MARTIN MARIETTA

ES/CNPE-2

EARTHQUAKE RISK REDUCTION IN THE UNITED STATES

AN ASSESSMENT OF SELECTED USER NEEDS AND RECOMMENDATIONS FOR THE NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM

December 31, 1994

Prepared for the
FEDERAL EMERGENCY MANAGEMENT AGENCY
by the
Center for Natural Phenomena Engineering
Oak Ridge, Tennessee

MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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We greatly appreciate the effort put forth by all participants of the Assessment. The Assessment Team members (Appendix A) did an outstanding job of meeting the compressed schedules of this project, approached it with enthusiasm, and responded positively to all last-minute requests by the Project Lead Team.

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Brian Cowan
FEMA Project Manager

James E. Beavers
CNPE Director

EXECUTIVE SUMMARY

This Assessment was conducted to improve the National Earthquake Hazards Reduction Program (NEHRP) by providing NEHRP agencies with information that supports their user-oriented setting of crosscutting priorities in the NEHRP strategic planning process.

The primary objective of this Assessment was to take a "snapshot" evaluation of the needs of selected users throughout the major program elements of NEHRP. Secondary objectives were to conduct an assessment of the knowledge that exists (or is being developed by NEHRP) to support earthquake risk reduction, and to begin a process of evaluating how NEHRP is meeting user needs. An identification of NEHRP's strengths also resulted from the effort, since those strengths demonstrate successful methods that may be useful to NEHRP in the future. These strengths are identified in the text, and many of them represent important achievements since the Earthquake Hazards Reduction Act was passed in 1977.

Selected users are categorized into four broad areas in this Assessment:

1. Seismic Hazard (users involved with seismic hazard research, risk reduction, and knowledge dissemination and users needing the knowledge to carry out earthquake risk reduction),

2. Built Environment (users involved with ownership, education, research, design and construction of lifelines, buildings, and other built facilities and users involved with regulatory, implementation, and decision-making for lifelines, buildings, and other built facilities),

3. Societal and Policy (users involved with social issues, economics, education, research for development of socioeconomic knowledge, and users needing the knowledge for decision-making for reducing the earthquake risk), and

4. Implementation (users involved with the implementation of earthquake risk reduction—e.g., code, emergency, public and health care officials—and users involved with research and education for improved implementation techniques).

For each of the four areas, an assessment team was established to gather user needs through interviews, mail surveys, and workshops. During the Assessment, over 900 selected NEHRP users had some level of direct input into the results of this Assessment, and 188 of those users were personally interviewed by a member of one of the assessment teams.

The Assessment effort was divided into six basic tasks: (1) identify selected users, (2) gather information, (3) compile and assess results, (4) develop recommendations and assess results, (5) conduct a user workshop, and (6) document the results.

Analysis of user input resulted in the identification of 37 major findings and corresponding recommendations in the four areas (10 in Seismic Hazard, 5 in Built Environment, 15 in Societal and Policy, and 7 in Implementation). NEHRP can improve its support of the user community by being mindful of these findings.

Common themes can be identified among findings and corresponding recommendations. Thus further analysis of the findings and recommendations (including the results of the workshop) was conducted. The analysis approach involved reviewing each finding with the goal of listing similar findings. As an example, for finding 3.6, it appeared that the root cause was funding; thus it was placed into a category called "Funding." This category represented a program-wide issue. During the initial phase of the analysis, 12 potential categories were identified. After several analysis iterations, however, six categories were left, categories that the Project Team felt encompassed all findings of the four assessment areas. These categories are major issues identified as (1) Funding, (2) Management, (3) Consensus, (4) Linkages-Research to User, (5) Codes and Standards, and (6) Education and Information Flow.

The table given below shows how each finding representing a generic area fits within the major issues. In only one case does a finding fall under two major issues. This was finding 3.8, whose recommendation dealt with funding needs and linkage between the user and researcher.

One of the pitfalls of analyzing common themes among 37 major findings and corresponding recommendations is that the reader of the six encompassing issues and corresponding recommendations will not appreciate the specifics of the 37 findings nor the analysis of each finding that led to specific recommendations. In addition, without reading the discussion of a specific finding (Chapters 3 through 6) or the discussion of the six issues (Chapter 10), it will be easy for a reader to misinterpret the teams' analysis logic that led to a finding or issue and corresponding recommendations.

Categorization of findings and recommendations into major issue

Funding	Management	Consensus	Linkage - researcher to user	Codes and standards	Education and information flow
Finding:	Finding:	Finding:	Finding:	Finding:	Finding:
3.6	3.1	3.3	3.5	4.2	3.1
3.8	5.10	3.4	3.8	4.3	3.2
6.4	5.12	3.7	4.1	4.4	3.9
	5.13		5.15	5.9	4.5
	5.14		5.3		5.1
	5.2		6.5		5.4
	5.7				5.5
	5.8				5.6
	6.6				5.11
					6.1
					6.2
					6.3
					6.7

For example, finding 3.1 states: "Awareness of what NEHRP supports and produces depends on personal contacts." An interpretation of this finding could be that the NEHRP agencies are not doing anything when it comes to publications and distribution of information to users. That is not the case, but the reader must read the discussion that led to that finding to fully understand what the finding means.

As a result, the authors of this document suggest that reading only the executive summary will not allow a reader to fully appreciate the needs that the users identified or what the teams went through to develop the final six issues and recommendations.

Those six issues and their recommendations are:

1. Funding

Issue. The availability of funding has prevented NEHRP from being a truly national program and has limited the pace of mitigation.

Recommendation. NEHRP needs to develop a strategic plan that addresses program priorities in the short and long term. NEHRP needs to leverage the funding for its own programs through greater cooperation with other federal agencies, state, and local governments, and private industry. Such cooperation could reduce some of the barriers to implementation and mitigation faced by state and local officials.

2. Management

Issue. Improvements need to be made in the overall management of NEHRP and NEHRP's coordinating support and cooperation with other federal agencies, state and local governments, private industry, and regional consortia to make significant gains in seismic risk reduction.

Recommendations. A management structure should be set up to ensure better coordination, cooperation, and support of all federal agencies, state and local governments, and nongovernmental organizations that are working in seismic risk reduction. NEHRP educational, training, and implementation programs should be tailored to user needs. NEHRP needs to include improved incentives or other alternative mechanisms to increase user support of seismic risk reduction.

3. Consensus

Issue. The lack of consensus for a number of NEHRP products is limiting the pace of risk reduction.

Recommendation. NEHRP needs to place a greater emphasis on the process of establishing consensus to ensure that consensus is achieved in the various products it develops before such products are distributed or introduced for broad use in seismic risk reduction activities. Some levels of consensus must be achieved even for products distributed for trial use; however, one must be careful when selecting products that require consensus, since obtaining consensus can be a significant impediment to timely transfer of a product to a user.

4. Linkages-Research to User

Issue. In all four assessment areas of NEHRP, the linkage is broken among various research products, user needs for those products, or a user's ability to use the products.

Recommendations. In parallel with recommendation 10.3.2, NEHRP must establish mechanisms to obtain user input in research agendas and priorities, and communication links should be set up through advisory committees and/or research/user-need summit meetings. In addition, NEHRP should conduct future self-assessments (such as this one) to continually determine whether research products fulfill user needs.

5. Codes and Standards

Issue. The lack, and the need for improvement, of existing codes, standards, guidelines, and methodologies are slowing the pace of seismic risk reduction.

Recommendations. NEHRP should address this issue in its strategic planning process; specifically evaluate the current status and user needs for codes, standards, guidelines, and methodologies; establish a plan for addressing the issue; and implement the plan as soon as possible.

6. Education and Information Flow

Issue. There is a significant need for more education and for improvements to information flow from researcher to user to enhance NEHRP and seismic risk reduction.

Recommendations. NEHRP needs to reevaluate its educational and information service activities, to become more proactive rather than reactive, and, in its strategic planning process, to develop new educational and information requirements that, when evaluated against the 13 Assessment findings that reflect this issue, will be considered as addressing those findings.

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ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ADA	Americans with Disabilities Act
A/E	Architect and engineering firm
AGA	American Gas Association
AIA	American Institute of Architects
AICP	American Institute of Certified Planners
AISC	American Institute of Steel Construction
APA	American Planning Association
API	American Petroleum Institute
APPA	Association of Physical Plant Administrators
ASBO	Association of School Business Officials
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ATC	Applied Technology Council
AWWA	American Water Works Association
BA	Bachelor of Arts (degree)
BAREPP	Bay Area Regional Earthquake Preparedness Project
BBS	(computer) bulletin board system
BET	Built Environment Team
BOCA	Building Officials and Code Administrators Association
BS	Bachelor of Science (degree)
BSSC	Building Seismic Safety Council
CA	California
CABO	Council of American Building Officials
CADRE	Community Agency Disaster Relief Effort
CALBO	California Building Officials
CCA	Comprehensive Cooperating Agreement
CCB	Construction Criteria Base
CDMG	California Division of Mines and Geology
CD/ROM	Compact disk/read only memory
CEQA	California earthquake attenuation studies
CERI	Center for Earthquake Research and Information
CEO	chief executive officer
CNPE	Center for Natural Phenomena Engineering

COE	Corps of Engineers
CUSEC	Central United States Earthquake Consortium
DEM	Department (or Division) of Emergency Management
DNR	Department of Natural Resources
DOE	(U.S.) Department of Energy
DOGAMI	Department of Geology and Mineral Industries
DOG-DGER	Department of Natural Resources—Department of Geology and Earth Resources
DRC	Disaster Research Center
DSR	Disaster Survey Report
DVA	(U.S.) Department of Veterans Affairs
EE	electrical engineering
EERC	Earthquake Engineering Earthquake Center
EERI	Earthquake Engineering Research Institute
EM	emergency management
EMA	emergency management agency
EMI	Emergency Management Institute
E/O	(lifeline) engineer and operator
EOC	emergency operating center
EQ	earthquake/environmental quality
EPRI	Electric Power Research Institute
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
GAO	(U.S.) General Accounting Office
GIS	geographic information system
GM	ground motion
GMA	Growth Management Act
GPS	global positioning systems
GRI	Gas Research Institute
GSA	(U.S.) General Services Administration
GSG	geotechnical and structural geology
HO	health official
IAPMO	International Association of Plumbing and Mechanical Officials
ICBO	International Conference of Building Officials
ICSSC	Interagency Committee on Seismic Safety in Construction

IEEE	Institute of Electrical and Electronics Engineers
IRIS	Incorporated Research Institution for Seismology
MS	Master of Science (degree)
MSU	Memphis State University
MSU-CERI	MSU-Center for Earthquake Research and Information
MTAS	Municipal Technical Advisory Service
NA	not applicable/not available
NAPA	National Academy of Public Administrators
NCEER	National Center for Earthquake Engineering Research
NEHRP	National Earthquake Hazards Reduction Program
NEIC	National Earthquake Information Center
NEIS	National Earthquake Information Service
NEPC	National Earthquake Prediction Council
NERRP	National Earthquake Risk Reduction Program (proposed title change for NEHRP)
NESEC	New England States Earthquake Consortium
NFPA	National Fire Protection Association
NIBS	National Institute of Building Sciences
NISEE	National Information Services Earthquake Engineering
NIST	National Institute of Standards and Technology (former National Bureau of Standards)
NMSZ	New-Madrid seismic zone
NOAA	National Oceanic and Atmospheric Administration
NRC	Nuclear Regulatory Commission
NSEQ	nonstructural earthquake (hazards)
NSF	National Science Foundation
OES	Office of Emergency Services
OR	Oregon
OSA	Office of the State Architect
PAS	professional association
PG&E	Pacific Gas and Electric Company
PhD	Doctor of Philosophy (degree)
PI	principal investigator
PNW	Pacific Northwest
PBS	Public Broadcasting System
PSHA	Probabilistic Seismic Hazard Assessment

PTA	Parent-Teacher Association
PUC	Public Utilities Commission
SBC	Southern Building Code
SBCCI	Southern Building Code Congress International, Inc.
SCEC	Southern California Earthquake Center
SCEPP	Southern California Earthquake Preparedness Project
SCS	Soil Conservation Service
SEAOC	Structural Engineers Association of California
SEAW	Structural Engineers Association of Washington
SEMA	state emergency management agency
SEMSU	Southeast Missouri State University
SEMSU-EEC	SEMSU Earthquake Education Center
SEOC	State Emergency Operations Center
SMACNA	Sheet Metal and Air-Conditioning Contractors' National Association
SMART	Strong motion amplitude and response in time
SPI	Superintendent, Public Instruction (Washington state office)
TBOA	Tennessee Building Officials Association
TCLEE	Technical Council on Lifeline Earthquake Engineering
TEMA	Tennessee Emergency Management Agency
TN	Tennessee
UBC	Uniform Building Code
UCA	University of California
UCEER	University Consortium of Earthquake Engineering Research
UO	University of Oregon
URM	unreinforced masonry
USBR	U.S. Bureau of Reclamation
USC	University of Southern California
USGS	United States Geological Survey
UW	University of Washington
VA	Veterans Administration
WA	Washington
WABO	Washington Building Officials
WDOT	Washington Department of Transportation

WES	Waterways Experiment Station
WSSPC	Western States Seismic Policy Council
WTCEA	West Tennessee Code Enforcement Association

1. INTRODUCTION

1.1 OBJECTIVES

The primary objective of the 1993 National Earthquake Hazards Reduction Program (NEHRP) Assessment was to take a "snapshot" assessment of the needs of selected users throughout all major program areas of NEHRP. Secondary objectives were to conduct an assessment of the knowledge that exists (or is being developed by NEHRP) to support earthquake risk reduction, and to begin a process of evaluating how NEHRP is meeting user needs. The two secondary objectives were basically a result of the assessment teams' efforts to understand and establish baselines for determining user needs (the first objective). Although not a stated objective of this Assessment, identification of NEHRP's strengths resulted from the effort. Those strengths are discussed in Section 9. This Assessment is meant to provide NEHRP agencies with information that supports their user-oriented setting of crosscutting priorities in a NEHRP strategic planning process.

The Assessment categorizes the selected users into four generic areas:[1]

1. Seismic Hazard (users involved with seismic hazard research, risk reduction, and knowledge dissemination and users needing the knowledge to carry out earthquake risk reduction),

2. Built Environment (users involved with ownership, education, research, design and construction of lifelines, buildings, and other built facilities and users involved with regulatory, implementation, and decision-making for lifelines, buildings, and other built facilities),

3. Societal and Policy (users involved with social issues, economics, education, research for development of socioeconomic knowledge, and users needing the knowledge for decision-making for reducing the earthquake risk), and

4. Implementation (users involved with the implementation of earthquake risk reduction, e.g., code, emergency, public and health care officials and users involved with research and education for improved implementation techniques).

These areas are not mutually exclusive. A user could easily be involved in more than one area.

1.2 BACKGROUND

To help establish a clear understanding of the purpose and scope of this Assessment, it is worthwhile to describe the background and events leading to its initiation.

The Earthquake Hazards Reduction Act, as amended, defines what is known as the NEHRP. The NEHRP agencies are the Federal Emergency Management Agency (FEMA), the National Institute for Standards and Technology (NIST), the National Science Foundation (NSF), and the United States Geological Survey (USGS). In this act, FEMA is established as the lead agency. In addition, the act requires these agencies to jointly prepare program plans at least every 3 years to include tasks and milestones required in conducting the activities of NEHRP.

[1]Others may divide the NEHRP into more categories or define the areas differently.

The 1990 amendment to the act established an Advisory Committee to advise NEHRP agencies on planning and implementing NEHRP and to submit a written report, describing any recommendations the Advisory Committee has made to NEHRP agencies, directly to Congress by January 31 of each calendar year.

In 1991, the program plan for NEHRP was updated, covering the 5-year period of FY 1992–1996. Since the timing of the preparation of the NEHRP plan and the formation of the Advisory Committee did not coincide, the plan could not reflect full input, review, and advice of the Advisory Committee. In the Program Integration Subcommittee[2] Working Paper, it is stated that:

> The current five-year plan for NEHRP developed by the agencies is...a list of topics, with no explicit statements of long-term goals, short-term objectives, or priorities.

At its March 1992 meeting, the NEHRP FY 1993 budget was presented to the Advisory Committee by the NEHRP agencies. This presentation prompted a proposal that the agencies conduct a comprehensive and complete inventory (an assessment) of the knowledge that exists to support effective earthquake engineering. The proposal was based, in part, on the desire for better prioritization and a problem-focused orientation for the earthquake engineering research supported by NEHRP.

In reviewing the proposal, FEMA felt that such an effort should be broadly based—the setting of priorities should cut across all NEHRP activities. This proposal was readily accepted by those discussing it, and, moreover, was in line with the general thinking at that time of the Program Integration Subcommittee's views on a NEHRP strategy-based program planning process. The activity to fulfill the requirements of the broader proposal thus became known as the NEHRP Assessment, or Assessment.

FEMA accepted responsibility for funding the Assessment because its lead-agency role included the need to conduct program planning. FEMA then established an interagency agreement with the Department of Energy (DOE) to conduct the Assessment and obtained the services of the Center for Natural Phenomena Engineering (CNPE) of Martin Marietta Energy Systems, Inc., a managing contractor to the DOE. Organizational and technical capabilities to manage a diverse collection of experts that represent the full breadth of NEHRP activities exist within CNPE through matrix activities with other Energy Systems organizations.

Work planning for the Assessment was begun in September 1992, after the interagency agreement was in place. (Project lead team members are listed in Appendix A.1.) A draft workplan was presented to the Advisory Committee at its October 1992 meeting. Reaction focused on two aspects: (1) that the Assessment reflected in the workplan was overly ambitious for the time and budget available to it; and (2) if the NEHRP agencies were going to conduct priority-based planning on the foundation of the information the Assessment would provide, then it was vital to involve the NEHRP user community in the identification of NEHRP needs.

The NEHRP agencies met subsequently and agreed that the scope of the Assessment needed to be reduced, and that user needs were vital to the relevance of the Assessment. In order for the Assessment to effectively impact NEHRP planning, time considerations were discussed and explained. Subsequently the workplan was revised to be responsive to available time and funds. Presentation of the Assessment project by FEMA (as funding agency of the project) at the January 1993 meeting of the Advisory

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[2]A subcommittee of the Advisory Committee.

Committee reflected a clear recognition that the Assessment should be considered the first step of a more comprehensive and continuing effort.

Advisory Committee comments and recommendations on the January presentation are included as an appendix to the Advisory Committee's 1993 report to the Congress. Principal among the comments are:

- Caution should be exercised in the identification of users and the collection of information from them, so that the most effective and useful input to the program is gathered.

- The schedule may be unrealistic, but could be accommodated if preliminary information is acceptable for commencement of the Program planning process.

- The project is feasible if depth is not a preoccupation and if it is viewed as an ongoing effort.

- The NEHRP Assessment as stated in the presented approach is actually seeking...participation in the decision process...of the user groups. That is a good goal to have.

A final draft of the workplan was approved by FEMA in February 1993 as the basis to begin the Assessment.

1.3 INITIATION OF ASSESSMENT

During March and April 1993, assessment teams were established in each generic area. Their selection was based on individual experience, capability, and knowledge of the generic area; geographic distribution; and any available and prior experience with such activities. Once all of the assessment teams were in place and the Steering Committee was formed, a kickoff meeting for the Assessment was held on June 2-3, 1993.

