Array Seismic Studies of the Continental Lithosphere), IRIS provides portable instrumentation and support facilities for the study of seismic sources and earth structure. Under development is the Rapid Array Mobilization Program, intended to support rapid deployment of instruments in the field immediately after a large earthquake or volcanic event.[8]

Another significant function of IRIS is the Data Management System, which tracks the operation of the stations and archives the data. In addition, the IRIS Data Management Center (in Seattle, Washington) makes available via the Internet these data, customized data products, and a number of other historical data sets.

[7]Incorporated Research Institutions for Seismology, 1994 *Annual Report* (Arlington, VA: 1994), p. 5.

[8]Incorporated Research Institutions for Seismology, 1992 *Annual Report* (Arlington, VA: 1992), p. 18.

TABLE B-3: NSF Earth Science Spending, FY 1994

Element	Spending (million dollars)
Direct grants	$4,3
incorporated Research Institutions for Seismology	3.6
Southern California Earthquake Center	3.3
Total	**$11.2**

SOURCE: Office of Technology Assessment, 1995, based on detailed National Science Foundation budget data

TABLE B-4: Allocation of NSF Investigator Awards in Earth Science, FY 1990-94

Research area	Award totals (thousand dollars)	Percentage of overall awards
Seismology	$10,450	48.3
Tectonics		
Geodesy	3,763	17.4
Nongeodetic	4,966	22.9
Paleoseismology	711	3.3
Microzonation	383	1.8
Tsunami	305	1.4
Other	1,077	5.0
Total NSF grants	$21,655	100,0

NOTES: Other includes support for workshops, travel, and conferences. The total does not include staff salary and expenses.

SOURCE. Off Ice of Technology Assessment, based on 1994 National Science Foundation geosciences award data

Southern California Earthquake Center

SCEC serves as the focal point for regional studies of earthquake hazards and risk mitigation measures. The principal institutions involved are: University of Southern California; University of California-Los Angeles, San Diego, and Santa Barbara; California Institute of Technology; and Columbia University.

The center has a multidisciplinary outlook that promotes earthquake hazard reduction by defining when and where damaging earthquakes will occur in southern California, calculating expected ground motions, and communicating this information to the practicing engineering community and the public. Products include conditional probabilities for major faults, maps of seismotectonic source zones and regional probabilistic seismic hazards, assessments of the implications of recent patterns of seismicity in the greater Los Angeles area, and up-to-date earthquake source databases.

SCEC also supports the operation of a seismic network and several data centers. In addition, the center has facilitated installation of a comprehensive crustal strain monitoring network using the Global Positioning System (GPS). This is intended to provide improved hazard estimation from regional strain rates and increased understanding of post-quake deformation patterns.

TABLE B-5: NSF Earthquake Engineering Budget (excluding NCEER), FY 1994

Area	Budget (thousand dollars)	Research examples
Geotechnical	$2,621	Liquefaction, tsunamis.
Structural	2,722	Active controls, repair and rehabilitation.
Architectural and mechanical systems	2,719	Active controls, hazard evaluation.
Earthquake systems integration	2,567	Planning, social science.
Total	$10,629	

NOTE: Including the $4 million awarded to the National Earthquake Engineering Research Center (NCEER), the total FY 1994 National Science Foundation engineering budget was $14.629 million.

SOURCE: Office of Technology Assessment, 1995, based on National Science Foundation detailed budget data.

Principal support comes from NSF (SCEC is an NSF Science and Technology Center) and USGS; SCEC is also supported by FEMA, the California Department of Transportation, and the City and County of Los Angeles.

University Navstar Consortium

UNAVCO maintains a standardized GPS equipment pool and data archiving center. One of the primary applications of geodetic measurements to earthquake research is the comparison of contemporary plate velocities and the rates of intraplate and plate boundary zone deformation with geological and geophysical observations and models.[9] Space-based techniques have revolutionized geodetic studies; they offer significant improvements over surface techniques in several applications.

Earthquake Engineering

The NSF earthquake engineering budget for FY 1994 was $14.6 million. It includes $4 million for the National Center for Earthquake Engineering Research (NCEER); the remainder is divided among four major research areas (see table B-5).

National Center for Earthquake Engineering Research

NCEER, located in Buffalo, New York, was established in 1986 with a five-year, $25-million grant from NSF.[10] This grant was renewed in May 1991 for five more years and $21 million. Additional funds for the center are provided by the State of New York and by various institutions.[11] The center mission is to "advance engineering, planning and preparedness to minimize the damaging effects that earthquakes have."[12] As summarized in

9 University Navstar Consortium, FY 95-99 Proposal (Boulder, CO: n.d.), p. 7. Besides earthquake-related research, UNAVCO staff collaborate with the National Aerobatics and Space Administration, the National Center for Atmospheric Research, the National Oceanic and Atmospheric Administration, the Federal Aviation Administration, and university investigators in projects related to solid earth dynamics, climate, and meteorology.

[10]The decision to award this grant to the State (University of New York at Buffalo, instead of to a competing bid from California researchers, was a controversial one. The story of this battle is told in VSP Associates, Inc., "To Save Lives and Protect Property," final report prepared for the Federal Emergency Management Agency, Nov. 1, 1988, appendix C.

[11]For example, the total NCEER budget in 1993-94 was $11.5 million: $4.0 million from NSF, $3.0 million from the Federal Highway Administration for research into the seismic vulnerability of the national highway system, $2.0 million from the state of New York, and $2.5 million from other sources. National Center for Earthquake Engineering Research, *Program Overview 1992-94* (Buffalo, NY: 1994), p. 30.

[12]Ibid., p. 1.

TABLE B-6: Research Funded by NCEER, 1993-94

Area	Funding (thousand dollars)	Examples
Seismic hazard and ground motion	$384	Ground motion and site response, seismic zonation.
Geotechnical engineering	375	Liquefaction and lifelines,
Structures and systems	1,025	Retrofit methods, lifeline system analysis,
Risk and reliability	344	Development of risk-based design criteria,
Intelligent and protective systems	826	Base isolation, hybrid control systems,
Socioeconomic Issues	600	Insurance and mitigation relationships, estimating damage with geographical Information systems, hazard perception,
Implementation activities	446	Workshops, education and training.

SOURCE: Office of Technology Assessment, 1995, based on unpublished National Center for Earthquake Engineering Research (NCEER) budget data

table B-6, the research portfolio supported by NCEER ranges from geotechnical engineering to socioeconomic issues. 13

Geotechnical

NSF-sponsored work on geotechnical engineering includes studies of liquefaction, tsunamis, the response of soils to earthquakes, and the response of structures to ground motion. This research is, for the most part, applicable to all structures, including new and existing buildings and lifelines.

Structural

NSF-funded efforts in structures and earthquakes include support of research in active and hybrid control systems, design methodologies, seismic behavior of components such as reinforced concrete frames or precast panels, and lifeline design. A significant fraction of the research in this category is in the area of "structural control''—the use of active or hybrid intelligent control systems to reduce seismic damage in structures.

Architectural anti Mechanical Systems

Much of the work in architectural and mechanical systems looks at specific building components such as composite walls and reinforced concrete frames. As in the structural category, active or hybrid controls are a significant topic, accounting for almost one-third of the funding in this category.[14]

Earthquake Systems Integration

Behavioral, social science, planning, and similar research is funded in earthquake systems integration. Issues addressed include code enforcement, decisions to demolish or repair a building, information transfer, and international comparisons of mitigation.

[13] For further information, see National Center for Earthquake Engineering Research, *Research Accomplishments 1986-1994 (Buffalo, NY:* September 1994).

[14] Research into *structural control, active control, hybrid control,* or similar phrases accounts for 32 percent of funding in the architectural and mechanical areas. Source is NSF detailed budget data.

FEDERAL EMERGENCY MANAGEMENT AGENCY

FEMA has two distinct roles in NEHRP: 1) as lead agency, FEMA is charged with overall coordination of the program; and 2) it also has responsibility for implementation of earthquake mitigation measures.