1.4 SCOPE OF ASSESSMENT

To provide a snapshot of selected users' needs and to place the conduct of the Assessment into a manageable forum, the scope of work was divided into the four generic user areas as defined above: seismic hazard, built environment, societal and policy, and implementation. NEHRP users are from a broad spectrum of professions and include geoscientists, seismologists, engineers, social scientists, economists, educators, emergency responders, health officials, and building code officials. The scope of the Assessment's workplan had two restraints: (1) to limit the input of the user community to selected users; and (2) to provide some preliminary results so as to have impact on the NEHRP agencies' next planning phase, which was to begin in December 1993. A crucial and underlying part of the project, however, was that the scope of work required each assessment team to integrate its assessment approach, findings, and results with the other assessment teams as the Assessment progressed.

Once the teams had been identified, the six basic tasks of the Assessment were to: (1) identify a group of selected users, (2) gather information, (3) compile and assess results, (4) develop recommendations, (5) conduct a user workshop, and (6) document the results. The six tasks are more clearly defined as follows:

Task 1

Each assessment team identified selected users of earthquake risk reduction knowledge and research in a process that would ensure input to the Assessment from the most knowledgeable user (characterized as a collaborative user) to the least knowledgeable user (characterized as an end-user). The knowledgeable user is defined as a professional who is very familiar with NEHRP activities, and possibly is even a champion of such activities. The least knowledgeable user is defined as a professional who is not very familiar with NEHRP but who needs NEHRP products and services to carry out his or her responsibilities. Users were chosen from a broad representative base in order to obtain, as best as possible, a determination of user needs in each team's fundamental area of NEHRP. This selection process occurred primarily during June and July 1993.

Task 2

Information gathering was planned to involve mail surveys and personal interviews of individuals and groups of users. Advanced trial runs of the interview process were extremely successful in obtaining user response; thus the use of formal mail surveys was not as extensive as originally planned. Section 8 discusses the results of two specific mail surveys, and a third mail survey is discussed in Section 4. Personal interviews often were on the order of 1 to 2 hours long. Common questionnaire guides were used to elicit responses from users concerning deficiencies, needs, and strengths of NEHRP. The teams used differing questionnaires to fit their areas of focus. Depending on how team members divided their tasks and depending on their approach to their user community, differing guides were used within disciplines. The team-specific data-gathering process is detailed in Sections 3 through 6. The data gathering occurred primarily during July, August, and September 1993.

Each interview was documented, and the detailed responses are archived in project files. Anonymity of interviewees has been maintained, where requested, even in those project files. In cases where names of interviewees are used in this report in reference to a particular need or concern, the interviewee has been asked for permission and to verify the accuracy of the reference.

In addition to information gathering through surveys of selected users, the Assessment Teams reviewed numerous publications by NEHRP and other agencies/organizations that interact with NEHRP. A bibliography is included as Appendix B.

Task 3

After conducting its interviews, each team evaluated, integrated, and summarized the results to identify common themes, needs, and findings for NEHRP. In addition, as part of this Assessment, teams shared common concerns. This process is described more fully in Sections 3 through 6 of this report.

Task 4

The next step was for each team to distill the common themes and single-area user needs and compile them into findings and recommendations. Each team's analysis of the common themes and needs resulted in findings and recommendations that include changes in process, areas where new knowledge is needed, methodologies and strategies to improve the transfer of knowledge, and delivery systems to meet those needs. These recommendations are also discussed further in Sections 3 through 6.

Task 5

Following the teams' development of findings and recommendations, a focused workshop was conducted that allowed for participation of a mix of selected users (some of whom had participated in the surveys and some of whom had not) to review the findings and recommendations for still further validation and calibration of the Assessment and to fill in any gaps in the assessments of user needs. This workshop, held on November 18-19, 1993, is discussed in Section 7.

Task 6

Results of the Assessment are being documented in this report to provide the NEHRP agencies with information that supports their user-oriented setting of crosscutting priorities in the NEHRP planning process and that establishes a foundation for further efforts to refine, update, and assess user needs.

As the Assessment progressed and as interaction and integration between the four teams began, it became evident that a glossary of terms needed to be developed. Thus, Appendix C in this report represents a glossary of terms that the Project Team identified so that misinterpretations and misunderstandings would be minimized. The reader is referred to this glossary. (See also the list of abbreviations.)

As noted above, the scope of this assessment was to provide a snapshot of selected users' needs. A selected group of users was chosen, rather than a comprehensive group representing a scientifically based sampling process, except for two specific, targeted surveys, small in scope (as discussed in Section 8), because of the time and funding constraints of the project. The Project Team, however, believes the users selected to participate in the project; the manner in which interviews took place; the manner in which findings and recommendations were developed, as discussed in Sections 3-6; the concluding user workshop held to review initial findings involving, in part, a set of users who had not been interviewed; and the final issues and recommendations as discussed in Section 10 have resulted in an excellent representation of user needs.

2. STEERING COMMITTEE, ASSESSMENT TEAMS, AND SELECTED USERS

2.1 STEERING COMMITTEE

The FEMA program manager and CNPE staff agreed, because of the scope and schedule of the Assessment and its potential impact on NEHRP, that a Steering Committee should be established to oversee and provide direction to the Assessment.

Considering the Assessment categories in the four basic, and wide, areas of seismic hazard, built environment, societal and policy, and implementation, it was logical to establish a Steering Committee with a national reputation and expertise in each of those four areas. The five-member Steering Committee is listed in Appendix A.2.

2.2 SELECTION OF ASSESSMENT TEAMS

As has been noted, assessment team members were selected based on their experience, capability, and breadth of knowledge of the area in which they would assess user needs; on geographic distribution; on availability to focus on a project with a compressed schedule; on experience in and knowledge of NEHRP; and on experience in conducting assessments.

Each team had three members, with one team member to be selected as the team leader. In addition to the criteria listed above, an effort was made to achieve representation of the full breadth of activities in each of the four generic areas. Team members were chosen as follows. To represent the seismic hazard team, the fields of seismology, geology, and geotechnical engineering were identified. To represent the built environment team, the fields of building design and construction, lifelines, and architecture were identified. To represent the societal and policy team, the fields of social science, public relations, and government relations were identified. To represent the implementation team, the fields of public and community education, policy-making, and policy-implementing for buildings were identified. Team members and leaders are listed in Appendix A.3.

2.3 SELECTION OF USER GROUPS AND USERS

As noted earlier, users of NEHRP knowledge and delivery systems were defined in the two categories of (1) collaborative users and (2) end-users. How each team identified users it would contact in its assessments is discussed in more detail in Sections 3, 4, 5, and 6. Each team made a conscious effort to identify user participants that represented as broad an area as possible. Appendix D includes a list of many who participated in this Assessment; however, not all participants are identified. Certain team members' organizational ethics and rules require that those individuals who participate in surveys not be identified, even in raw data form. Thus what is included in Appendix D is a listing of only those persons who were personally interviewed by team members and who were not restricted to the total anonymity rule. To protect those who are named, individuals are listed alphabetically and are not directly associated with any team or interview results. The participation reflected by Appendix D gives the reader an opportunity to see the breadth and depth of the interview process.

The users that participated in the Assessment through interviews and mail surveys were not selected by any process of statistical sampling. Rather, the selection was based on the judgment of team leaders and members, on input requirements, on areas of focus, and on geographical distribution. It should be pointed out that the users who participated, while in excess of 200, represent only a limited, selected sampling of all users. The Project Team, however, believes that the user community is fairly represented by those selected and that the results are representative of user needs for NEHRP.

In summary, more than 188 personal interviews were conducted (181 interviewees are listed in Appendix D-1), and 1300 individuals had the opportunity to participate in one of three mail surveys to which 479 responded, for a return rate of 37%. This total, however, does not include input obtained from professionals (estimated by team members as approximately 200) who participated in ad hoc workshop sessions related to the Assessment that were conducted when team members attended national and regional meetings. In addition, the Assessment User Needs Workshop had 65 participants. Thus, approximately 900 professionals had some level of direct input into this Assessment.

3. USER NEEDS IN DEFINING THE SEISMIC HAZARDS

3.1 DEFINITION OF SEISMIC HAZARDS

Achieving the objectives of NEHRP—to reduce human and economic losses from earthquakes—is based on an understanding of seismic hazards. In the context of this study, seismic hazards are defined as information on the location, timing, and size of future earthquakes and assessments of the geologic and geotechnical effects of earthquakes such as strong ground shaking, soil liquefaction, or landsliding. Seismic hazard data are used to make hazard assessments. Examples of seismic hazard data include instrumental seismicity data, paleoseismic interpretations, and geotechnical properties of soils. Seismic hazard products are written documents and maps that present the types and levels of seismic hazard at particular sites or regions. Examples of seismic hazard products include probabilistic ground motion maps, shaking-induced landslide maps, and liquefaction probability maps. The users (or collaborators) in the seismic hazard assessment process provide the foundation for NEHRP; that is, they generate or analyze the data used to assess earthquake hazards and develop seismic hazard products, or they use the hazard information to make design and hazard mitigation decisions.

The Seismic Hazard Team found a role in this assessment as evaluating the issue of how and whether data and analyses developed for seismic hazard purposes make their way to end-users. Thus, identified issues and recommendations developed by the Seismic Hazard Team are intended to assist in creating an optimal program in which research results are translated into usable products, and those products are used to achieve reduction of earthquake risks.

3.2 IDENTIFICATION OF SELECTED USERS

In considering the seismic hazard assessment process, the team concluded that three categories of users could be identified: (1) data generators and researchers, (2) hazard analysts, and (3) hazard-product users. The activities, capabilities, and needs of each category are sufficiently different to make their distinction meaningful for the present assessment. Although any given individual may fall into more than one of these categories, usually an individual can identify primarily with one. As will be shown in the discussion of the interview results, the three groups did, in fact, show different levels of awareness of NEHRP and different needs.

The Seismic Hazard Assessment Team, with input from other Project Team members, compiled a list of selected users to be interviewed. The primary criteria for inclusion on the list included (1) full representation of the three categories of users, (2) geographic distribution throughout the United States, (3) diversity of technical expertise ranging from earth scientists to facilities engineers to owner representatives, (4) diversity of organizations ranging from the federal government to academic institutions to private companies, and (5) diversity of past experience and involvement with NEHRP.

After confirmation with each individual, the list of users was divided into the three user categories. Descriptions of each of these groups and profiles of the users interviewed are provided in the following section. A total of 42 users were interviewed, with a breakdown of user categories as follows: 7 data generators/researchers, 13 hazard analysts, and 24 hazard-product users (two users were interviewed for more than one category). The greatest diversity in seismic hazard experience and responsibility occurs in the hazard-product users category; therefore, the largest number of interviews was in that category. As a group, the individuals represent a broad range of federal, state, and local government agencies; educational and research institutions; and the private sector (e.g., consulting firms). A geographic sample was selected from 12 states plus Washington, D.C.

It should be noted that the selection of users for this assessment was not intended to be based on any statistical sampling of a larger population of users, nor should the responses be used in a statistical sense as a representative sampling. If 25% of those interviewed expressed a certain concern, for example, that percentage should not be interpreted as indicating that 25% of the total population of seismic hazard-product users would also express the same concern. Instead, the results of the interviews should be viewed as providing a reasonable expression of many of the critical issues regarding the needs of seismic hazard users.

Selected interview results are provided in Appendix E.1 as examples of the types of information received by the Seismic Hazard Team during its interview process.

Each user category is described below.

3.2.1 Data Generators/Researchers

Data generators/researchers collect basic earthquake-related data and conduct basic research. Their findings are used by hazard analysts as input to prepare hazard products that represent the seismic hazard (e.g., ground motion analyses and maps). The data generators/researchers interviewed for this assessment conduct many aspects of earthquake-related research, including seismic network operation, seismic source studies, paleoseismic investigations, and applied research for geotechnical engineering applications. These activities are being conducted in Utah, Alaska, and the New Madrid region as well as at specific facility sites throughout the United States. The data generators/researchers interviewed for this assessment spend ~25 to 100% of their time on earthquake-related data collection or research. The percentage of this time that is supported by NEHRP ranges from 0 to ~65%. Some data generators/researchers who are not funded by NEHRP are not familiar with the program or the information generated. The data generators/researchers interviewed identify public officials as the principal group making hazard mitigation decisions.

3.2.2 Hazard Analysts

Hazard analysts compile, model, and analyze basic data to arrive at a representation of seismic hazard (e.g., earthquake-related landslide maps, probabilistic liquefaction maps, or probabilistic vibratory ground motion analyses). These seismic hazard products are used by owners and regulators for siting and design decisions, emergency response planning, and public education and outreach efforts. The hazard analysts interviewed typically are very involved in consulting and advising on where their products are used; many make recommendations that are directly implemented in facility designs or are formally approved by facility owners. The hazard analysts interviewed spend between ~20 and 100% of their time on seismic hazard analysis. Across the range of those interviewed, the percentage of time funded by NEHRP ranges from 0 to 100%.

3.2.3 Hazard-Product Users

Hazard-product users use hazard information to make design and hazard mitigation decisions. The hazard-product users interviewed for this assessment included officials at all levels of government with responsibilities in engineering and planning, managers with responsibility for the engineering of federal and private-sector facilities, and private consultants. For the most part, the hazard-products users interviewed make decisions on, or recommendations for, facility design and retrofit and on policies and priorities for seismic hazard mitigation. Many hazard-product users are not familiar with NEHRP or the data and hazard products that have been developed by the program.

3.3 PROCESS FOR INFORMATION GATHERING

Once the list of seismic hazard users was identified, the elicitation and documentation of information followed these steps: (1) development of questionnaires, (2) telephone or personal interviews, (3) feedback of documentation, and (4) analysis and summary. Each step is discussed below.

Through discussions among the Seismic Hazard Team members and through consideration of the goals and objectives of the NEHRP assessment as a whole, questions were developed that would provide information related to user needs. It was found that each of the three categories of seismic hazard users should be asked slightly different questions. For example, it is useful to ask data generators/researchers about their perceptions of how their data are used by others for hazard analyses, and it is also enlightening to ask the hazard analysts how they identify and receive the appropriate data needed for analyses. Therefore, three questionnaires were developed for the three categories of seismic hazard users (see Appendix C). Draft questionnaires were reviewed by Center for Natural Phenomena Engineering Project Team members, who made helpful comments that were used to improve the clarity, consistency, and organization of the final questionnaires.

After the individual users agreed to participate in the study, they were sent a letter explaining the assessment and including the questionnaire. In cases where the assignment of an individual to a category was unclear, the user was sent questionnaires from two or three categories and allowed to decide which questions were most appropriate to his or her experience. Most questionnaires were sent at least 1 week prior to a scheduled interview date to allow time for the user to prepare responses. The interviews of the users were conducted, for the most part, by telephone and lasted about 1 hour each. In some cases, individuals were interviewed in person. The users were told that their responses to questions would remain anonymous. During the interview, the users were asked the questions given in the questionnaire and, importantly, were provided with any clarification needed to understand the underlying intent of the question. Occasionally additional questions were asked in order to understand the positions taken by the user. The give-and-take of individual interviews proved to be extremely valuable and, we suspect, much more effective than merely eliciting a written response to the questionnaire. In nearly all cases, the interviews went smoothly, and the users were prepared and enthusiastic about their participation in the project.

Documentation of the interviews was conducted primarily by Seismic Hazard Team members and was reviewed by the users. During the interviews, the responses and discussion were documented either by written notes taken by team members or by tape recording and subsequent transcription. This approach was followed, rather than requiring the users to document their own responses, to free the users from the burden of developing the documentation and to expedite the process on this time-sensitive project. After the interview, the draft documentation of the interview was sent to each user for review and modification. This review was intended to ensure accuracy in reflecting the views of the user and to allow for any changes that might be deemed appropriate by the user. When the draft documentation was sent to the users, they were asked if they wished to waive their anonymity in the documentation of their responses for the report. In those cases where anonymity was waived, the responses documented in this report are attributed to the user by name.

Upon completion of the interviews, the Seismic Hazard Team met on two separate occasions to analyze the information. During the first 2-day meeting, each of the interviews was reviewed and the responses were summarized. The result of this effort is shown on the summary matrices in Tables 3.1, 3.2, and 3.3. (Note: Tables 3.1, 3.2, and 3.3 are at the end of Section 3.) The advantage of this summary is that it allows one to readily compare the responses to certain questions across a large number of users. As a result of this comparison, important and recurring issues and needs were identified, which are summarized in Section 3.4. At the second meeting of the team, the set of user needs and issues was reviewed in detail, and the highest-priority user needs were identified and recommendations made for each (see Section 3.6).

3.4 RESULTS OF INFORMATION GATHERING: IDENTIFICATION OF USER NEEDS

As discussed above, separate questionnaires were developed to address the unique seismic hazard-related experience of each of the three user groups. Following the interviews, the responses were summarized (Tables 3.1, 3.2, and 3.3) and discussed by the Seismic Hazard Team. On the basis of these discussions, several findings and observations were made. These findings, given below, are not prioritized by their relative importance.

3.4.1 Data Generator/Researcher Needs/Findings

Table 3.1 contains the responses of the data generators/researchers interviewed for this study. Important findings summarized from these responses are listed below.

1. Many data generators see their data being used in hazard mapping and design, but others feel that their findings are not being used adequately because of poor technology transfer.

2. Important issues have been adequately identified in the program, but not all of the issues have been pursued because of funding limitations.

3. Specifically mentioned by the user group was that the seismic and strong motion information networks provide important basic data but are inadequately funded.

3.4.2 Hazard Analyst Needs/Findings

Table 3.2 contains the responses of the hazard analysts interviewed for this study. Important findings from these responses are summarized below.

1. Personal contact with data generators/researchers is needed to be aware of and to gain access to particular data sets.

2. Formats and standards for data [e.g., strong motion recordings, geologic map units, seismicity network data, and geographic information system (GIS) data bases] are not consistent.

3. Accessibility of contractors' reports (e.g., external USGS contract reports) is limited.

4. Indexing of NEHRP products geographically and/or topically is needed.

5. Products often are not readily available or generally usable (e.g., computer code documentation, nearly completed products).

6. Significant, pertinent data bases still do not exist for large parts of the United States, especially outside California.

7. The needs of hazard analysts often are not addressed by data generators/researchers.

8. Methods and techniques for hazard analysis and mapping need to be better developed and consistent.

9. Planners commonly do not know how to use the products of the hazard analysts.

10. The focus of NEHRP is on new research; little incentive or funding exists for synthesizing or developing information to make it more available and useful to end-users.

3.4.3 Hazard-Product User Needs/Findings

Table 3.3 contains the responses of the hazard-product users interviewed for this study. Important findings summarized from these responses are listed below.

1. Knowledge of the projects that NEHRP funds is not widespread; often the products that are used are interpreted without acknowledging the NEHRP component (e.g., agencies implementing NEHRP do not acknowledge NEHRP support; they credit their own agencies).

2. The data quality generally is considered good, but data sets may be incomplete.

3. National hazard maps are very useful, but opinions vary regarding the quality of the USGS national hazard maps. These maps need to be periodically updated.

4. The delay in getting materials published (e.g., professional papers) is a chronic problem.

5. Because publications and personal contacts are relied on to identify who is doing what, most hazard products users are not aware of the studies being conducted.

6. Data are available and can be obtained, if one is aware that they exist.

7. More hazard mapping at regional scales (1:24,000 to 1:100,000) is needed.

8. Methods, codes, and standards are needed for consistent approaches and product formats (e.g., hazard analysis, site response, liquefaction mapping, GIS formats).