History

FEMA's role in NEHRP can best be understood by looking at how its role has evolved over time. When NEHRP was founded in 1977, the legislation called for a lead agency but did not specify what agency was to take that role. FEMA was given lead agency status by executive order in 1979. This was confirmed by Congress in the NEHRP reauthorization for 1981,[15] which also provided an explicit authorization for FEMA spending on earthquakes.

In the early years of its NEHRP activities, FEMA functioned primarily as a coordinator rather than as a strong leader or director. A 1983 U.S. General Accounting Office (GAO) report criticized FEMA's leadership, noting that FEMA had not carried out several responsibilities assigned to it in the legislation. GAO found that "FEMA could better prepare the United States for a major earthquake by more aggressively implementing the [NEHRP] act's requirements and providing stronger guidance and direction to Federal agencies."[16] In 1987, an expert review committee, assembled to assist in NEHRP planning and review, noted that "serious questions were raised regarding FEMA's performance in its assigned role."[17] The committee recommended the creation of an oversight commission, with some budget authority for NEHRP activities.

The 1990 NEHRP reauthorization contained extensive reference to FEMA's role in NEHRP. Although there was not a clear change in FEMA's role, the legislation specifically directed FEMA to:

- prepare an annual NEHRP budget for review by the Office of Management and Budget,
- prepare a written NEHRP plan for Congress every three years,
- operate a program of state grants and technical assistance, and
- ensure appropriate implementation of mitigation measures.

According to the Senate report accompanying the legislation, the intent of this language was in part to separate FEMA's leadership function from its operational (implementation) role.[18]

The 1993-94 reauthorization hearings suggest that concerns over coordination and implementation continue. In the Senate hearings, a senator asked of the witnesses, "Has coordination among the four NEHRP agencies improved?"[19] In the House hearings, a representative asked, "Is the program doing enough to ensure application of its findings?"[20]

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[15] Public Law 96-472, Oct. 19, 1980.

[16] U.S. General Accounting Office, "Stronger Direction Needed for the National Earthquake Program," GAO/RCED-83-103, July 26, 1983, pp. i,ii.

[17] Federal Emergency Management Agency, "Commentary and Recommendations of the Expert Review Committee 1987," p. xiii.

[18] U.S. Congress, Senate Committee on Commerce, Science, and Transportation, *National Earthquake Hazards Reduction Program Reauthorization Act*, Report 101-446 (Washington, DC: Aug. 30, 1990), p. 12.

[19] U.S. Congress, Senate Committee on Commerce, Science, and Transportation, Subcommittee on Science, Space, and Technology, hearing, May 17, 1994, p. 4.

[20] U.S. Congresss, House Committee on Science, Space, and Technology, Subcommittee on Science, hearing, Sept. 14, 1993, p. 2.

TABLE B-7: FEMA Major Budget Components, FY 1993

Area	Approximate budget (million dollars)	Examples
Leadership	$1.3	User needs assessment. Small-business outreach program. NEHRP plans, reports, and coordination.
Design and construction standards	5.0	Manual for single-family building construction. Preparation of seismic design values. Preparation of NEHRP Provisions.
State and local hazards reduction	6.1	Grants to states and cities for mitigation programs. Grants to multistate consortia.
Education	1.1	Training in use of NEHRP Provisions. Dissemination of information on retrofit techniques,
Multiple hazards	1.7	Loss estimation software development. Wind-resistant design techniques,
Federal response planning	0.9	Urban search and rescue. National federal response.

SOURCE: Federal Emergency Management Agency, Office of Earthquakes and Natural Hazards, "Funds Tracking Report," Nov. 9, 1993,

Current Activities

FEMA currently conducts a broad range of activities under its NEHRP mandate.[21] Table B-7 lists the FY 1993 budget and examples of activities for each of six core areas of effort.

Leadership

According to the 1994 NEHRP report to Congress,[22] recent activities under FEMA's leadership function include:

- preparation of NEHRP plans and reports to Congress,
- assessment of user needs,
- support of earthquake professional organizations,
- arranging interagency meetings,
- support of problem-focused studies—specific issues of concern to the earthquake community, and
- outreach programs for small businesses.