9. Education of end-users is needed on uses and limitations of hazard products; problems occur with translation.

10. Education of hazard analysts and data generators/researchers is needed to understand what end-users want and need.

11. Some specialized hazard products are needed by end-users that are not—and properly so—provided by NEHRP (e.g., site-specific hazard analyses).

12. NEHRP research and mitigation activities should be coordinated with appropriate federal agencies (e.g., the Corps of Engineers and DOE).

13. Knowledge gaps often are due to communication and translation gaps.

14. Although the Seismic Hazard Team did not attempt to comprehensively identify specific research needs, real gaps in data and knowledge exist.

15. Consensus, verification, and stability are needed in products such as hazard maps and guidelines for engineering design and construction.

Through consideration of these lists of significant needs and findings, a set of high-priority needs and findings is developed, along with recommendations for each, in Section 3.6.

3.5 STRENGTHS OF NEHRP

Many strengths of the NEHRP program were identified in the interviews conducted by the Seismic Hazard Team. In addition, many interviewees were asked the following questions: "What has NEHRP done well? What research, products, or accomplishments have led to significant hazard reduction?" Four major areas of strength were identified, as follows.

1. Important, basic earthquake-related data have been collected. Specific data types cited include earthquake catalogs, seismic source assessments, paleoseismic investigations, strong motion data, site response data, and hazard maps (liquefaction, landslides, etc.).

2. Seismic provisions have been incorporated into building codes throughout the nation as a result of NEHRP-supported effort. This effort is considered particularly significant in areas of historically low seismic activity (e.g., the eastern United States). A related issue is the inclusion of hazard maps in codes and regulations. Although opinions are diverse regarding the quality of current USGS national hazard maps, the importance of these maps is acknowledged.

3. Public awareness of hazards has increased, which is considered to be of particular value in areas that have experienced rare but significant earthquakes, such as the New Madrid and the Charleston, South Carolina, regions. The development of hazard mitigation plans by lifelines operators (e.g., major water and wastewater utilities in the Puget Sound area) also is credited for increased public awareness.

4. Cooperation within the earthquake community has increased, and the establishment of a network for sharing data and interpretations is cited as a valuable accomplishment. As noted by other users, however, significant improvements in the network need to occur.

3.6 ASSESSMENT OF FINDINGS AND RECOMMENDATIONS

In Section 3.4, the findings and observations made in the interviews were presented. In this section, the high-priority issues are identified and recommendations are made to address each issue. The Seismic Hazard Team identified high-priority issues based on these considerations: recurring themes from interviews; issues articulated in only a few interviews, but deemed to be particularly important; and issues that generalized several expressed concerns. An example of the latter is the issue of accessibility of NEHRP products, which was expressed in a variety of ways by those interviewed. The high-priority issues are identified without any attempt to rank their relative importance.

The recommendations are made with specific reference to each high-priority issue. Some recommendations can almost be taken directly from the responses given by the interviewees. An example is the often-expressed request to make the contractor reports for the USGS program publicly available. Most of the recommendations, however, were developed through analysis by Seismic Hazard Team members based on knowledge gained from the 42 interviews as well as their familiarity with the program.

It should be noted, and strongly emphasized, that in identifying findings and observations listed in Section 3.4 and in identifying high-priority issues in this section, a deliberate attempt was made to avoid an emphasis on technical or research priorities for NEHRP. This effort is particularly important for the Seismic Hazard Team, because a large part of the NEHRP program is focused on the development of seismic hazard-related data and analyses. This study, however, is designed to examine the issue of how and whether data and analyses developed for seismic hazard purposes make their way to end-users. Of course, in this examination, certain data and knowledge gaps are identified—even in the basic data that are used for hazard analysis. No attempt has been made, however, to identify important data or research needs, their priority, or to recommend that certain studies be conducted. Other recent and ongoing assessments of NEHRP have had this focus.

The high-priority issues and recommendations for addressing the issues are listed below, with no significance to the order given.

Finding 3.1

Awareness of what NEHRP supports and produces depends on personal contacts.

Many hazard-product users commented on their lack of knowledge about NEHRP. Unless one is directly familiar with NEHRP (e.g., as a contractor), it is difficult to know what the program supports and what it produces. As a result, a common way of finding out about the program is through ad hoc personal contacts and networks. For example, if one is interested in learning about NEHRP-supported geologic studies that have been conducted in the Pacific Northwest, the most effective way of finding out who is doing what is by contacting individuals who are familiar with the program in that region. Some hazard-product users have little knowledge of these contacts and, as a result, little knowledge of the program.

Typically it is difficult to identify specific data sets and hazard products that have been generated by NEHRP because there is no requirement that NEHRP support be acknowledged when this kind of work is published. By directly crediting the program, public knowledge of NEHRP could be increased. This knowledge would likely be noted by policy-makers evaluating the relevance of the program. An indication of a practice that could help fill this knowledge gap was described by William Bakun (USGS coordinator for Northern California earthquake risk reduction activities), who prepared an open-file report for northern California that summarizes research conducted in 1993 and includes the names, organizations, and telephone numbers of investigators. That report was distributed to approximately 100 potential end-users.

Recommendation. To promote more widespread understanding of NEHRP, guidelines should be developed for NEHRP contractors to follow in this acknowledgment of program support for their products. NEHRP-supported studies related to seismic hazards should be indexed according to a number of search parameters such as geographic location, topic, principal investigator, and institution. These indices should be made generally available and routinely distributed not only to NEHRP-supported individuals, but to others as well. Research summaries similar to the type given above for Northern California could be prepared for other geographic areas throughout the nation. Outreach and education programs through professional societies of user groups (e.g., utility groups) also might be effective mechanisms for disseminating information on available NEHRP products. Regional or state earthquake program managers could assume responsibility for distribution to interested user groups. The possibility of providing information directly to users through computer bulletin board systems (BBS) should be examined; access to such systems is likely to become widespread within the next decade.

Finding 3.2

NEHRP-generated information is often difficult to obtain and to use.

This issue relates to the general issue of accessibility and availability of NEHRP data sets and hazard products. As Klaus Jacob of the National Center for Earthquake Engineering Research (NCEER) stated,

> Data are available in concept, however, they are not readily retrievable in practice....NEHRP agencies have neither a policy or system for making data available; it is the responsibility of the contractors to distribute data, and some are very possessive.

Symptomatic of this problem is the general lack of availability of external contractor reports. For example, external contractors that receive NEHRP support from the USGS are required to submit their final reports to only the contracts office; there is no USGS requirement that these reports be made generally available, and they are not routinely open-filed or distributed after receipt. NEHRP-supported researchers (internal and external) are expected to report study results in published papers; however, many hazard-products users, particularly in the engineering field, do not routinely review the journals and conference proceedings where many of the papers are published. Also, as one interviewee observed, "Articles published in journal and conference proceedings typically summarize only study results and do not include the raw data." Hazard analysts often must have the basic data to develop hazard products.

There seems to be a general problem of delay in getting NEHRP products finalized. Examples were cited of both internal and external studies that have been near completion for long periods of time but that are not available until a final report is produced. Thus, although the user community may be aware of the study, it has no access to it until the principal investigator makes a formal submittal. Several interviewees mentioned this delay with respect to strong motion recordings. USGS professional papers are cited as being subject to chronic delays (lasting in some cases several years), and the time interval from submittal of a final technical report to publication is often quite long. An associated problem cited was of studies funded by NEHRP to develop computer codes without the requirement that the codes be fully documented and made usable by others (see finding 3.3). Consistent formats and standards are not usually required of NEHRP products, thus leading to the potential for inconsistencies and difficulties in using the products.

Recommendation. Because the greatest contribution that NEHRP makes to hazard mitigation—at the seismic hazard level—is the products that it supports and develops, the program should establish and fund a system for distribution of contractor reports and other products through existing resource centers. Repositories for those reports could be libraries associated with national or regional earthquake centers, such as the Southern California Earthquake Center (SCEC), NCEER, and the Central United States Earthquake Consortium (CUSEC). Contractor reports from both internal and external researchers should be required within a finite time period. Such a requirement can be readily included as a provision of an external contract. Similar accountability also should be developed for the internal program. The possibility of allowing for interim accessibility of internally generated data sets (e.g., by modifying the restrictions on current USGS open-filing procedures) should be explored.

Finding 3.3

> **Many NEHRP-sponsored research or data collection efforts are not carried to a sufficient state of completion to allow practical application of the results for hazard mitigation.**

NEHRP-funded research has emphasized collection and analysis of new information; follow-up development of hazard products for practical use has received much lower priority. That lower priority hampers translation of research results and data into practical products for two related reasons: (1) little financial support or incentive exists for investigators to validate results or to develop user-oriented products; and (2) to maintain a viable research program, investigators must continuously develop new research ideas at the expense of practical development of past results. Additionally, the process of translating research results into design practice may require special skills, and in some cases, a researcher may not be the best qualified person to conduct the process.

The following comments highlight these issues. Woody Savage [Pacific Gas and Electric Company (PG&E)] states:

> NEHRP is not adequately focused on accomplishing data gathering and analysis, and there are many gaps that could be filled if a program-driven study were developed and implemented. Currently the program is Principal Investigator driven and academic approaches and attitudes direct research projects; it is not a problem-focused or goal-oriented program (thus, obtaining research study results that have direct utility for hazard reduction is often fortuitous, not the result of good planning).

With respect to computer codes, Geoffrey R. Martin [University of Southern California (USC)] states:

> I believe there should be a policy...that would require public release of programs in a useable form for practitioners. I also respect, however, concerns about liability and misuse of computer programs that have not been fully tested and documented....There needs to be an additional component of funding available for work that has been judged successful that would provide for proper documentation and conversion of that analytical approach for practitioners. Funding should be available for validation to ensure that the originator incurs minimum liability. That component of funding always seems to be missing.

Incomplete data collection efforts were also cited, particularly for studies that are viewed as "less exciting" from a scientific point of view. One example that was cited by several interviewees is the incomplete geotechnical site information for many strong motion instruments. Since verification of strong motion models relies on knowledge of the instrument site conditions, obtaining these data should be given a higher priority.

Recommendation. Strategic planning by the NEHRP agencies should place a priority in their research programs on developing and translating successful research products for user application. Such development should include verification of models, development of user guides, proof tests by users, and collection and synthesis of data bases.

Finding 3.4

> **Standards, guidelines, and professionally accepted methodologies are needed for many hazard mitigation products.**

Conflicting or competing models or methodologies exist for actually implementing many potentially useful research products. Many hazard-product users do not have sufficient expertise to evaluate these differences. The variability is perplexing to the user, which hampers application of the product. Also, many needed standards and guidelines have not been developed, particularly those that use geologic data. A broad base of support in the scientific community, commonly referred to as consensus, is needed to ensure acceptance and appropriate application of these guidelines.

Jeffrey Kimball (DOE) states:

> Regarding geologic and seismic information--we need consensus on standards for data collection, hazard analysis, etc. (standards are not as developed as for the engineering community). For example, a standard is needed on what is necessary to complete a site-specific probabilistic seismic hazard analysis.

With respect to hazard maps, Geoffrey R. Martin (USC) states:

> Each group has developed its own techniques and approaches. It has become critical that these groups talk to each other before we suddenly have a multitude of maps generated for various parts of the country, each purporting to represent acceleration contours or ground motion or ground failure hazards of various sorts. We are now in the computer age, and it's so easy to generate a map. I am very concerned that we'll soon be inundated with maps unless there is some degree of coordination to determine what maps are needed and what maps should be compiled.

With respect to ground motions, Larry Von Thun (U.S. Bureau of Reclamation) states:

> A high-priority gap for us is better definition of design earthquake ground motions. For a given site, there is a wide range of potential earthquake ground motions that can be developed depending on which seismic source model is selected, which attenuation relationship is used, which analysis for local site conditions is applied, what probability of exceedance is suggested, etc. We need a more standardized procedure for assessing ground motions for design.

Mary Ellen Hynes [U.S. Army Corps of Engineers (COE)] states:

> We need better criteria for predicting load capacities for foundations, both shallow and deep. Another big black hole for the profession is the load capacity and behavior of pile foundations subject to dynamic loading, particularly foundations that will experience

> liquefaction and lateral deformation....We don't have adequate dynamic design procedures.

Successful examples of efforts to obtain a broad base of scientific support are provided by the working groups that have developed consensus documents on estimated probabilities of large earthquakes on several California faults during the next 30 years. A Phase 2 study on earthquake probabilities in Southern California is currently being conducted by the Southern California Earthquake Center. Described as breaking new gound as a consensus-building process, the study involves a multidisciplinary group that is incorporating a variety of data into a kinematic model to produce ground motion maps for the region.

Recommendation. NEHRP should place greater emphasis on consensus building and consensus documents in the seismic hazard area, including design guides, standards, and methodologies. Development of such documents will require verification of proposed techniques and a broad base of support within the scientific community. Working groups and advisory committees that have been formed to address various seismic hazard issues are successful models for these efforts. Such groups should be established to develop consensus on many additional critical issues, such as data collection methodologies and hazard assessment methodologies.

Finding 3.5

> **Limits in the level of communication and translation among data generators/ researchers, hazard analysts, and hazard-product users result in many useful products not being generated.**

The importance of the basic seismic hazard research funded by the NEHRP program is widely recognized and is frequently cited as a major strength of the program. Nonetheless, Woody Savage (PG&E) states:

> NEHRP-supported studies frequently do not meet the needs of PG&E end users; this is a function both of the specific needs of PG&E and the observation that studies generally address researcher interests but not necessarily user needs. Because of the latter, obtaining raw data and interpreting it internally is usually necessary.

Carl Stepp [Electric Power Research Institute (EPRI)] states: "[NEHRP-supported] attenuation modeling is of high quality for research purposes, but not for integrated product mode (i.e., origin of uncertainties is not well understood)."

To make the most informed decisions for reducing earthquake risk, hazard-products users must have information that is available, understandable, and useful. As a group, data generators/researchers want to see their research results used. Improved communication among researchers, hazard analysts, and hazard-product users could help to ensure that the most useful products are generated.

Users' perceptions that their needs are not being met may result from many factors, including funding limitations, insufficient scientific knowledge, and scale problems. Improved communication can ameliorate many of these factors, as illustrated by examples. On the policy side, an example was given by William Bakun who, for the past 2 or 3 years, has organized an annual workshop with planners, engineers, and others in the earthquake community to set priorities for seismic hazard research in Northern California. These priorities are used as directions in external grant panel decisions. On the data collection side, an example was given by a hazard-product user who stated that his organization learned in advance that a particular study was to be conducted; they were then able to request a modification in data collection to provide information that was particularly useful to the end-users.

Recommendation. A variety of approaches could be taken to enhance communication, translation, and team building among the three groups. Forums that permit the exchange of ideas, needs, and approaches—on a systematic, recurring, and local basis—would be very useful. NEHRP agencies could take a more proactive role in targeting relevant studies or end products that could meet the needs of owners and regulators. The regional centers (e.g., SCEC, NCEER) could assume a more active role in this process and provide direct input into priorities for decisions. Particularly for regional studies, data generators/researchers and hazard analysts should be encouraged to communicate directly with potential end-users.

Finding 3.6

> **NEHRP addresses the major seismic hazard issues, but, because of funding limitations, not all issues are being pursued.**

As stated by Dr. Walter Arabasz (University of Utah):

> In my opinion, NEHRP's best and brightest have been intelligent and creative enough to identify and "target" a sufficient scope of relevant technical issues. The issue isn't the technical agenda, it's the lack of reasonable resources consistent with the scope of that agenda. My repeated experience and observations (for example, on numerous NEHRP proposal review panels) tells me that NEHRP has never been funded at a level that would make it a truly credible national program, given the scope of technical issues under its mandate.

The holes or gaps in the program vary geographically. Regions of the country having high vulnerability and moderate hazard, such as the Northeast, are not given priority. Similarly, high-hazard areas lacking significant populations, such as Alaska, are given low priority. Basic research on the causative structures, seismic sources, and earthquake recurrence rates in much of the central and eastern United States is not part of the program. NEHRP support for seismic networks is inadequate, and some networks, such as those in the Intermountain Seismic Belt, are being reduced for the first time in history. Even within California—which is often viewed with envy by those in other regions—significant gaps in the program have been noted. One result of the continuing resource limitation problems is a higher degree of uncertainty in assessing seismic hazards. Higher uncertainties can mean either that a hazard is ignored until it can be better defined (such as that in the Northeast) or additional levels of conservatism are assumed, ultimately resulting in higher costs.

Dr. Arabasz states:

> As a result of [funding limitations], the gathering of basic earthquake information is being neglected in rural parts of the Intermountain region that are inherently seismically dangerous and where there are threats to regional lifelines and infrastructure. I presently am involved in shutting down parts of Utah's regional seismic network, outside the populated Wasatch Front area, throughout seismically hazardous parts of southwestern, central, and eastern Utah....The Intermountain region desperately needs high-quality

seismological information to deal with what may be unique aspects of large normal-faulting earthquakes.

Recommendation. The most effective way to deal with the issue of NEHRP resources is, of course, to remove the funding limitations that prevent the program from being a complete and truly national program. Short of this, program priorities and strategies should be reviewed to ensure that available funds are being used as effectively as possible to address both short-term and long-term needs. Additional cost efficiencies may be made in the following ways: Provide focus and priority to those studies that make extensive use of existing data to produce more useful hazard products (see finding 3.3); increase coordination and mutual support of earthquake-related studies with other federal agencies, and target specific joint studies with those agencies (e.g., DOE, COE, Bureau of Reclamation) in which products are developed that would assist both groups (see finding 3.10).

Finding 3.7

> **National hazard maps are used extensively, but they lack a broad base of support in the scientific community.**

A key product of the NEHRP program that has direct utility is the national probabilistic seismic hazard maps. Jeffrey Kimball (DOE) states:

> The state of knowledge within the scientific community is not adequately reflected on these maps....Potential exists for misuse; there should be guidance on the use of maps, and there should be a mechanism to consistently apply the maps.

National hazard maps, such as those included in building codes and federal agency design standards, may be the most widely used and most important seismic hazard products. Although the process that results in adoption of specific maps is considered by many to be a consensus process, in fact, the hazard depicted on the maps may not have a sufficiently rigorous technical basis to be generally accepted within the earth sciences and seismic hazard assessment community. Given the importance of these maps, it is essential that the data and models on which the hazard analysis is based be fully documented, that uncertainties be properly represented, and that the methodology and results have the widespread acceptance of the scientific community. The process of translating scientific information into a design values map is complex and requires the cooperation of earth scientists and engineers.

Recommendation. The national seismic hazard maps should be updated on a periodic basis with a specific objective to obtain a broad base of technical support in the scientific community. The updates should consider new data that have been developed as well as new seismic hazard assessment methodologies. Guidance on the use and limitations of maps should be provided. Other federal agencies such as DOE and the Nuclear Regulatory Commission (NRC) have ongoing studies designed to identify appropriate seismic hazard methodologies. NEHRP agencies should consider the applicability of these methodologies in developing the national maps and the advisability of formally adopting a specific approach. The map that will be used in the 1997 Uniform Building Code (UBC) is currently being developed, and a plan to provide input to that map should be established and implemented in a timely manner so that an important opportunity is not lost. The national maps should incorporate state and regional scale maps (see finding 3.8).

Finding 3.8

Regional to urban scale hazard maps are used increasingly for hazard-reduction decisions, but they are not available for many regions.