Design and Construction Standards

FEMA contributes to the development of practices and standards to reduce seismic risk in both new and existing structures. Examples include sponsoring the development of the *NEHRP Provi-*

[21] This section draws on Federal Emergency Management Agency, *Building for the Future,* NEHRP FY 1991-1992 Report to Congress (Washington, DC: December 1992); Federal Emergency Management Agency, *Preserving Resources through Earthquake Mitigation,* NEHRP FY 1993-1994 Report to Congress (Washington, DC: December *1994);* and Federal Emergency Management Agency, Office of Earthquakes and Natural Hazards, "Funds Tracking Report, FY 1993," 1993,

[22] Federal Emergency Management Agency, *Preserving Resources through Earthquake Mitigation, see* footnote 21.

sions (a synthesis of design knowledge for adoption by model codes),[23] development of handbooks for retrofitting existing buildings, and support of an earthquake testing and research facility at the University of Nevada.

State and Local Hazards Reduction Program

States and local governments bear primary responsibility for implementing plans and technologies to increase the resilience of communities toward seismic hazards and thus minimize the long-term effects of earthquakes. Through its State and Local Hazards Reduction Program, FEMA provides grants to states, local governments, and multistate consortia to support their earthquake mitigation activities. Of the 43 states and territories[24] with low to very high degrees of seismic hazard, 28 participate in one manner or another in the FEMA program. Seventeen of these states joined NEHRP at its inception in 1977.

Activities funded by FEMA grants vary, but typically involve education, outreach, code adoption, training, and similar implementation activities. Indiana, for example, used FEMA funding to develop a brochure on techniques to measure risk in existing buildings, North Carolina used FEMA funding to update its building code to include seismic provisions, and Arizona conducted public awareness and education workshops.[25]

Financial Requirements

Current cost-sharing regulations are that FEMA provides 100 percent of the first year's funding; 25- and 35-percent in-kind matches are required for years two and three; and a 50-percent cash match from states is necessary for the following years.[26] The effects of the matching requirement vary greatly among states. Participation by some states appears to decline after reaching the 50-percent cash threshold; others have declined to participate at all because of the cash requirement.

For example, of the six states in the highest risk category, only Wyoming does not formally participate in NEHRP. Wyoming indicated that fourth-year financial requirements (i.e., 50-percent cash match) precluded such involvement. However, it does participate in NEHRP-related activities and belongs to the Western States Seismic Policy Council.

Program Elements

The five primary matching fund program elements are: Leadership and Program Management; Fundamental Research and Studies; Hazard Mapping, Risk Studies, and Loss Estimation; Hazard Mitigation; Preparedness and Response/Recovery Planning; and Information and Education. In addition, there is a "Special Projects and Other Programs" category. Under the latter, for example, New York State established in 1990 an Earthquake Lifelines Project to assess earthquake hazards, analyze lifeline vulnerability to support mitigation efforts, inform and educate the public, and provide training.

Typically, state efforts in the mitigation category relate to bridge safety analysis and reinforcement. New Jersey's activities under this program, however, also include a Prudent Business Practices program that encourages businesses to educate their employees and customers about seismic risks. At least nine states have activities in all NEHRP matching fund program areas.[27]

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[23] Building and Seismic Safety Council, *NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings*, 1991 Ed., prepared for Federal Emergency Management Agency (Washington, DC: January 1992).

[24] Including Guam, Puerto Rico, and the U.S. Virgin Islands.

[25] Examples from Federal Emergency Management Agency, *Building for the Future*, see footnote 21.

[26] VSP Associates, Inc., "State and Local Efforts To Reduce Earthquake Losses: Snapshots of Policies, Programs, and Funding," report prepared for the Office of Technology Assessment, Dec. 21, 1994.

[27] Arkansas, California, Kentucky, Mississippi, Missouri, Nevada, New Jersey, New Mexico, and Tennessee.

Regional Efforts

Three regional organizations play important roles in supporting individual states' seismic safety efforts: the Western States Seismic Policy Council, founded in 1977; the Central United States Earthquake Consortium (CUSEC), established in 1985; and, most recently, the Northeastern States Earthquake Consortium. CUSEC is the only one of the three groups that receives federal funds. These groups typically facilitate the exchange of information among states; provide a convenient mechanism for holding meetings and training sessions; act as an "issue network" by helping to forge state views on NEHRP priorities and programs; and, because of their administrative flexibility, can often do more things for their member states than individual state procedures allow.[28]

Education

FEMA supports a number of educational activities, including a course on post-earthquake reconstruction, a natural hazards information center, and dissemination of information on existing building retrofits.

With funding from USGS and NSF as well as FEMA, the Natural Hazards Research and Applications Information Center in Boulder, Colorado, serves as a national clearinghouse for information on the economic loss, human suffering, and social disruption caused by earthquakes, floods, hurricanes, tornadoes, and other natural disasters.

Multi-Hazard Assessment and Mitigation

Some FEMA activities in NEHRP address multiple hazards. For example, FEMA recently supported work on wind-resistant designs for buildings. Also under this heading is FEMA's support of the development of a loss estimation computer tool for use by cities and states in earthquake planning.

Federal Response Planning

FEMA has primary responsibility for preparing the federal government for national emergencies. FEMA activities include carrying out exercises, getting agencies to agree on emergency response plans, and supporting regional operating centers. FEMA has also supported urban search and rescue teams.

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

NIST's role in NEHRP has been largely in applied engineering research and code development. The agency's funding under NEHRP has been low—less than $500,000 annually until the 1990s—so its NEHRP-related activities have been modest in size and scope. Current NEHRP funding is approximately $1.9 million.

Funding History

The initial NEHRP legislation did not provide explicit authorization for NIST (then the National Bureau of Standards), but NIST did receive some funding in the early years of NEHRP. The 1980 NEHRP reauthorization bill specifically authorized NIST as one of the four key NEHRP agencies, and these authorizations have continued in subsequent bills. In recent years, NIST's budget for earthquake-related activities has expanded due to contributions from other federal agencies, as well as a small contribution from the private sector. In FY 1994, for example, NIST received an additional $1.5 million from the Northridge supplemental appropriations for a total NIST earthquake-related budget of nearly $3.6 million.[29]

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[28] Examples include securing out-of-state consulting assistance and paying honoraria and invitational travel so that speakers can participate in training conferences.

[29] Richard N. Wright, Director, Building and Fire Research Laboratory, National Institute of Standards and Technology, testimony at hearings before the Senate Committee on Commerce, Science, and Transportation, May 17, 1994, table 1.

Activities

NEHRP's initial legislation and subsequent amendments did not define a specific role for NIST. In the 1980s, NIST's activities were "exclusively focused on the studies of performance of buildings through in-house experimental and analytical research."[30] The 1990 NEHRP reauthorization defined NIST's role as follows: "The National Institute of Standards and Technology shall be responsible for carrying out research and development to improve building codes and standards and practices for structures and lifelines."[31]

Increased funding since 1990 has allowed NIST to expand into new areas. Its current NEHRP-related work includes:[32]

1. Applied engineering research:
   - preparation of guidelines for testing and evaluation of seismic isolation systems,
   - development of design provisions for precast concrete connections and for seismic strengthening of concrete frame buildings,
   - testing of masonry walls to determine shear capacity, and
   - development of improved methods to predict the effects of ground motion on lifelines.
2. Code development and distribution, including technical support for model code adoption of the NEHRP Provisions.
3. Technology transfer (e.g., support of conferences and meetings for engineering research).
4. International cooperation, including technical and financial support for various meetings and exchange programs with other countries.

OTHER RELATED FEDERAL AGENCY ACTIVITIES

Several federal agencies in addition to the four primary NEHRP agencies spend many millions of dollars in earthquake mitigation. These efforts include evaluating the seismic safety of facilities and improving their seismic resistance, conducting earthquake-related research and development, and other efforts.[33] Although detailed agency spending data are not available, this non-NEHRP federal spending on earthquake-related research and development on upgrading the seismic resistance of facilities probably exceeds the $100 million spent annually by the four primary NEHRP agencies.[34] The contributions of many non-NEHRP agencies are summarized in table B-8.