Although some applications such as building codes require national scale hazard maps, many hazard-reduction decisions are made on the basis of local information because relevant data are best depicted on a local scale. National ground motion maps are of limited value in seismically active parts of the country because the information they contain is not sufficiently detailed. Some maps, such as probabilistic ground acceleration or velocity maps, can be useful at a regional scale (1:500,000 or greater), but they are available for only a few areas. When combined with more detailed maps of surficial conditions that affect local ground-shaking intensity, these maps could provide a valuable basis for quantitatively defining the level of seismic hazards for decision-makers. For example, the State of California has embarked on a program to provide both regional ground acceleration/velocity maps and more detailed, local surficial geologic and geotechnical maps in areas of the state that are experiencing rapid urbanization.

Sufficient geologic and seismologic information to prepare useful regional maps currently is available for only a few areas of the country. Appropriate data need to be collected, analyzed, and interpreted, which requires commitment of money and effort. NEHRP is the logical program to fund this effort, especially in urbanizing areas within regions of active seismicity. The importance of the targeted-area research done by NEHRP in the past decade (e.g., in Utah, Tennessee, and Washington) for identifying the regional hazard and alerting the population in that region is widely recognized. Accurate regional to urban scale hazard maps (e.g., the Southern California project described in finding 3.4) will provide important input to the national hazard maps (see finding 3.7).

Recommendation. NEHRP should take a major role in setting standards for regional hazard maps and funding the data collection efforts upon which the maps are based. Several criteria should be met so that the resulting maps are (1) as accurate as possible using current data, (2) easily updated when new data become available, and (3) in a form that can be used by hazard-product users (e.g., guidance on the use and limitations of maps should be provided). The map-based information provided to end-users should be consistent with the information provided to the adjoining city, county, or state.

Finding 3.9

Education of hazard-product users (e.g., owners, regulators) must occur for the hazard information to be useful and implemented.

Jim Gates (Coltrans) states:

> I am concerned that some users do not adequately understand the meaning of some products. For example, AASHTO [American Association of Highway and Transportation Officials] criteria use the latest national hazard maps, but these may not indicate worst-case scenarios--if [critical] structures are designed to these criteria, they could be subject to collapse.

The hazard-reduction decision process is influenced by a variety of economic and political issues, only a few of which are supported by technical arguments. It is important for data generators/researchers and hazard analysts within the technical community to recognize how the decision process works and to provide hazard-product users with technical information that is accurate, relevant, and consistent with the process. Several of the hazard-product users interviewed spoke of the impact of one or more city council members or county supervisors who became educated about earthquake hazards in their community and persuaded their organizations to take appropriate action.

Many hazard-product users do not have a technical background; typically they reach their career positions as decision-makers through the political process rather than through professions as scientists or engineers. Many of them have a strong interest in understanding hazards and assimilating information that could help them make informed decisions. The NEHRP technical community has an important outreach responsibility to such users to prepare information in a consistent and usable form, and to guide the process of explaining what the information means and how it is to be used.

To quote Geoffrey R. Martin (USC),

> When we have research products, we need more effort to put those products into a form that can be understood by practitioners. Perhaps we should have workshops where researchers convey, in practical terms, through joint discussion, the manner in which those products should be used.

Recommendation. Outreach through professional organizations of user groups (e.g., utility groups), workshops, and other educational forums may be effective mechanism for educating hazard-product users. Providing descriptions of mitigation methods that are technically supportable is useful for assisting hazard-product users in evaluating available options.

Finding 3.10

> **Greater cooperation and coordination are needed among NEHRP agencies and other federal agencies, state and local governments, and private industry to produce mitigation and implementation products and programs.**

Federal agencies such as DOE, COE, the Bureau of Reclamation, and the General Services Administration (GSA), as well as many state and local agencies, are extensively involved in the development of seismic hazard data and hazard products and the implementation of measures to lower seismic risk. Private companies also conduct these activities, either for their own facilities or by providing consulting services. To attain an optimal program in which research results are translated into usable products and those products are implemented to achieve reduction of earthquake risks, increased coordination and cooperation are needed among all involved organizations. Coordination and cooperation are necessary to ensure that the program truly meets national needs for research and information development, particularly for implementation and mitigation to reduce earthquake hazards.

With respect to publicly funded agencies, one hazard analyst stated, "Public money was used to obtain data, and it should be shared." Mary Ellen Hynes (COE) pointed out:

> Since the Corps [of Engineers] and several other non-NEHRP agencies have a history of success in conducting focused research programs and applying mitigative measures, NEHRP might consider working more closely with other agencies to determine research needs and improve implementation of basic research products. We do have to be careful in our research efforts that we achieve synergism without duplicating mission areas.

With respect to local governments, Gary Christenson (Utah Geological Survey) stated:

> I think there is much to be gained from effective cooperation and exchange of information between states sharing earthquake hazards. It is my understanding that CUSEC and NESEC [New England States Earthquake Consortium] play active roles in this regard in the central and northeastern U.S. FEMA partially funds the Western States Seismic Policy Council (WSSPC) to perform this function in the west. That group has not been effective because it has no staff (all work is done on a volunteer basis) or "home base," it only meets once a year, and has yet to really take any policy positions. I would like to see more support to help WSSPC serve its member states.

Recommendation. A decision-making structure that will ensure greater cooperation and coordination with federal agencies, state agencies, and private industry should be developed by NEHRP. Leveraging strategies (such as providing matching funds) that will result in mutual benefits should be considered. Coordination and cooperation are necessary to ensure that the program truly meets national needs for research and information development, particularly for implementation and mitigation to reduce earthquake hazards. For example, a federal agency such as DOE might need site-specific seismic hazard information for one or more sites. NEHRP, while not focused on site-specific applications, can provide information on, for example, seismic sources and regional ground-motion attenuation. The agency and NEHRP should jointly sponsor the seismic source and attenuation studies, resulting in high-quality data available to the agency for its own site-specific evaluation and additional information for NEHRP to include in, for example, regional hazard maps.

Table 3.1. Interview results—Data Generato

Interviewee	1. What is focus of earthquake-related research?	2. & 3. Percent time on research & percent on NEHRP funding?	4. How are data used in their final form?	5. Who makes decisions regarding hazard mitigation?
A. Johnston Memphis State University	seismic network operation; New Madrid zone studies	100% time 40% funding	published literature; seismicity bulletins; hazard studies	NEHRP program managers who decide funding priorities
G. Christenson Utah Geological Survey	paleoseismic investigations; Utah hazard mapping; data collection and compilation	35% time 25% funding	consulting community; land use regulations; state agencies; public home buyers	consultants make recommendations; public agencies make decisions
W. Arabasz University of Utah	seismic network operation; Wasatch fault studies	90% time 65% funding	seismicity catalog; hazard and risk studies; earthquake prediction	serves as consultant; public officials make decisions
M.E. Hynes U.S. Army Corps of Engineers	applied research for dam safety, strong motion studies	100% time 0% funding	literature; reports	joint decisions made within COE by researchers, facility owner, technical monitors
G. Martin University of Southern California	geotechnical parameters for hazard maps	20% time 0% funding	GIS-based hazard maps	public agencies
R. Page U.S. Geological Survey	tectonic framework of Alaska; hazard methods	50% time 50% funding	engineering studies; hazard maps; public education; advice to government agencies	regulatory agencies; recommendations made re: studies to be conducted
P. Heigold Illinois Geological Survey	neotectonics of So. Illinois	25% time 10% funding	catalog/reports; EMA; hazard maps	EMA; planners

1. Interview results—Data Generators/Researchers

ta used in orm?	5. Who makes decisions regarding hazard mitigation?	6. Are research findings being adequately utilized for hazard mitigation?	7. Relevant technical issues not targeted by NEHRP?	8. Data of potential importance to NEHRP not developed or utilized adequately?
ture; tins; hazard	NEHRP program managers who decide funding priorities	yes, data published; data have an impact on codes	short-term earthquake prediction; not a national program	inadequate national seismic networks and strain rate monitoring; CEUS studies outside New Madrid; global earthquake studies
nunity; land state home	consultants make recommendations; public agencies make decisions	yes, but not enough; state agencies and private consultants use hazard maps to various extents	for Utah: ground shaking maps; instrumentation; scenarios for response planning; basic research	for Utah: strong motion instrumentation; Wasatch PSHA; monitoring of strain rates across faults
og; hazard ; earthquake	serves as consultant; public officials make decisions	yes, for hazard analyses and designs for critical facilities; no, for public policy issues	important issues have been identified, but studies not funded	Utah seismic network inadequate; national seismic networks & strong motion instrumentation inadequate; broader geographic focus
ts	joint decisions made within COE by researchers, facility owner, technical monitors	yes, applied by COE	lack of information on NEHRP	performance information
d maps	public agencies	some, but could be improved with better technology transfer	issues identified; funding limited	strong motion data base is uncoordinated
ies; hazard ication; ment	regulatory agencies; recommendations made re: studies to be conducted	use hampered by poor technology transfer	deep fault zone drilling	earthquake recurrence in Alaska; strong motion from large earthquakes; integrated hazard studies
EMA;	EMA; planners	no, haven't been implemented yet	intensity maps for Mississippi Valley; site response in soft sediments	predictive intensity maps in Midwest

Table 3.2. Interview results—Hazard

Interviewee	1. What is focus of seismic hazard analysis efforts?	2. Percent time on hazard analysis; percent of NEHRP funding	3. Data used in hazard analysis provided directly by NEHRP	4a. How easily available and retrievable are these NEHRP databases?	4b. Suggestions for making data more easily available	5. Additional information needed	6. Are data NEHRP … available? … form?
K. Jacob National Center for Earthquake Engineering Research	strong motion data compilation; design ground motions	70% time 25-30% funding	seismicity catalogs; strong motion data	not readily retrievable; must use personal connections; generally no NEHRP policy/system for making data available	enter into database (similar to IRIS, NEIS) within one year; provide telephone access	geologic data for areas with low to mod. seismicity, but high risk potential; systems approach to obtain products that can be implemented; seismic source zone map with updated info; strong motion attenuation analysis for area east of Rockies; nationwide spectral site response data	regional seism… difficult to ob… stations (e.g., … etc.) hold valu… should be shar…
M. Power Geomatrix Consultants	code development; PSHA; liquefaction hazard	40% time 10-15% funding	fault characteristics; seismicity catalogs; ground motion data; geologic maps	need to be an active participant in scientific community to identify relevant studies; timely access to new data sets is needed	open-file all contractor reports; create indexes and synthesis reports; general repository for all data	Quaternary geologic mapping; map-based soil & ground water data	contractor/rese… needed, as jour… lack basic data
L. Jones U.S. Geological Survey	short-term earthquake prediction; public information	20% time 100% funding	seismicity data, including broadband data	very easily available and retrievable; dial-up availability for some data		improve real-time earthquake data and methodology; move beyond generic probabilities	available and u… have difficulties)
C. Real California Division of Mines and Geology	PSHA mapping	100% time <5% funding	ground motion hazard assessment methodologies; slip rate data; seismicity catalogs	generally available	use GIS format; provide digital information on Internet; create index of products/data	dynamic properties of rocks and soils; hazards mapping in more detail; high-resolution remote sensing; incorporating uncertainty treatment; cost-benefit analyses for losses	not aware of any… an index would b… identify available… need guidelines f…
J. Davis California Division of Mines and Geology	probabilistic earthquake forecasts; scenario earthquakes; review of site specific hazard evaluations	65% time 20% funding	ground motion maps; seismicity catalogs; Working Group on Earthquake Probabilities reports	needs improvement	implement GIS databases		aware of importan… more communicat… practicing enginee…
R. Bauer Illinois Geological Survey	hazard mapping	35% time <10% funding	no NEHRP data used	data limited for Illinois		ground motion mapping for different soil types; update national seismic hazard map for Midwest	information not av… from researchers
S. Palmer Washington State Dept. of Conservation	liquefaction susceptibility, strong ground motion; support for Washington Dept. of Transportation	75% time 33% funding	borehole data, shear-wave data, paleoseismic setting	very available, through propriate and personal contacts	need catalog of external program reports	accurate and updated PSHA maps, better way to evaluate socioeconomic proposals	not aware of any
W. Cotton William Cotton & Associates	fault slip rates; landslide hazard	40% time 10% funding	regional studies and maps	data not generally available to non-technical public	need indexes and summaries of work done	ground motion maps for Calif.; liquefaction, landslide, ground shaking maps	
G. Mader William Spangle & Associates	post-earthquake recovery; public media data	25% time 20% funding	hazard maps (e.g., landslide); socio-economic studies	not good; not indexed, derivative maps not available, information on on-going projects lacking	indexing and annotations	better statistical analyses of risk; validation of land use decisions for risk reduction	no uniform GIS; wo… in GIS but little is av… format

ble 3.2. Interview results—Hazard Analysts

Suggestions for making data more easily available	5. Additional information needed	6. Are data generated by NEHRP researchers not available? In an unusable form?	7. Percentage of analyses conducted internally	8a. Knowledge gaps: data to hazard	8b. Knowledge gaps: hazard to application	9. How are results of hazard analyses used?	10. Who makes decisions regarding hazard mitigation?
r into database (similar to , NEIS) within one year; ide telephone access	geologic data for areas with low to mod. seismicity, but high risk potential; systems approach to obtain products that can be implemented; seismic source zone map with updated info; strong motion attenuation analysis for area east of Rockies; nationwide spectral site response data	regional seismicity data generally difficult to obtain; other organizations (e.g., DOE, COE, EPRI, etc.) hold valuable data that should be shared	70-100%	gap for all data in low/med seismicity-high consequences areas; gap for lifelines and critical facilities; national seismic hazard maps use outdated catalog info, attenuation laws, source zones, and no reliable maps available for Alaska, Hawaii, Puerto Rico, etc.		BSSC code used for NY City and State codes, and AASHTO code used by FHWA; hazard analyses used for design criteria for bridges in NY; public education and outreach	makes recommendations that are often formally signed off by others; design information and evaluations are used directly for implementation
-file all contractor reports; e indexes and synthesis ts; general repository for ta	Quaternary geologic mapping; map-based soil & ground water data	contractor/researcher reports needed, as journal articles often lack basic data	95%	analysts unaware of data unless active in scientific community	applications not strongly emphasized; users may not know what to do with hazard products/maps	San Jose liquefaction maps reviewed in permit process; San Diego liquefaction maps used to indicate when special studies required; Wasatch PSHA was basis for proposed upgrading to Zone 4	serves in advisory role to owners; site specific spectra used directly for design decisions and checks
	improve real-time earthquake data and methodology; move beyond generic probabilities	available and usable (others may have difficulties)	100%		users don't know how to use products	short-term prediction warnings to state; business emergency response plans; public information	makes recommendations for California Office for Emergency Services decisions; translator for public information
IS format; provide digital ation on Internet; create of products/data	dynamic properties of rocks and soils; hazards mapping in more detail; high-resolution remote sensing; incorporating uncertainty treatment; cost-benefit analyses for losses	not aware of any data that are not; an index would be useful to identify available relevant studies; need guidelines for data collection	100%	methodologies to conduct analyses not well developed	planners don't know how to use probabilistic products to make policy decisions	special studies zones maps for local government use; review and oversight of local government decisions	local governments, state agencies for siting state buildings; serves as an expert or consultant
nent GIS databases		aware of important data; need more communication with practicing engineers	100%	need better analytical methods for ground motion amplification and seismically induced landslides; better methods and data needed for inclusion in UBC; attenuation relationships	more earthquake scientists (geologists/seismologists) needed at local level	building siting decisions; local jurisdictions follow state laws and regs; provide informal advice to local decision makers	provides information to state agencies and local governments
	ground motion mapping for different soil types; update national seismic hazard map for Midwest	information not available except from researchers	100%	site response	need to identify user community	teaches short courses for engineers, school officials, local city and county staff, etc.; public education; state emergency planning department uses information	county and state emergency response staff
talog of external n reports	accurate and updated PSHA maps, better way to evaluate socioeconomic proposals	not aware of any	100%	USGS has been assuming role of translating data to hazard very successfully	most decision makers don't know the magnitude and nature of the risk yet	state agencies adopting products, but progress is slow; codes are behind, but will be upgraded in 1994	other state agencies, especially WDOT, DEM; serves as a consultant
dexes and summaries of ons	ground motion maps for Calif.; liquefaction, landslide, ground shaking maps			bias in NEHRP support toward fault studies, and away from earthquake effects (e.g., landsliding)	need better focus on what will be needed after earthquake; change priorities from publication to hazard mitigation	education of "champions" at public agencies	private developers; school board, city and county elected officials and planning committees; local jurisdiction technical staff; consultants
g and annotations	better statistical analyses of risk; validation of land use decisions for risk reduction	no uniform GIS; would like data in GIS but little is available in this format	70-80%		planners don't know how to use probabilistic risk information	develop policies and ordinances that local governments adopt	city planners, elected officials, technical advisory committees; serves as consultant

Table 3.2 (cont.)

Interviewee	1. What is focus of seismic hazard analysis efforts?	2. Percent time on hazard analysis; percent of NEHRP funding	3. Data used in hazard analysis provided directly by NEHRP	4a. How easily available and retrievable are these NEHRP databases?	4b. Suggestions for making data more easily available	5. Additional information needed	6. Are da NEHRI availab form?
J. Wieczorek U.S. Geological Survey	hazard maps; landslide maps and methodology	25% time 55% funding	geologic maps, seismicity catalogs, landslide distribution maps	easily available	accurate summary descriptions of NEHRP projects needed; access to external contractor reports		external rep
M.E. Hynes U.S. Army Corps of Engineers	dam safety	100% time 0% funding	seismicity catalogs; strong motion data; very few seismic hazard maps	for strong motion records: need more retrievability, more uniformity, more user-friendly, without glitches		needs include more performance data and information; better prediction of earthquakes; better methods for assessing residual strength of soils; better foundation design criteria; and much more; many of these needs may be beyond NEHRP	not a proble community
G. Martin University of Southern California	hazard analysis including ground shaking and ground deformation	20% time 0% funding	seismicity catalogs; strong motion data	need timely release of new information (e.g., strong motion data); more uniform treatment of data		timely release of new information following earthquakes	delays in rele strong motion products (e.g need more dc translation fo
W. Bakun U.S. Geological Survey	USGS coordinator for No. Calif. earthquake risk reduction activities	100% time 100% funding	all types of geologic and seismic information	efforts are being taken to make data bases more easily available (e.g., earthquake catalog and strong motion data on Internet)	has prepared open-file report with summaries of research in No. Calif. by county; approach could be used in other geographic areas	USGS wants to see work used; communication gaps and limited funding to implement programs are issues	
T. Henyey Southern California Earthquake Center	PSHAs; probability forecasts; methods for predicting ground shaking	100% (50% research; 25% integration; 25% education & outreach) 80% funding	all data for So. Calif.	generating data, so it is easily available	establish regional data centers; need indexes	neotectonics and fault zone geology; broad band seismic data; more permanent GPS stations	available and w with structural NCEER could

Table 3.2 (cont.)