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[30] Riley Chung, National Institute of Standards and Technology, personal communication, June 30, 1994.

[31] Public Law 101-614, sec. 5b5, Nov. 16, 1990.

[32] Federal Emergency Management Agency, *Preserving Resources through Earthquake Mitigation*, see footnote 21.

[33] David W. Cheney, Congressional Research Service, "The National Earthquake Hazards Reduction Program," 89-473SPR, Aug. 9, 1989.

[34] The last budget data were for the period ending 1987. Ibid., p. 20.

TABLE B-8: Summary of Federal Earthquake-Related Activities

Agency/department	Examples
National Aerobatics and Space Administration (NASA)	NASA conducts research and development (R&D) in basic earth processes. Its space-based geodesy program has enabled important advances in monitoring and characterizing crustal deformation and strain before, during, and after seismic events
National Oceanic and Atmospheric Administration (NOAA)	NOAA provides real-time tsunami warnings for the United States and its possessions and territories; the warnings are issued from two centers, located in Alaska and Hawaii. In addition, NOAA's seafloor mapping and monitoring of marine earthquakes support improved understanding of offshore earthquake hazards and the reduction of tsunami risk. NOAA also disseminates earthquake and tsunami data through the National Geophysical Data Center.
Department of Energy (DOE)	DOE has conducted earthquake hazard research related to nuclear powerplants and waste disposal. DOE has upgraded the seismic resistance of many of its facilities, including its national laboratories and nuclear weapons production facilities. As part of its nuclear energy research programs, DOE has also studied ways to Improve the seismic safety of new reactor designs.
Nuclear Regulatory Commission (NRC)	In the past, NRC has sponsored seismographic networks in the eastern United States to aid in analyzing seismic risks to nuclear powerplants. The commission has also conducted engineering research related to improving the seismic resistance of nuclear powerplants and waste disposal facilities.
Department of Defense (DOD)	DOD has a seismic safety program to ensure appropriate seismic safety of its facilities, and conducts seismic R&D with applications to other government and privately owned infrastructure. The Army Corps of Engineers, for example, addresses the seismic safety of dams. DOD also operates seismic stations for nuclear test monitoring and supports seafloor research (by the Office of Naval Research).
Department of Transportation (DOT)	DOT conducts seismic research in advanced earthquake-resistant design, construction, and retrofit of highway bridges through the American Association of State Highway and Transportation Officials specifications and guides of recommended practice, assesses DOT facilities to prevent interruption of vital functions; and provides immediate response after major earthquakes.
Bureau of Reclamation, Department of the Interior	The bureau is the lead technical agency for Interior's Safety of Dams Program. In addition to dam modifications, it conducts seismotectonic studies, operates three seismic networks in Colorado and Wyoming, and operates strong-motion instruments at dams and other critical facilities.
Department of Veterans Affairs (VA)	Since 1971, the VA has undertaken the seismic strengthening of its hospitals in areas of moderate and high seismic hazard.
Department of Housing and Urban Development (HUD)	HUD funds earthquake studies related to disaster response, damage assessment, and mitigation; conducts seismic risk assessments for HUD-assisted properties; develops seismic safety standards for such properties, as well as for manufactured housing; and provides major rebuilding and emergency housing assistance to earthquake-stricken communities.
Centers for Disease Control and Prevention (CDC), Department of Health and Human Services	CDC conducts research on the health impact of natural and technological disasters in order to develop strategies to prevent or reduce future disaster-related health problems.

SOURCES: Office of Technology Assessment, based on David W. Cheney, Congressional Research Service, "The National Earthquake Hazards Reduction Program, " 89-473SPR, Aug. 9, 1989; and unpublished Office of Science and Technology Policy material, For a further description of earthquake programs in these and other contributing federal agencies, see Federal Emergency Management Agency, *Preserving Resources Through Earthquake Mitigation,* FY 1993-94 NEHRP Report to Congress (Washington, DC: December 1994), pp. 131-170