Suggestions for making data more easily available	5. Additional information needed	6. Are data generated by NEHRP researchers not available? In an unusable form?	7. Percentage of analyses conducted internally	8a. Knowledge gaps: data to hazard	8b. Knowledge gaps: hazard to application	9. How are results of hazard analyses used?	10. Who makes decisions regarding hazard mitigation?
rate summary descriptions NEHRP projects needed; ss to external contractor rts		external reports difficult to obtain	100%	need better methodologies for analyses		products used by county geologists for siting decisions; used by states for zoning methodology; Federal land agencies for land use decisions	county geologists, resource managers for federal lands agencies; serves as consultant
	needs include more performance data and information; better prediction of earthquakes; better methods for assessing residual strength of soils; better foundation design criteria; and much more; many of these needs may be beyond NEHRP	not a problem within scientific community	70%	gaps are a part of the process of transferring research into practice; to unduly rush the process could be detrimental to quality of practice		dam safety and remediation; flood control and navigation structures	for COE, joint decision by research scientists and engineers, technical monitors and the facility
	timely release of new information following earthquakes	delays in release of data (e.g., strong motion records); research products (e.g., computer codes) need more documentation and translation for end users	100%	better technology transfer is needed		used by public engineering and construction agencies	makes recommendations, owners make decisions; serves as consultant
repared open-file report summaries of research in Calif. by county; ch could be used in geographic areas	USGS wants to see work used; communication gaps and limited funding to implement programs are issues			need to educate local planners (e.g., seminar on GIS planned); need dialog with users (e.g., in No. Calif. have annual seminar to set priorities for research); No. Calif. ideal for gathering information, knowledge applicable nationally			
lish regional data centers; indexes	neotectonics and fault zone geology; broad band seismic data; more permanent GPS stations	available and useable; connections with structural engineers and NCEER could be strengthened	0-100% (most of work funded, but all researchers considered "internal")	ability to transmit data between researchers and users; geographic-based raw data, like regional geologic maps; subsurface geotechnical data	translation between earth scientists and practicing engineers	emergency preparedness; engineering decisions; education in schools; research connection to other communities	state emergency response staff, city and county officials, public safety staff, teachers and school administrators

Table 3.3. Interview results—End-U

Interviewee	1a. Earthquake-related data and analyses used in your organization?	1b. Estimate how much of this information is supported by NEHRP	2. Opinion of quality and reliability of NEHRP products	3. How easily available and retrievable are these NEHRP products?	4. Additional data needed?
J. Kimball U.S. Department of Energy	strong motion data, attenuation models; site response tools; PSHA; GSG characteristics; standards, sampling techniques & applications	GM $\leq$ 50% PSHA $\leq$ 10-25% GSG < 50-75%	high, except for national seismic hazard maps that need to incorporate current data	obtain data from publications and personal contacts; Interagency Committee on Seismic Safety; Red Book conferences	geology and seismicity: need codes and standards, good geologic maps; site response maps are poor
D. Stephenson Westinghouse Savannah River Company	seismicity catalogs; geology and geophysics data (including national seismic hazard maps)	unknown	uncertain what NEHRP sponsors; national seismic hazard maps reliable and good quality	indexes and summaries would be helpful; needs information on available products; relevant studies identified through publications and contacts	needed information generated in-house or by contractors; may not be aware of potentially useful NEHRP data
J. Talbot U.S. Soil Conservation Service	NEIC earthquake data; seismic hazard analyses for dams; SCS manual contains national seismic hazard map	unknown	uncertain what NEHRP sponsors. USGS data good; NEIS provides good service	indexes and summaries would be helpful; needs information on available products; relevant studies identified through publications and contacts	technology based on available data (e.g., software) could be improved; increased understanding of fault locations, histories would be helpful
N	paleoseismic investigations; regional seismotectonics; seismicity catalog, crustal propagation parameters; earthquake source parameters	50-75%	high-quality paleoseismicity data and catalogs	obtains data from publications and personal contacts	data needs are specific to region: need better constraints on Q, stress drop, shear-wave velocity, paleoseismology
S. Kupferman Riverside County, California	Alquist-Priolo zone maps; County Seismic Safety Elements; USGS, CDMG publications for county; CEQA studies	50%	confident it is good if it is peer-reviewed	relatively good; needs GIS datasets	needs more geologic mapping; seismicity catalogs; weekly/monthly updates on local seismic activity
R. Hawke City of San Diego, California	UBC, Alquist-Priolo zone maps	unknown	national seismic hazard maps good; scenario earthquakes information valuable	no opinion; doesn't use NEHRP products directly	need moderate earthquake in San Diego Bay to increase public awareness; more outreach to non-technical decision-makers
J. Hooper Ratti-Swenson-Perbix	national seismic hazard maps; site-specific data obtained from consultants; involved with design values panel in BSSC effort	100% for USGS national hazard maps; $\leq$ 50% for site-specific data	for Pacific Northwest region, adequate consensus not used for national seismic hazard maps	personal contacts needed; information should be disseminated through technical societies	common definition of terms needed (e.g., "duration" and "time history")

Table 3.3. Interview results—End-Users

3. How easily available and retrievable are these NEHRP products?	4. Additional data needed?	5. Are data generated by NEHRP researchers not available? In an unusable form?	6. Percentage of analyses conducted internally?	7. Do you make decisions or recommendations regarding hazard mitigation?	8. Gaps in knowledge between NEHRP products and those products you use?
obtain data from publications and personal contacts; Interagency Committee on Seismic Safety; Red Book conferences	geology and seismicity: need codes and standards, good geologic maps; site response maps are poor	unaware of any problems; information dissemination on NSF/NEHRP side not as effective	90% contracted; 10% in-house for confirmation	yes, which characterization studies to be conducted, concurrence in results, accept/reject input for design and remediation/retrofit studies	data and hazard analyses: state of knowledge in scientific community not reflected on hazard maps hazard analyses and end use; potential exists for misuse, should be guidance on use of maps
indexes and summaries would be helpful; needs information on available products; relevant studies identified through publications and contacts	needed information generated in-house or by contractors; may not be aware of potentially useful NEHRP data	unaware of data unless it is published	30%	yes, recommendations for design, identification of hazards that might be expected; Defense Board makes ultimate decision	gap between products and needs: analyst may not fully consider impact on end user; data gatherer may not collect most useful data; careful planning stage needed; data gatherers and hazard analysts should talk with end users
indexes and summaries would be helpful; needs information on available products; relevant studies identified through publications and contacts	technology based on available data (e.g., software) could be improved; increased understanding of fault locations, histories would be helpful	suspects data available for buildings, but not lifelines	by number of sites, 90% in-house; for larger structures, 70%	yes, writes documents on policies and procedures to mitigate earthquake hazards that must be followed by SCS staff	need to accelerate understanding in lifelines area
obtains data from publications and personal contacts	data needs are specific to region: need better constraints on Q, stress drop, shear-wave velocity, paleoseismology	USGS not releasing some data in a timely manner; need mechanism for input into study plans	20-25%	yes, makes recommendations of ground motions to be used; decisions on priorities for work activities	needs more information on NEHRP studies
relatively good; needs GIS datasets	needs more geologic mapping; seismicity catalogs; weekly/monthly updates on local seismic activity	unaware of any problems	0%	yes, building permit approvals; recommendations for county land use decisions	better sources of data for geologic maps needed
no opinion; doesn't use NEHRP products directly	need moderate earthquake in San Diego Bay to increase public awareness; more outreach to non-technical decision-makers	unaware of any problems	0%	yes, building permit approvals; recommendations for city land use decisions	cities and counties typically five years behind; politicians and citizens need to be educated
personal contacts needed; information should be disseminated through technical societies	common definition of terms needed (e.g., "duration" and "time history")	does not know	> 90%	yes, makes recommendations on hazard mitigation; educates facility owners	consensus/stability needed for national seismic hazard maps

Table 3.3 (cont.)

Interviewee	1a. Earthquake-related data and analyses used in your organization?	1b. Estimate how much of this information is supported by NEHRP	2. Opinion of quality and reliability of NEHRP products	3. How easily available and retrievable are these NEHRP products?	4. Additional data needed?	
J. Fisher Ventura County, California	geologic information in USGS, CDMG publications, private consulting reports	<10%	good; some studies validated later by consultants	not good because County can't afford to build a library; need on-line retrieval; most NEHRP products obtained from personal contacts	needs accurate hazard maps	
C. Nelson Salt Lake County, Utah	geologic and seismic hazard information for region	>90%	very good	easily available; preprints obtained from personal contacts	needs new microzonation maps for ground shaking and liquefaction potential; private borehole data should be incorporated into local map database	
M.E. Hynes U.S. Army Corps of Engineers	seismicity catalogs, strong motion data; do not use national seismic hazard maps	very little	reasonably good; expert opinion approach may not be appropriate; many models not verified	seismicity good; strong motion dataset has problems; need personal contacts to get recent information	accurate and quantitative earthquake predictions; residual strength of sands, silts, and gravels; better criteria for dynamic load capacity of deep foundations; better and cheaper methods for geotechnical site characterization; verified analytical models and remediation methods	
L. Von Thun U.S. Bureau of Reclamation	seismicity catalogs, strong motion data	much data	generally reliable, but not comprehensive	seems to be available to seismologists, but engineers and other end users may have difficulty obtaining information	fault and seismic source data are incomplete or not fully summarized for many regions; need better criteria for liquefaction of gravels, need more strong motion records	If r Ide obt
T	UBC and local data	unknown	very limited data for Alaska	very limited data for Alaska	need local hazard maps for Anchorage region	mo nee rec suc
D. Ballantine Kennedy-Jenks, Seattle	observational data from past earthquakes; hazard maps if available (ground failure),	large percentage	information is not complete and not adequate for design of pipelines	not generally available; need to depend on personal contacts	need more liquefaction mapping; need magnitude and distribution of ground failure displacements; need maximum magnitude and recurrence intervals for earthquakes in Pacific Northwest	nee too info com year
J. Christian Stone & Webster, Boston	seismicity catalogues; strong motion records	much comes from NEHRP; also, much pre-dates NEHRP	fairly good; some poorer quality analyses come from national labs	generally easy to get; strong motion records might not be processed correctly; need to speed up processing and improve uniformity	information generally available but publication takes time; strong motion records could be improved	

Table 3.3 (cont.)

. How easily available and retrievable are these NEHRP products?	4. Additional data needed?	5. Are data generated by NEHRP researchers not available? In an unusable form?	6. Percentage of analyses conducted internally?	7. Do you make decisions or recommendations regarding hazard mitigation?	8. Gaps in knowledge between NEHRP products and those products you use?
ot good because County can't fford to build a library; need n-line retrieval; most IEHRP products obtained rom personal contacts	needs accurate hazard maps		0%	yes, building permit approvals; recommendations on county land use decisions	local information on crustal structure and tectonic setting; translation of data into significance to hazard evaluation
asily available; preprints btained from personal ontacts	needs new microzonation maps for ground shaking and liquefaction potential; private borehole data should be incorporated into local map database		high %, mostly using NEHRP funds	yes, building permit approvals; recommendations on county land use decisions	better ground shaking analysis than UBC; teaching building officials importance of enforcement; develop uniform rules between jurisdiction
eismicity good; strong otion dataset has problems; eed personal contacts to get ecent information	accurate and quantitative earthquake predictions; residual strength of sands, silts, and gravels; better criteria for dynamic load capacity of deep foundations; better and cheaper methods for geotechnical site characterization; verified analytical models and remediation methods		70%	yes, group decision by WES, technical monitors, and Corps District	see answer to Question 4
ems to be available to ismologists, but engineers d other end users may have fficulty obtaining formation	fault and seismic source data are incomplete or not fully summarized for many regions; need better criteria for liquefaction of gravels, need more strong motion records	If relevant information is identified, it usually can be obtained	90%	yes, within USBR, we make decisions	not familiar enough with NEHRP program to comment
ry limited data for Alaska	need local hazard maps for Anchorage region	more transfer of information is needed, particularly to those remote from the NEHRP program, such as in Alaska	varies, building 100%, other 60%	we make recommendations; some municipal owners without technical expertise are pushing for engineer to take legal responsibility for decisions	hazard maps for Anchorage and other non-priority areas; local training workshops for users; not familiar enough with NEHRP program to note specific gaps
t generally available; need depend on personal contacts	need more liquefaction mapping; need magnitude and distribution of ground failure displacements; need maximum magnitude and recurrence intervals for earthquakes in Pacific Northwest	need maps in GIS format; NEHRP too slow in releasing maps and information; product may be 95% complete and not released for years	60%	we make recommendations or incorporate mitigative measures in design; client and regulators weigh these with other constraints and make decisions	development of better databases and methodologies; less emphasis on sophisticated loss models until basic information developed
erally easy to get; strong tion records might not be ocessed correctly; need to ed up processing and prove uniformity	information generally available but publication takes time; strong motion records could be improved		50%	we make recommendations, client and regulators make decisions	many analysts too heavily involved in uncertainty, producing unreal results for low probability applications; best estimate most robust information

Table 3.3 (cont.)

Interviewee	1a. Earthquake-related data and analyses used in your organization?	1b. Estimate how much of this information is supported by NEHRP	2. Opinion of quality and reliability of NEHRP products	3. How easily available and retrievable are these NEHRP products?	4. Additional data needed?
W. Savage Pacific Gas and Electric Company	all available map-based data (liquefaction, slope stability, site response); seismic hazard analyses in literature	unknown; could be 30-70%?	studies don't meet needs of PGandE end users; it is usually necessary to interpret raw data	could be improved; staff time and money required to track NEHRP products; index (e.g., GIS) with geographic location information would be useful	program not adequately focused in data gathering, analysis; need program-driven study; current program is PI-driven, not goal-oriented
C. Stepp Electric Power Research Institute	all types of geologic and seismic information	85%	moderate to high, but lack of quality control; strong motion dataset fragmented; attenuation modeling and hazard map uncertainties not clearly stated	variable; earthquake dataset good; some strong motion data unavailable; USGS should work with NOAA to provide repository for strong motion data, and make uniform corrections	dense array data; soil dynamics and soil response issues should have higher priority
J. Gates California Department of Transportation	important structures receive deterministic and probabilistic hazard assessments; analyses of ground motion and site amplification conducted	unknown	not familiar with NEHRP studies	no opinion; needs information on NEHRP	economic evaluation/loss studies to assist in retrofit decisions (cost-benefit, risk assessment, quantification of building importance)
D. Cotton Cotton-Boland Associates	seismicity, fault locations, other geologic data	unknown	not familiar with NEHRP studies	no opinion; doesn't use NEHRP products directly	cities want confidence that construction standards for critical facilities are necessary and adequate
X	site seismicity, fault locations	unknown	good	good; dependent on personal contacts at USGS, CDMG	more on liquefaction, intense ground shaking, strong motion records
P. McDonough Mountain Fuel Supply	many sources of data: FEMA yellow books, EERI and ASCE publications, UBC, etc.		practical products and guides are good and useful	information is available for those involved in the program through professional organizations or personal contacts	pipe performance in earthquakes, performance of structures and components in moderate-sized earthquakes
E. Rinne Kleinfelder, Inc.	earthquake-risk type programs, UBC, hazard maps; some from CDMG and some from USGS	unknown	need to understand assumptions behind maps in NEHRP provisions of building code	generallly available and useful	more research needed on sensitivity of estimated ground motions to input assumptions; on K-factors and building performance
Y	seismicity information for Safety Element, rules for URM building retrofits	probably large percentage	believe it is very good	don't use products; will have GIS using Arcinfo in future	locations of active faults in area

Table 3.3 (cont.)

3. How easily available and retrievable are these NEHRP products?	4. Additional data needed?	5. Are data generated by NEHRP researchers not available? In an unusable form?	6. Percentage of analyses conducted internally?	7. Do you make decisions or recommendations regarding hazard mitigation?	8. Gaps in knowledge between NEHRP products and those products you use?
could be improved; staff time and money required to track NEHRP products; index (e.g., GIS) with geographic location information would be useful	program not adequately focused in data gathering, analysis; need program-driven study; current program is PI-driven, not goal-oriented	information available and usable	50%	yes, including defining guidelines for hazard evaluations for existing buildings; decisions on continued occupancy; priorities for funding earthquake mitigation	see answer to Question 4.
variable; earthquake dataset good; some strong motion data unavailable; USGS should work with NOAA to provide repository for strong motion data, and make uniform corrections	dense array data; soil dynamics and soil response issues should have higher priority	geophysical datasets difficult to obtain, may be difficult to use	15%; 85% contracted out but managed in-house	yes, 40-50% of EPRI effort to develop codes, guidelines to implement codes, etc.	EPRI/utilities must develop products for their particular problems; NEHRP could improve datasets and analysis tools
no opinion; needs information on NEHRP	economic evaluation/loss studies to assist in retrofit decisions (cost-benefit, risk assessment, quantification of building importance)	needs to know what data have been generated	goal is 80-90%	yes, design and retrofit decisions	concern that some users do not adequately understand meaning/use of some products; overemphasis on probabilistic approaches and not enough on worst-case scenarios
no opinion; doesn't use NEHRP products directly	cities want confidence that construction standards for critical facilities are necessary and adequate	no opinion	15%	yes, for public buildings	translating technical reports into language for laymen
good; dependent on personal contacts at USGS, CDMG	more on liquefaction, intense ground shaking, strong motion records	information available and usable	0% (closely review contrator work)	yes, dam safety and design parameters	information on liquefiable sediments
information is available for those involved in the program through professional organizations or personal contacts	pipe performance in earthquakes, performance of structures and components in moderate-sized earthquakes	if relevant information is identified, it can be obtained	90%	yes, decisions on seismic design and retrofit for company facilities	getting information to nontechnical industry leaders
generally available and useful	more research needed on sensitivity of estimated ground motions to input assumptions; on K-factors and building performance	if relevant information is identified, it can be obtained	90%	yes, we make recommendations for hazard analyses and input design values; owners and regulators make final decisions	NEHRP needs to be more sensitive to uses and abuses of information it produces (e.g., estimates of low probability ground motions may be unrealistic)
don't use products; will have GIS using ArcInfo in future	locations of active faults in area	not that we know of	0%	yes; URM ordinance, safety element of general plan	see answer to Question 4

4. USER NEEDS IN THE BUILT ENVIRONMENT

4.1 DEFINITION OF THE BUILT ENVIRONMENT

The definition of the built environment could be considered as everything related to the urban infrastructure, including buildings, facilities, and lifeline systems. For this Assessment, the Built Environment Team (BET) primarily focuses on building construction, or buildings, and lifelines. The definition of a building is straightforward; it includes architectural design, engineering design, construction, and use of the building. Lifelines, according to the American Society of Civil Engineers' Technical Council on Lifeline Earthquake Engineering (TCLEE), are infrastructure systems and facilities that provide services vital to society, including:

- communications,
- electric power,
- gas transportation and storage,
- liquid fuel transportation and storage,
- sewage,
- transportation including ports and harbors, and
- water.

4.2 IDENTIFICATION OF SELECTED USERS

The Built Environment Team established a process for the identification and selection of key collaborative and end-users for interviews and a mail survey. For the built environment, collaborative users include professionals dealing with planning, design, and construction of the urban infrastructure, including all buildings, facilities, and lifeline systems (e.g., researchers/ educators, architects, civil engineers, structural engineers, industrial engineers, urban planners and designers, professional association/institute officers). End-users are those associated with regulatory aspects, implementation, and decision-making for the built environment (e.g., code and standards promulgators, building officials, building inspectors). Lifelines would fall into both categories because of the diverse functions within the lifeline system.

Resource lists used for the identification of key users by name and location included the principal documents listed in Table 4.1.

The seven resource lists (shown in Table 4.1) provided by the BET included a pool of 4534 potential names to be used in the selection of key persons for interviews and mail surveys. This number was reduced by eliminating (1) those practicing in seismic zones 0 and 1 of the Uniform Building Code, except for lifelines, and (2) any names duplicated in the seven lists (i.e., persons were counted only once). This reduced the general pool by about 25% to 3400 eligible names. With respect to lifelines, persons selected included consultants and operating company personnel in systems having operations in seismic areas.

Next the team developed a flow diagram, shown in Fig. 4.1, that highlights the flow of information (transfer of knowledge) in the built environment from research to implementation. Coincidentally, this flow diagram can also be considered as a representation of the flow from the most collaborative user (often a researcher) to the one who uses the information the most (the implementer or constructor) of the built environment.

Table 4.1. Resource lists for identification of key users and interviewees

Document	No. of names listed
EERI Roster 1993-94	1913*
EERI Conference/Annual Meeting/Symposium Participant Lists	707
American Institute of Architects/Research Council Seismic Design Seminars Participant Lists	159
AIA Profile Directory List	391
NIBS/CCB Private Sector List	709
CUSEC Participants Listing	140
ASCE Committee/Division Member Lists (including all lifeline categories)	515
Total	4534

*Regular members only.

Using this flow diagram as a guide to match with the shortened resource list of eligible candidates, the final selection was made of key persons to participate in the interview and mail questionnaire surveys. Interviewees were selected from each resource listed in Fig. 4.1.

The names of 65 interviewees who participated in the telephone interviews and scheduled one-on-one interviews, including 116 persons to whom survey questionnaires were mailed, are included in Appendix D.

Persons interviewed by telephone and by face-to-face contact were primarily experienced, knowledgeable persons in each category (user and collaborator) with recognized skills in their field. Persons to whom questionnaires were sent primarily represented typical practitioners at all levels of seismic risk. They were asked to provide a list of their needs. In almost every case, needs cited by this mail survey group concurred with needs expressed by the interviewed group.

4.3 PROCESS FOR INFORMATION GATHERING

In the development of common approaches, strategies, and methods of data collection and to solidify findings, the Built Environment Team met on three occasions for results analysis, discussions on progress made to date, and for coordination purposes:

- July 11, 1993 Boulder
- September 8, 1993 Washington, DC
- September 15, 1993 Denver

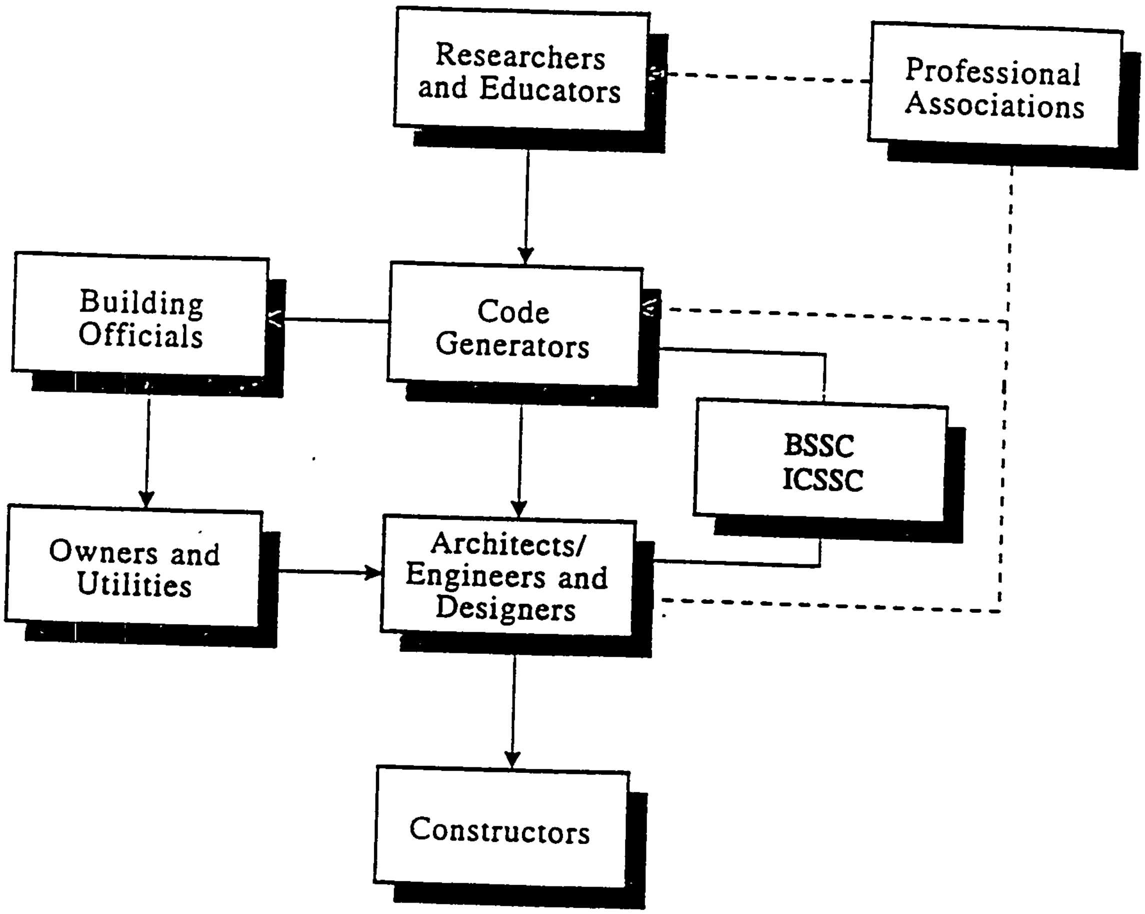

Fig. 4.1. Flow diagram of built environment information transfer as a basis for data collection.

The steps used in data collection, information analysis, identification of findings, and the development of recommendations for this study included:

- examination of background reference literature;
- identification and selection of key users and interviewees for interviews and a mail survey questionnaire;
- data collection by
  - — telephone and/or one-on-one interviews of selected key users and interviewees;
  - — written mail survey to an additional list of key users and interviewees as a cross-check on interviews;
  - — interviews at selected earthquake engineering meetings; and
- preparation of interview and survey/questionnaire results.

The Built Environment Assessment Team established common themes before beginning the data collection process. Those themes were integrated under several categories to allow interviewees an organized expression of their needs and problems related to seismic design and construction. Those themes and categories are:

1. Process assessment:
   - knowledge creation,
   - knowledge utilization,
   - education,
   - interactions, and
   - administration of programs.

2. Status of needs:
   - needs now adequately met,
   - needs that could be met with more effective use of existing knowledge, and
   - needs that require new knowledge.

3. State of practice:
   - products of research,
   - codes and standards,
   - design and construction, and
   - technology transfer.

4.3.1 Background Reference Literature

To develop an appropriate data base against which to measure advances in earthquake engineering, more than 100 publications were examined. Of these, 38 were selected for further review and study (these are included in Appendix B). The National Research Council publication entitled *Earthquake Engineering Research—1982* (also referred to as the Housner Committee Report) was of particular interest as a resource document. It provided a baseline for comparing data compiled from key person interviews and mail survey forms of Phase 3 of this study. From this comparison it was clear that many substantial breakthrough advances and accomplishments in earthquake engineering and NEHRP have occurred within the last 15 years.

Another significant document used in this study is *Participant Responses: Workshop on Directions for NSF Earthquake Engineering and Earth Science Research in the Next Decade* (Jirsa, 1993) in which more than 125 interviewees identified recent important NSF research developments and recommended broad topics of research for future activities. Each workshop participant listed the number of students or coworkers associated with their NSF earthquake-related research over the past 5 years. As the questionnaire provided an objective appraisal of NSF research efforts in earthquake engineering and earth sciences, it became a resource document for the Built Environment Team and was used to compare user needs from the NSF responses with those of this effort.

4.3.2 Data Collection

As discussed above, the approach used in data collection involved four methods: telephone interviews, one-on-one interviews, attendance at respective earthquake engineering meetings, and mail surveys.

When collecting data from the 181 professionals identified in the two built environment areas of buildings and lifelines, the BET further subdivided the professionals into three categories: (1) architects and engineers of buildings, or designers and consultants, referred to herein as A/Es; (2) building owners; and (3) lifeline engineers and operators, referred to herein as lifeline E/Os. Table 4.2 summarizes the method of data collection.

Table 4.2. Classification of data collection methods used

Type of method	Number of interviewees
Telephone interviews	65
One-on-one scheduled interviews	included above
Personal discussions at earthquake engineering meetings	included above
Mail questionnaires	116
Total	**181**

4.3.2.1 Personal and Telephone Interviews

The scheduled one-on-one interviews and the telephone interviews were intensive. The interview was prescheduled when possible, so that the interviewee would feel comfortable in taking the time needed to give detailed explanations in his/her answers.

Depending on the interviewee's available time, interviews ranged from 35 minutes to 3 hours. Of the shorter interviews, some interviewees followed up their comments within a few days with extensive written statements and observations.

To develop uniformity in the types of questions to be asked during the telephone interviews and one-on-one scheduled meetings, and for continuity purposes in assessing results, responses and views were requested on items outlined in Section 4.2 and grouped according to the following topics:

- use of available products in practice (i.e., the state of practice),
- progress of earthquake preparedness (i.e., process assessment),
- product and knowledge needs in earthquake practice (i.e., status of needs),

- recommendations on future directions and areas of focus of NEHRP programs, and
- suggestions for improving existing processes.

4.3.2.2 Role of Earthquake Engineering Meetings and Workshops

Attendance at earthquake engineering meetings and workshops around the country gave opportunities for collecting data not covered by the telephone interviews and mail survey. Attendance at meetings by team members enabled them to obtain comments from groups of people and allowed placement of data in relevant perspectives. A sampling of the meetings attended and used for professional development and data collection purposes by members of the Built Environment Team include those shown in Table 4.3.

Table 4.3. Sampling of meetings attended

Meeting	Location	Date (1993)
Workshop on Directions for NSF Research in NEHRP	Washington, DC	June
American Geophysical Union/FEMA Meeting on Earthquake Hazard Public Education Program	Boise	June
18th Annual Hazards Research and Applications Workshop	Boulder	July
NIBS/FEMA Meeting on Loss-Estimation Methodology Development	Washington, DC	July
Technical Briefing on the Hokkaido Earthquake of July 12, 1993	San Francisco	August
NSF Meeting on Seismic Repair and Rehabilitation Research Program	Washington	September
ASCE Technical Council on Lifeline Earthquake Engineering Committee Meeting	San Francisco Seattle	September October
U.S. Natural Hazards Symposium	Washington, DC	November

4.3.2.3 Mail Surveys/Questionnaire

Three separate mail survey forms (questionnaires) were prepared to conform with the three categories cited in Section 4.3.2. Development of these survey forms went through three iterations before the final formats of 16 questions for A/Es, 20 questions for lifeline building owners, and 22 questions for lifeline E/Os were ready to be sent out. These questionnaires are included in Appendix F.

The 116 mail questionnaires were sent across the country to the three types of users that included these organizations and specific technical areas:

- large architectural and engineering firms;
- medium to small architectural and engineering firms;

- urban design firms;
- constructors;
- lifeline systems:
  - communications,
  - electric power,
  - gas systems,
  - liquid pipelines,
  - transportation,
  - ports, and
  - water and sewage.

An additional mail survey was conducted by two members of the Project Lead Team for publications. That survey gathered results from owners and designers representing 24% and 62% respectively of interviewees, and therefore focused on groups similar to those surveyed by the BET assessment. The findings of both surveys are in agreement. The Lead Team survey dealt with greater numbers and provides a statistical basis for categorizing results based on available documents. The BET assessment provided interviewees with opportunity to define needs and allowed presentation of discussions regarding the basis of needs. The results and an analysis of the Lead Team survey are provided in Section 8.

4.4 RESULTS OF INFORMATION GATHERING: IDENTIFICATION OF USER NEEDS

This section deals with the results of information gathered to identify user needs. The material will be presented in two parts, results of questionnaire responses and discussion of needs resulting from interviews.

4.4.1 Questionnaire Results

As noted earlier, the purpose of the questionnaires was to verify data collected in the interviews and to receive data regarding attitudes of typical users in the built environment from around the country. Of the 116 questionnaires mailed, 25 A/Es responded, 6 building owners responded, and 26 lifelines E/Os responded. Thus, 57 total responses were received, or 49%, which is a very high response rate.

In general, responses on the questionnaires agreed with information obtained from interviews, with significant agreement in certain areas of concern. No new data were uncovered from the questionnaire results.

Responses from A/Es were obtained from all sections of the United States and represented UBC seismic zones 2 through 4. While most A/Es' objectives are to ensure life safety (24), a large number provide designs to ensure functionality (15) and minimize property loss (13). All 25 A/Es believe that seismic design issues should be included as part of State Board Professional Licensing Examinations. Approximately half of the A/Es attended universities in which seismic design was offered in the curriculum. Most designers use NEHRP publications to assist design, and they attend technology transfer sessions on a regular basis, that is, at least twice a year on the average. The majority of responders requested more technology transfer for applications of planning and design.

While most A/Es expressed needs that were related to the processes associated with NEHRP (e.g., continuing education, better design guides, more specific code provisions), relatively few suggested specific technical needs (e.g., tunnel design, structural joint accommodations). A summary of the questionnaire results is provided in Appendix E.2.

Six questionnaire responses were received from building owners. Summaries of these questionnaires are also provided in Appendix E. Responses from building owners were obtained from Puerto Rico, Missouri, South Carolina, Tennessee, and Washington. Responses were received from industrial, commercial, and public utility companies. The geographic U.S. distribution of companies included the Northeast, Southeast, Central, and West Coast and represented users of all existing model building codes.

In every case, building owners believe that a major earthquake represents a threat to their facilities, although hurricane and fire were considered to be greater threats in some areas of the country. All building owners believe that life safety represents their greatest performance objectives; however, a significant number also believe a need exists for maintaining functionality and controlling property loss.

Only one building owner specifically requested improved lifeline technical information, although several owners suggested improving the availability of information related to earthquake resistant design.

Twenty-six questionnaire responses were received from the lifeline E/Os. Summary responses of this questionnaire are provided in Appendix E.2. Those responses represented the following lifeline systems:

communications (7),
electric power (2),
natural gas (2),
oil pipelines (3),
highway (7),
port and harbor (1),
water (8), and
sewage (4).

Responding lifeline E/Os operated in at least 1 to as many as 13 states. One communications lifeline operator, however, has facilities in all 50 states. The distribution of responding lifelines ranged from the Northeast (1) to the West (15), including seven from the southeast, and five from the Central United States. Typical model codes [UBC, Building Officials and Code Administrators Association (BOCA), and Southern Building Code (SBC)] are used, including special provisions such as AASHTO and NRC provisions for nuclear power plants.

Seventeen lifeline responders consider earthquake to be a major threat, while seven believe earthquake to represent a moderate threat, and two believe that earthquake poses no threat. Ten responders believe that other hazards represent a greater threat than earthquake. Other hazards include flood, high wind (hurricane and tornado), volcanism, fire, construction processes, and landslide.

Of the 26 lifeline responders, all consider that maintaining functionality is important with life safety, and 21 consider the reduction of property loss also to be important. Maintaining service during and after an earthquake is a fundamental requirement of lifelines, and responders believe that performance requirements will be expanded in the future.

Responses to questions 6, 7, and 9 (summarized in Appendix E.2) indicate increased activity in recent years to improve seismic resistance. That activity includes retrofit, improved planning, and adoption of emergency procedures. The lifeline responders indicated that good use is made of NEHRP's wide range of information and knowledge to assist in seismic design presentations in publications, seminars, workshops, and available guidelines.

Needs expressed by lifeline responders are consistent with those expressed by interviewees. The majority of responders requested more technology transfer in the form of workshops, seminars, and special conferences. Also requested were guidelines for design and implementation of design codes and standards for lifelines. At least one responder requested continuation of the work of NEHRP.

4.4.2 Interview Results

The assessment team performed analyses of interviews through a series of meetings and telephone and fax exchanges, as described in Section 4.3.

Even with the advancements made in the development of higher degrees of interdisciplinary involvement in earthquake engineering, many researchers and design professionals agree with one user who responded that NEHRP "is not going anywhere until complete integration of social and economic components takes place" with design objectives. In other words, a solid integration is needed among disciplines, rather than simply an involvement of social and economic considerations in parallel with each other. The rationale behind this response is that the built environment user (e.g., client), when faced by seismic safety issues, always asks, "How much will it cost?" The bottom line, then, in end-user acceptance of proposed earthquake engineering solutions will continue to be driven by the question of cost.

Disciplinary integration, assimilation of new technologies, and derivation of cost-effective methods are essential to success in reaching principal earthquake hazard reduction goals. According to the interview responses, new technology can never be assimilated quickly and effectively without the realization of total integration of involved groups in the development and implementation processes. As pointed out by one interviewee, one approach to knowledge transfer that was considered important to researchers but that no longer exists is the University Consortium of Earthquake Engineering Research (UCEER) where, at annual meetings, new technologies were brought to the attention of the design professions for rapid assimilation and use.

Interviewees indicate they still see gaps between the state of the art and the state of practice (e.g., code provisions) in many areas, particularly in small jurisdictions when compared to large urban centers around the country. As stated by one interviewee, "The small guy doesn't know what to do." To get new developments folded into practice sooner, research results need to be made better known and made available more rapidly. One approach, which became evident from the interviews, would be to encourage or support research that demonstrates an ability to carry the process through to implementation.

An observation frequently made in the interviews was, as expressed by one interviewee, that while much of NEHRP's "materials and products, including new knowledge, is available, it is not being systematically applied." As an extension to this viewpoint, it is perceived by some users that appropriate information is not reaching target groups; that is, it is not getting down to public policy makers for implementation because cost and compliance standards are lacking. For example, despite extensive work completed on the seismic repair and rehabilitation of existing structures, specific building type costs, code provisions, and performance standards have not been developed, uniformly promulgated, or adopted on a national basis. In some jurisdictions where seismic building code provisions exist, they are not being enforced.[1]

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[1]It was pointed out, however, that this problem is being addressed by an ongoing program of the Building Seismic Safety Council (BSSC).

One topic clearly identified by interviewees as very important is continued attention to "education, education, education at all levels." Those interviewed acknowledged that NEHRP has an excellent record on education, but many indicated that even more education efforts and innovations in education techniques are needed. Continuity in professional built environment education should be clearly established to form bridges from basic education at university levels to professional training, to licensing requirements, and finally to continuing education activities. As one collaborative user indicated,

> More education is needed and more information transfer is also needed for the design professions. Building designers in smaller jurisdictions do not understand seismic principles as yet.

While citing the successes of NEHRP postearthquake investigation programs, some users indicated that the lessons learned from such field studies could be improved by conducting more appropriate longer term follow-up studies in addition to those short-term efforts that focus on collection of fragile data during the immediate emergency recovery period. When completed after a longer period of time following an earthquake, it is anticipated that the follow-up studies could also produce valuable results in topic areas that may not have been immediately evident during the intense emergency recovery period. It would be useful to conduct follow-up studies 5 or even 10 years—or more—after the initial earthquake event. In most cases, particularly regarding lifelines, follow-up studies after 6 to 12 months to assess the actual impact of the damage, cost of repair, and service interruption would be desirable. Follow-up NEHRP-sponsored postearthquake studies after the Mexico, Loma Prieta, and Northridge earthquakes have provided knowledge on structural performance, recovery, and societal aspects of the losses to the built environment. These practices are encouraged and should be extended.

Several interviewees indicated that it is becoming increasingly important that NEHRP research focus also on lifelines and critical emergency facilities that must remain functional and operational after an earthquake. Other than for hospital design (1972 Hospital Act of California), few cost-effective research results are available to designers on how to achieve this goal. End-users, such as operations managers and utility system maintenance personnel, are especially interested in this topic. In this regard, the role of nonstructural components relative to operational capacities of emergency and utility facilities needs closer scrutiny.

One review (Butler, 1993) stated that:

> There is a strong consensus that a great deal of useful information about hazards exists, and that it is simply not being used - in large part because public officials, decision makers, planners, and private individuals who could benefit from the knowledge are not aware of it or do not know how to obtain it.

End-users often indicated that "in some cases, there is too much information, and it is difficult to determine which information is most pertinent or useful." As one professional put it,

> The average practitioner cannot keep up with all the literature. It would be most helpful if someone, or the NEHRP agencies, could look at all the publications available year by year, categorize and prioritize them according to field and importance, and find out what really has been accomplished and what is particularly useful.

Today there are no regulations or standards that specify the seismic performance requirements for lifelines. With the exception of the AASHTO specification for highway bridges, the standards, codes, and regulations that govern design, construction, and operation of oil and gas transmission and distribution pipelines, electric power systems, water and sewage systems, and transportation systems have no substantive seismic requirements. The provisions of national building codes are used, when judged applicable, in the design of buildings, structures, components, and appurtenances, but these requirements have little or no bearing on overall system performance.

In the absence of regulations, requirements, or incentives, earthquake hazard mitigation for lifelines depends on

- awareness of owners and design professionals of the vulnerability to seismic hazards,
- desire to protect capital investment and avoid loss of revenue because of service interruptions, and
- liability concerns.

In response to a congressional directive, NIST in collaboration with FEMA recently drafted a plan for the development of national earthquake standards for electric power, communications, gas and liquid fuel, transportation, and water and sewage lifeline systems. The plan was to be submitted to Congress in 1993, but it met with mixed reviews within the NEHRP agencies and the NEHRP Advisory Committee. A senior technical staff member at a large California utility viewed the draft plan as "ill-conceived and not beneficial, and the cost of the proposed research [as] high and wasteful." As a result of the comments, NIST and FEMA rewrote the plan, at which time it was approved by the NEHRP Advisory Committee. The plan was then submitted to the Office of Management and Budget in early FY 1994 for review and approval before it was to be submitted to Congress. One key issue raised by several interviewers engaged in the practice of lifeline earthquake engineering is that unless performance requirements for lifelines are mandated or legislated, little progress will be made.

Many lifeline professionals believe that NEHRP activities apply indirectly toward reducing earthquake risks in their systems, and that NEHRP has provided useful products and studies. Among those are improved building code provisions that have been adapted to aboveground facilities, some of the studies on buried pipeline response to ground movements, quantification of the liquefaction hazard, and the mapping of seismic geotechnical hazards in certain regions.

Many lifeline managers believe that, taken in context with other problems that society must address, there simply are not enough financial resources available in this country to make existing lifelines fully earthquake resistant over the short term. Consequently, earthquake hazard mitigation for lifelines should focus on

1. ensuring that all new facilities will be sited, designed, and built in accordance with appropriate seismic standards;

2. replacing or strengthening critical components with high seismic fragility; and

3. developing emergency response plans that expedite recovery from damage that is not avoided.

It is important to recognize that earthquake mitigation for lifelines relies extensively on judgment and cost-benefit considerations. Documentation and evaluation of lifeline performance in past earthquakes is essential for this approach. This knowledge should include not only information on which components are susceptible to damage, but the short- and long-term impacts of the damage on the owner, customers, and public at large. The lessening of system impacts depends in part on the effectiveness of the response plan and the degree of redundancy existing in the lifeline system. Until these types of questions are fully addressed, lifeline organizations will be hampered in their efforts to develop perceptive and cost-effective programs for improving seismic resistance.

Recognizing the importance of experience for mitigation of earthquake hazards for lifelines, it is evident that postearthquake investigation of lifelines must be given increased emphasis to analyze and synthesize this experience.

Levels of expertise in earthquake engineering vary broadly among lifeline companies. The struggle is continual to implement seismic criteria because of the general lack of understanding of dynamic analytical requirements. Simple cookbook methods are often requested by designers, but such procedures are usually not realistic for seismic engineering applications. Education at the university level is the key. University research in lifeline earthquake engineering is necessary to solve basic problems and to ensure an adequate supply of trained professionals.

Problems and shortcomings occur in the dissemination of earthquake hazard mitigation information to the lifeline sector. Most information that reaches practitioners in lifeline engineering is in the form of papers and project technical reports that improve the state of knowledgeability in seismic engineering. Conferences and workshops that emphasize lifeline themes have been beneficial, but they are typically not attended by practitioners of small utilities, nor are they provided uniformly in all areas subject to major seismic activity. A workshop series to implement uniform practices for seismic resistance in electric power utilities in the central United States is presently under way. This workshop series was initiated through the cooperative activities of the Kentucky Governor's Earthquake Hazards and Safety Technical Advisory Panel and TCLEE, coordinated by CUSEC, and sponsored by DOE and FEMA. This type of interaction involving technical society, federal agency, interest group, and regional technology transfer agency represents a model for implementing uniform vulnerability reduction procedures in lifeline systems. The process provides a plan for reaching more utility systems in a region, with the result that awareness is increased and practices for seismic vulnerability reduction in lifelines are uniformly applied.

4.4.3 Summary of Needs of Designers, Owners, and Lifeline E/Os

The Assessment Team reviewed the needs of these three groups within the user-interviewee categories. Many of the needs expressed by A/Es are also contained in the list of needs expressed in the NSF survey of June 1993 (Section 4.4.4). Some specific recommendations include:

- simple methods for characterizing ground movements and distortion associated with liquefaction;
- knowledge of response during prolonged severe ground shaking and long-duration ground shaking characteristics;
- models for simulating seismic ground motion;
- knowledge of materials properties and performance under dynamic loads;
- knowledge of relationships between damage and functionality of building structure;
- structural analysis for damage states;
- standard methodology for estimating lifeline and structure vulnerability;
- analysis for nonlinear behavior (performance characteristics) of structures;
- knowledge and methodology for modeling the interaction between structural and nonstructural components of the building system;
- retrofit design methodology;
- knowledge of performance of structural connections;
- knowledge and models for estimating structure demand based on fracture, instability, and loss of ductility;

- code criteria for performance-based (use-based) design;
- code criteria for improved ground motion design characterization for use in design;
- development of code provisions based on reliability concepts;
- improved tools regarding seismic safety in residential construction;
- improved procedures for decision-making related to seismic risk reduction;
- schemes for integrating cost-effectiveness in seismic design practice;
- knowledge of criteria for nonstructural damage;
- knowledge of loss of serviceability and economic consequence due to damage;
- knowledge for guiding and prioritizing planning for utilization;
- improved quantification of failure-limit states, particularly compressive wrinkling, for welded steel pipe;
- improved simulation of soil-pipeline interaction in the zone of differential movement;
- better estimates of earthquake recurrence interval in the Central and Eastern United States; and
- comprehensive investigation of earthquake effects on lifelines.

4.4.4 NSF Workshop Findings

As part of the June 1993 Workshop in Washington, D.C., on Directions for NSF Research in NEHRP, a sampling of specific broad recommendations for an agenda for future activities at NSF included the following items, which reinforce opinions expressed during the BET interview sessions:

1. Develop knowledge necessary for communities to prioritize their mitigation efforts.

2. Create new systems and materials for improved performance without economic penalty.

3. Improve simulation models of system responses including models for structures with added intelligence (control devices and/or smart materials and techniques, etc.) in an integrated fashion. A special example is the need to improve procedures for the nonlinear behavior of structural responses.

4. Research should focus on consistency and uniform reliability in seismic design methods. Greater emphasis should be placed on the serviceability and economic consequences of the seismic design method.

5. Develop structural systems for areas of low to moderate seismicity.

6. Research products should provide an example for practitioners. Procedures are needed that support guidance for use of research intended for application in practice. Results can and should be presented with different levels of complexity. (An advisory panel representing the practice area to advise the research needs would be helpful.)

7. Develop rational bases for seismic design codes and provisions for buildings and nonstructural components.

8. Develop verified procedures for analyzing earthquake response of high-rise buildings.

9. Report damage and economic losses as a basis for determining primary and secondary economic effects. Administrative and management response costs must be separated from physical damage reports.

10. Improve knowledge relating ground motions and performance of buildings.

4.5 STRENGTHS OF NEHRP

4.5.1 General Strengths

Ample evidence exists that NEHRP has been successful on many fronts. Using the National Research Council's 1982 (Housner Committee) report as a baseline for comparison purposes, many advances have occurred since that report was issued. As indicated in 1982,

> The ultimate beneficiaries of earthquake engineering research are the citizens of the country, but the immediate users of research results are the various professions, industries, and government agencies that are concerned about earthquake hazards.

While that is certainly still true today, the total list of user groups, areas of concern, social and economic issues, and applications has expanded tremendously. One chapter in the referenced report (pp 201–221) was devoted to social and economic aspects. Today, entire publications address that aspect alone of earthquake engineering, and social scientists, as an integral component in seismic safety considerations, are heavily committed to developing plans and programs to meet earthquake hazard mitigation goals. In short, it is clear that there is a higher degree of broad interdisciplinary involvement in earthquake hazard reduction programs than ever before.

4.5.2 Specific Strengths

A highly visible accomplishment can be identified in the successful development and adoption of the NEHRP Provisions for New Buildings consensus document on a national basis. As stated by one interviewee,

> The NEHRP provisions document is fantastically successful. It is fabulous that they actually succeeded in providing a consensus document. Think about it, only a few years ago this was considered an impossible task.

Several interviewees identified specific products and applications that did not exist 10 years ago but that are now used effectively to reduce the impact of earthquake hazards. Supported under the umbrella of NEHRP research efforts, such developments as base isolation and energy-dissipation devices are excellent examples of the technical advancements made in the realm of practical applications. Other examples of new technologies developed under NEHRP support during the past 20 years cited by several interviewees as being useful were eccentrically braced frames, structural analysis software, and ductility in reinforced concrete structures.

A common thread in many interviews clearly targeted the series of successful education programs developed by NEHRP. These ranged from the NEHRP-supported Earthquake Engineering Research Institute's (EERI's) "Learning from Earthquakes" postearthquake investigation project to advanced seminar/workshop activities of professional associations/institutes [e.g., ASCE, American Institute of Architects (AIA), TCLEE] to earthquake education programs at public school levels.

Interviewees at research and professional practice levels also pointed to NEHRP's effectiveness over the years in providing support to graduate research assistants and in attracting a large share of bright and able young people into earthquake engineering disciplines, who later, in turn, will take the lead in becoming influential design professionals and researchers. As stated by one interviewee, "Strong rejuvenation is, of course, very important to the health of any discipline."

General agreement exists among users that NEHRP programs dealing with the seismic repair and rehabilitation of existing buildings have the opportunity to continue the development of much needed design guidelines and new technologies and to emphasize the importance of published documents to information transfer. An awareness of methods available and general costs associated with the seismic repair and retrofit of existing structures has advanced considerably.

One major advance in NEHRP activities that is recognized and appreciated by collaborative users is the development of full-scale testing. To quote one interviewee,

> Many full-scale buildings and other structures have been subjected to vibration tests over the last three decades, including a few full-scale structures built especially for this purpose. This hard won knowledge is an important component of our understanding of earthquake hazard.

According to collaborative user responses, regional earthquake centers [e.g., CUSEC, NESEC, WSSPC, Bay Area Regional Earthquake Preparedness Project (BAREPP), SCEPP] supported by NEHRP have provided substantial and useful information to local jurisdictions, as they can focus on local needs and issue-specific mitigation recommendations that are most helpful. Those centers are perceived as a useful resource in technology transfer. (Note: In this regard, it is unfortunate that the BAREPP and SCEPP programs, California Office of Emergency Services, are facing a difficult budget period and in the process of potentially losing their distinction.)

Several interviewees affirmed that the NEHRP-supported libraries and information centers (e.g., the library at the FEMA National Emergency Training Center at Emmitsburg, the National Information Service on Earthquake Engineering at the University of California, Berkeley, The National Center for Earthquake Engineering Research at Buffalo, New York, the National Hazards Research and Applications Information Center at the University of Colorado, Boulder) are excellent sources of earthquake hazards data. These libraries and information centers represent a significant advance in storage capacity and distribution of resource materials, not only for professionals but for the public as well.

4.5.3 Strengths of NEHRP—Where They Have Occurred

During the interviews and workshops, notable strengths and accomplishments of NEHRP were identified. They are summarized in three categories: (1) education and technology transfer, (2) improvements in analysis, and (3) improvements in design practice and code development.

1. Education and technology transfer accomplishments follow.

   - Support of international and national conferences and workshops on various topics related to earthquake and the effects on structures has been effective.
   - Postearthquake investigations have provided useful data for estimating damage expectations.
   - Support of researchers at universities has contributed to the advancement of technology and permitted new young practitioners to enter the field.

2. Improvements in analysis follow.

- Knowledge has increased about soil-structure interaction.
- Knowledge has increased about liquefaction and methods developed for predicting potential for liquefaction.
- Methods have improved for earthquake vulnerability planning through microzonation study.
- Procedures are being developed for one- and two-dimensional analysis of seismic wave transmission through soil.
- Computer structural analysis procedures including nonlinear response mechanisms have been developed.
- Computer graphics and simulation techniques for lifeline systems have been developed.
- Procedures for interaction analysis of nonstructural components with building structure have been developed.
- Procedures for reliability analysis of structures and systems have been developed.

3. Improvements in design practice and code development follow.

- The NEHRP building standards are in practice.
- Guidelines exist for seismic detailing of some structural connections and members.
- Characterizations have been developed for ground motions and stability design of earth structures.
- Models have been developed for characterizing tsunamis.
- Seismic hazard models have been developed.
- Some seismic damage models have been developed.
- Studies have been performed on structural response to earthquake.
- Methods have been developed and applied to enhance response control of structures.
- Procedures exist for seismic repair and rehabilitation of structures.
- Nonlinear design of masonry structures has been advanced.
- Procedures for strength evaluation and retrofit of bridges are in practice.

4.6 ASSESSMENT OF FINDINGS AND RECOMMENDATIONS

4.6.1 General

This section provides the major findings and recommendations based on an analysis of user input that focused on the most essential elements, as viewed by the Built Environment Team, required to meet or improve user needs. During the development of the first draft of this report, the BET identified 24 potential findings. With further analysis of user workshop results and a closer examination of common themes, the findings were grouped into five significant issue areas related to (1) the translation of research into design practice, (2) understanding and reducing vulnerability of buildings and lifelines, (3) codes and standards, (4) development of improved knowledge in the performance of structures, and (5) education and knowledge utilization.

To establish findings, the team reviewed the needs and comments expressed by interviewees during the assessment process. In a very few cases, users/collaborators expressed needs for specific technical information about special design conditions, but most needs were related to the process for obtaining and using design and analysis information.

Within each area, the needs were grouped according to desired objectives. When needs expressed common themes or objectives, they were further evaluated to determine their ability to provide effective solutions.

In each case, findings are accompanied by discussion. All quotations are from interviewee comments. The attitudes and needs expressed in the quotations, although made by one person, represent similar attitudes and needs of other interviewees. Discussions are presented to clarify the findings and recommendations, and also to illustrate the complexity of issues involved so that the reader will not be misled by a simplistic view.

The Built Environment Team recognized the need expressed by lifelines E/Os to achieve an ability to design for functionality. That need was also expressed by many building owners. Interviewees who expressed those needs believe they would be met by adoption of code provisions and standards and could be assisted by representation of financial markets (insurance, mortgage, etc.) in the process for achieving incentives. Recommendations are made for achieving those needs most earnestly and frequently requested.

4.6.2 Findings and Recommendations

The process of final selection of findings was based on careful integration of data in each of the five issue areas and careful selection of elements of data that comprised the essence of the problem as expressed in the data. Only data that were related to the expressed need in each issue area were applied in the final analysis. The data integration and assessment process was achieved through three meetings of the team and frequent review of the status of findings through telephone and fax communications. The process was assisted significantly by the Steering Committee and the assembled users/collaborators at the User Workshop. Findings were not considered essential if they were contributed by only one person.

Finding 4.1

> **Improvement is needed in adapting research findings to a form easily used by designers. The process for achieving translation requires better coordination in setting goals and meeting objectives within NEHRP and improved channels of communication between the practice/research community and NEHRP agencies. Users and collaborators need adequate representation or input into the processes for defining needs and setting priorities for knowledge development and knowledge implementation.**

Discussion: Results of research are not typically expressed for designer application. One researcher noted that "researchers are not good at putting their findings into user form." One researcher noted that researchers do not often put their findings into user form. Many designers and researchers believe that the development of knowledge through basic and applied research programs has been excellent. Some believe that focused research programs are desirable but should also improve on methods for putting results into the hands of designers. The need for adapting research for design was a consistent request. Comments from the built environment community clearly show that these users believe that the NEHRP program should provide for the development of design guidelines from research findings.

One user stated that "the efforts must be coordinated to improve" the state of practice from this point. Some designers and constructors believe that the program is "primarily a research program" with little implementation effort. It has been suggested that communication between researchers and practitioners coordinated through NEHRP would help to create a process of research translation to fill the gaps in knowledge and practice through a formalized technology transfer process.

One interviewer expressed concern that the diverse budget control conditions administered by the four independent agencies present difficulties to establish an integrated or coordinated organization. Budgets of four agencies are not entirely consistent with the desired state of affairs.

Thus, it appears that some research is not effectively translated because it is accomplished on an ad hoc basis. A formalized process would help to (1) define needs, (2) set priorities for research utilization, and (3) integrate the efforts of NEHRP agencies.

Improved communications are needed for setting priorities for research that contributes to practice. To provide continuity from research and development through implementation, interaction among disciplines that affect the processes involved should be encouraged. For example, the need for continuity, as expressed by one user, is that the manufacturer provides guidance for equipment used for seismic safety but little is done to integrate the use of equipment with structural performance requirements for use in design.

Several designers believe that the process of setting priorities for research should begin with practitioners so that the effects on structural safety, performance, and cost can be considered. "Dealing with architectural features is complex," requiring communication among designers and researchers to resolve issues.

A perception exists that the network of researchers and research organizations that obtain the majority of research contracts is too small. Qualified researchers outside this network believe that they should be included in collaboration with practitioners in the process of establishing priorities for satisfying local needs. Several users believe that "greater control over listing of research needs should be applied by the practice community."

Some experienced seismic designers believe that

> our approach to problem solving should be to get a comprehensive view of the problem and follow it through research and development to design practice and an ability to satisfy performance criteria.

Less experienced seismic designers believe that "ways are needed to support the design profession by developing guidelines for the typical designer." They believe that some research is inaccessible to designers, who are unable to fill in the requirements for using available research products.

Designers in areas of infrequent but significant seismic activity believe that a "better procedure is needed to ensure that practical information for design is widely disseminated to all who need to know." They say that "there is a lack of follow-through on problems beyond the basic research stage, and that better use can be made of technical and professional groups" to develop knowledge for application to design. "Lack of design knowledge locally is a problem" in these areas because

> architects and engineers lack firsthand experience and knowledge of details including costs and practice of seismic designs. California reports are useful but are not an adequate substitute for firsthand knowledge to make owners more confident of the abilities of prospective designers.

Designers also need to increase their own confidence as it relates to seismic design.

Recommendation. Initiate a formal intermediate step between research production and user implementation to develop user guides derived from research products. The process would include review and evaluation of selected completed research, assessment of the applicability for design use, and priorities for continued development based on

- potential for satisfying usability and practicality,
- closing the gap between state of the art and state of practice, and
- expectation for developing procedures for needed design tools.

The preparation of design guides should specify the objectives for use, the scope of application, and the resources required for use. The guides and associated products should be readily available and usable. The procedure would target needed research linked to existing knowledge and would include qualified practitioners and researchers to define the dimensions of gaps between needs and current practice.

The process of implementation and knowledge utilization would be provided through technical and professional associations [e.g., American Water Works Association (AWWA), American Gas Association (AGA), ASCE, AIA] on a continuing basis through such avenues as technical meetings, workshops, and seminars coordinated through NEHRP programs.

Finding 4.2

> **The extent of vulnerability of the many buildings and lifelines in the national inventory that lack adequate seismic design is unknown. Standardized methods for assessing that vulnerability need to be improved. Procedures for calculating expected damage are needed to support design.**

Discussion. It has been observed that

> earthquake disaster reduction is not a short time issue, so it will not be finished in a short time. The earthquake vulnerability reduction program will need to continue for several decades in order to obtain the results that are desired.

Effective disaster response planning is an important ingredient of the process for vulnerability analysis, earthquake response, and the recovery process. In California, lifeline emergency plans get tested—to a limited degree—and awareness is heightened by frequent earthquakes of moderate intensity. In the Central United States, no significant earthquakes have affected population centers in this century. Carefully crafted exercises increase earthquake awareness of public officials and utility managers. Earthquake exercises are more realistic when developed in conjunction with vulnerability assessments.

Vulnerability assessments have been performed for a number of moderate- to large-sized lifelines in California and the Pacific Northwest. Similar assessments in the Central United States and possibly on the East Coast are needed for all potential natural hazards to evaluate operational consequences, to facilitate emergency planning, and to prioritize mitigation efforts. Many lifeline operators complain of the lack of standard methods for assessing lifeline vulnerability. Some consultants and owner engineering staffs have established their own approaches and methodologies. Standards are lacking because assessments are conducted on an ad hoc basis without established procedures. Standardized investigation of earthquake effects on lifelines could improve the understanding of component behavior and system impact and, hence, improve the credibility of vulnerability assessment.

Many users agree with the one who pointed out that "we have an enormous inventory of buildings and structures that may or may not be responsive to seismic safety needs." Experienced designers agree with one interviewee who believes that methods för evaluating and reducing vulnerability would help to "convince owners that they must incur costs to assure safe construction and support the argument that loss will be too costly."

Designers believe that they are "not able to provide designs for achieving performance regarding damage control" because criteria are needed to improve knowledge about the effects of damage on structural performance and on the extent of expected loss from a scenario earthquake. Part of the problem is that currently certain specific bits of technical and economic information are lacking to realistically and adequately measure building vulnerability and/or seismic performance levels.

Earthquake damage reconnaissance is important in understanding the vulnerability of structures to earthquake hazards. Long-term postearthquake investigations have recently been funded through NEHRP for the 1989 Loma Prieta and 1985 Mexico earthquakes. These studies provide excellent long-term data on recovery and effects of the events. The investigation of earthquake damage to lifelines is often hampered by the urgency to make immediate repairs to restore system operation. Field repair records generally do not provide adequate documentation of earthquake damage. Long-term postearthquake investigations help overcome this problem. "Investigations of earthquake damage to lifelines [are] needed since funding allocated to basic and applied research for buildings has had limited impact on lifelines."

The scope of earthquake damage investigations of lifelines should include these three elements:

1. detailed documentation of damage to lifelines,

2. development of statistical data about component fragilities, and

3. assessment of impact of damage on system performance and recovery.

Cost-sharing with utilities that choose to make voluntary vulnerability assessments might be used to qualify utilities for federal disaster relief.

Recommendations. Develop methodologies for assessing vulnerabilities of existing buildings and lifeline systems. Procedures for performing vulnerability assessments should be required when federal funds are involved. Develop standard procedures and/or guidelines for postevent investigations to be implemented to develop damage-cost, damage-hazard, and other loss relationships. Such procedures or guidelines must be developed and implemented to promote a uniform and consistent data base.

Federal funding should be provided to cost-share specific projects that perform vulnerability assessments to create guidelines for collecting data with standardized procedures and formats. Small, well-defined projects on specific systems are suggested.

Finding 4.3

> **Code provisions for building construction are not responsive to solving uncertainties about building behavior under loads. That unresponsiveness may result in variance from expected building performance. Code provisions need to provide seismic hazard characterizations and assist design procedures that will reduce risk to acceptable levels. Code provisions should be consistent with their objectives.**

National standards are needed for seismic performance of lifeline systems and their components.

Financial markets (insurance, mortgage, etc.) need to be suitably represented in the development of standards and codes to improve their responsiveness to national needs.

Discussion. Several users agreed that "building codes drive the state of practice." In certain cases, "There is a significant lack of prescription and information with respect to construction." Some users believe that codes should encourage creative seismic design practice, including options for "accepting and rejecting risk," and they should also "give most designers a good feeling of what is required and why." "Codes should be clear and provide designers with information and guidance that do not restrict creativity while achieving performance and safety."

Some companies are subject to different codes and believe that "building codes are fragmented," resulting in differences from jurisdiction to jurisdiction. Consistent code provisions would be welcomed by these companies. It has been suggested that a single national model building code would be desirable.

"More careful zoning" has been requested that will lead to "effective design data." Possible options for improving design provisions "consider microzoning to include cost-risk" relationships. Some present code provisions contain seismic mapping with "unclear boundaries" and questionable definitions of risk. Concern has been expressed that "most seismic information is obtained from California and very little from Eastern and Central U.S., which contributes to the existing confusion and uncertainty." Some users believe that current seismic risk maps are "too conservative in some cases."

Some designers believe that an intermediate step is needed "in the process for implementing products for practice-through-regulation in the form of code-type documents" that considers the objectives to be satisfied and the practitioner who will implement the provision. For example, several designers believe "there is an urgency for adoption of codes and ordinances based on realistic seismic load values that are not modified by political expediency."

Some designers believe that "engineering design is more complicated and difficult than codes suggest, that codes do not give guidance for selection of appropriate earthquake characterization."

Others believe that "seismic zoning should assist designers to determine when resistance is great enough to preclude needs for retrofit," and that safety factors should be applied by designers and not included in seismic zonation maps. They suggest that "realistic values are needed, for example, average values plus one standard deviation, to provide cost-effective measures without sacrificing safety."

This measure is requested "along with 'estimated' return period so that the level of risk may be intelligently estimated." These issues represent attitudes of several users and are reflected by the comment, "Codes may or may not be responsive to building safety needs."

Private lifeline organizations in California are required by the state public utilities commission to address the earthquake threat. In response, utilities have taken steps to assess system vulnerability and prioritize mitigation efforts and, when necessary, to conduct their own research and develop their own specifications and standards with minimal coordination by NEHRP. This practice leads to individual specialized approaches and prevents the development of national standards.

No standards exist that prescribe performance requirements for lifelines subjected to earthquakes effects. With the exception of the AASHTO specification for highway bridges, the standards, codes, and regulations that govern design, construction, and operation of lifelines do not provide substantive seismic requirements. Provisions of national building codes are used, when judged applicable, in the design of buildings, structures, components, and appurtenances, but in most cases those requirements have little or no bearing on overall system performance or on structure performance. Some practitioners engaged in lifeline earthquake engineering feel that unless standards are mandated or legislated, little progress will be made.

Good progress has been made in improving seismic design specifications and design methodology for highway bridges and in developing effective procedures for bridge retrofit. These efforts have been carried out through the Federal Highway Administration (FHWA) and the Transportation Research Board.

Several designers have requested that mechanisms be applied for enforcement of code provisions. One would recommend enforcement or incentive through "insurance and banking based on hazard and risk rating." "Insurance and banking are grossly underrepresented as means for enforcing design/construction practice or to improve codes and enforce standards." It is believed that codes would be more easily understood and accepted by "political and economic development groups who make decisions" about construction policy if support for decisions were based on risk derived "from realistic threat." The process suggests creation of opportunities that would "consider the owner in codes and standards by addressing political and economic objectives for getting codes to reflect" needs for design that impact loss.

> Financial incentives must be provided to induce local jurisdictions and private enterprise to adopt and implement seismic safety procedures. It is difficult to encourage action when seismic activity has not caused damage or loss. Tax benefits, loans, and other inducements must be used to promote seismic safety procedures. To convince owners that they must incur costs to assure safe construction against earthquake, reasonable data must be presented that support the argument that loss will be more costly than prevention. The problem of providing inducements for seismic design costs must be viewed from several sources such as insurance, third party (financial markets), federal assistance, etc.

Recommendations. Implement a mechanism to prevent exceptions and other practices that promote competitiveness while subverting enforcement of provisions of codes and standards that deal with strength and safety. Provide seismic hazard characterizations in codes at two or more levels: regional seismic hazard maps such as in NEHRP provisions and seismic structural design maps. Develop the ability to provide site seismic hazard characterizations for dynamic analysis.

Establish a procedure to develop standards for lifelines, and prescribe guidelines for reducing vulnerability of all structures that would result in significant loss. Standards would allow lifelines to be evaluated for expected earthquake loss and provide a basis for improvements based on cost-benefit, functionality, and life safety. The experience gained from vulnerability assessments through performance standards applied to achieve seismic improvements would then be considered in developing design standards for lifeline systems and subsystems.

Investigate the interface of financial markets (insurance, banking, mortgage) with code development to produce incentives, and develop procedures for integrating interests related to reducing loss through codes and standards.

Finding 4.4

> **Earthquake performance goals for buildings and lifelines need to be established, and risk levels related to various levels of earthquake must be better understood. Performances of structures and their modifications represent important considerations for achieving ability to control loss. Knowledge of the performance of damaged structures is needed.**

Discussion. Some design practices are "intuitive, such as reduction factors for inelastic analysis." Some designers believe that more realistic characterizations should be applied, such as three-dimensional inelastic analysis methods and in-ground seismic wave transmission. Experienced designers believe that "[we] haven't the tools to evaluate the damage states" for many hazards. Knowledge of expected damage resulting from specific levels of hazard is needed. An emphasis on "research into the performance of structures" is particularly needed for lifelines to relate damage to functionality.

A consistent theme of lifeline designers and owners suggests that a need exists for the capability to design for performance. Designers have found it difficult "to provide designs with respect to achieving performance," particularly for controlling damage that affects serviceability. Uncertainty exists for building designers about "what performance standards are expected for buildings to satisfy what people want." Designers of masonry structures have suggested that design of "masonry structures should be consistent with the state of knowledge of their performance and the expected level of shaking." Some designers believe that masonry design code requirements may be excessively conservative when properly designed.

Lifeline managers find it difficult to assess costs and benefits related to performance because of the limited knowledge of earthquake recurrence, the uncertainty involved in projecting damage to lifelines, and the need for quantification of the impact of service interruptions. In the absence of earthquake performance goals, decisions about earthquake mitigation strategies are made by each organization. The result is a lack of continuity in approach and, perhaps, failure to account for the impacts of service interruptions in lifelines at the regional or national level.

Other issues exist regarding the development of new concepts for controlling or modifying structures into so-called smart buildings. Some designers believe that "these concepts present a social problem requiring active awareness of the system's needs," and it was suggested that knowledge and application of "basic design are of fundamental essential importance," particularly in areas of infrequent seismic activity. The development of smart buildings emphasizes the need for greater interdisciplinary involvement in planning and implementing these designs.

Recommendations. Define procedures for establishing and achieving performance goals for buildings and lifelines in seismic regions. Goals should reflect consideration of levels of earthquake intensity and expected recurrence intervals as related to the protection needed by and affordable to society. Develop and implement seismic structural design procedures for use in achieving performance requirements.

Give recognition to retrofitting crucial lifeline and building components with favorable cost-benefit solutions. Consider perceptive contingency plans that expedite repair following an event.

Because deficiencies in designing for performance represent serious gaps in knowledge and methodology, it is recommended that a steering group advise the NEHRP program and/or guide prioritization and coordination of research and development to focus on filling gaps in a timely manner.

Finding 4.5

> **Improvements are needed in national basic education and technology transfer programs in order to achieve effective dissemination of hazard-related knowledge to users and collaborators and to improve the technology base of designers and constructors for seismic safety. The interactive effects of decisions about seismic vulnerability of one professional group on another need to be better understood.**
>
> **Courses in basic principles and theory of all natural hazards are needed in U.S. universities to improve the technology base for hazard policy and design.**

Discussion. Some companies and utilities have formed departments in their organizations that integrate disciplines. Other companies, however, do not have this apparatus, and true coordination among disciplines dealing with hazards has not been achieved. One user phrased that concern this way: "Research and practice activities should be coordinated among disciplines rather than dealing with common subject matter by isolating portions of the whole" and attempting to assemble the products. Interaction among disciplines should be part of the planning process for research and development phases. Coordination of requirements is needed among all interacting disciplines and particularly between hazard analysts and structural designers, where the need for "more knowledge about the transmission of seismic ground motion through the soil and into the structure" has been consistently expressed by experienced designers.

To assist interaction among disciplines, the work of NEHRP to promote coordination is strongly encouraged. Coordination of design and construction through common issues may also help to create "innovative schemes as experienced in Japan."

A need has been expressed for developing guidelines

> for presenting design information developed to a point and to assist in applying new information. Then, "after feedback," further focused development of knowledge and information should be continued and applied directly to the existing knowledge to achieve continued progress.

This practice applies to all areas affecting the safety of people and the performance of structures. Research activity concerned with performance of structures should be interdisciplinary when factors affecting society are involved in the design.

Dissemination of technical information to collaborators and users needs to be improved. Methods for information dissemination typically have consisted of professional papers, journal or magazine articles, research reports, conferences, symposia, workshops, and seminars. In many professional gatherings, consultants and academics primarily talk to one another ("preach to the choir") so that the level of awareness and understanding among those less knowledgeable is not improved.

On the other hand, a number of information successes have occurred (e.g., EERI's seminars on lessons learned from recent earthquakes, AIA Regional Workshops, BSSC seminars, FHWA-sponsored seminars on seismic design and retrofit of bridges, and an AWWA seminar on seismic upgrading of water systems). While these activities represent significant steps forward, much still needs to be done.

A coordinated technology transfer program is needed. Technology transfer or knowledge utilization is a concern of typical practitioners. Well-conceived processes for ensuring knowledge utilization are required. Because the need to accomplish implementation at the local level represents a complex problem, it has been suggested that "better use can be made of professional groups." That use requires a well-planned and coordinated technology transfer program for providing basic education and design training.

From past experience, it is believed that continuing education will be more effective when it is conducted by technical organizations with established links to the groups targeted for training. Examples include AGA, the Gas Research Institute (GRI), AWWA, EPRI, and AASHTO. Professional organizations such as ASCE, AIA, and the American Society of Mechanical Engineers (ASME) are successful in reaching specific technical audiences such as TCLEE for lifelines.

Distribution of existing computer software or support of computer program development can be a valuable supplement to the dissemination of knowledge. Software used, developed, or enhanced in conjunction with NEHRP-sponsored research should be appropriately documented and available for distribution.

The process for developing and maintaining a steady source of practitioners able to provide competent design for reducing seismic risk depends upon a viable education program. One user suggested that

> there is need for design training for architects and engineers through university courses and continuing education. We presently have no plan for educating practitioners about seismic design.

Another user states, "Basic education in seismic design is needed in universities within states where seismic threat may exist." One building official estimates that about "90% of design professionals in the central U.S. require continuing education" in seismic design. Another suggests that licensing examinations "should apply seismic analysis and design requirements" to further support education and training in seismic design.

Building officials and owners expressed a concern that the number of designers needing continuing education in the Central and Eastern United States is staggering. It has been suggested that "lack of design knowledge locally is a problem." "We presently have no plan for educating practitioners about seismic design," which denies future owners an opportunity to deal confidently with local designers. Specific needs when dealing with existing buildings include "workshops on guidelines for design, basic practical measures for detailing construction, and design support with respect to strengthening requirements."

The levels of expertise of engineers and designers in earthquake engineering vary widely, particularly in lifeline organizations. As a result, a question arises as to how to implement seismic criteria when there is a lack of understanding of earthquake engineering. Practitioners consistently ask for simple (cookbook) approaches, but these often are not possible or realistic. The key to solving this problem is basic education. Short courses could benefit practicing engineers, but formal education at the university level is the preferred long-term solution.

Recommendations. Federal agency support of conferences, workshops, newsletters, and other information-dissemination activities should be provided that

- present methodology and procedures in a form suitable for practice,

- explain the use of tools and guidelines to facilitate design or analysis, and
- encourage participation by local collaborators and users engaged in earthquake hazard mitigation.

Knowledge and resource information about lifelines must be effectively distributed to owners and decision-makers. Continuing education programs should be offered in conjunction with trade and professional groups and associations (AWWA, AGA, GRI, API, EPRI, ASCE, AIA, and ASME) at regional levels.

Distribution of federal support of universities throughout the United States should be provided for including natural hazard studies that

- create interaction among disciplines (geology engineering, architecture, construction, social science, policy, political science, etc.) and
- provide research activities that encourage and support students entering the field of natural disaster reduction.

State professional licensing boards should be encouraged to initiate mandatory inclusion of natural hazard resistance problems in professional licensing examinations in states subject to seismic natural hazard threat. These requirements would encourage universities to include essential seismic theory in their university curricula.

5. USER NEEDS IN SOCIETAL AND POLICY PROGRAMS

5.1 DEFINITION OF SOCIETAL AND POLICY

The Societal and Policy Team understood its mission to be that of support for the interagency strategic planning process of the National Earthquake Hazards Reduction Program by providing recommendations that can guide NEHRP program development and help set priorities over the next 3 to 5 years.

Early in the assessment process, this team was called the Societal and Recovery Team. Recognizing that the intent was for this group to address the nonengineering and nonearth science topics that are part of NEHRP, the group decided that Societal and Policy more closely reflected the kinds of issues that it would be identifying. After the initial interviews, team members decided that this broad topic could be addressed best by focusing on four subtopics: knowledge transfer, regional user needs, incentive development, and policy analysis and social science research. Team members felt that for the purposes of this assessment these topics encompassed the major issues and problems.

(It is important to note that the Societal and Policy Team defined mitigation—broadly—to mean any action that reduces risk from an earthquake, in contrast to the Implementation Team, which defined mitigation to mean actions that reduce the potential for damage in the built environment, as, for example, through building codes and land use ordinances.)

5.2 IDENTIFICATION OF SELECTED USERS

The team defined its users' group as those individuals involved in social and organizational aspects of earthquake risk reduction and preparedness. This definition includes professionals in the fields of social science research, economics, education, planning, disaster preparedness, and program management—that is, those who provide or need knowledge, information, and resources to support earthquake hazard reduction, preparedness, and educational activities.

These users also included state and local officials. The Societal and Policy Team interviewed several local officials, primarily emergency managers. Local officials interviewed by the Implementation Team, on the other hand, were primarily planning and building officials.

5.3 PROCESS FOR INFORMATION GATHERING

Because the team recognized that trying to interview a statistically representative sample of users in the societal and policy arena would be impossible, it decided to interview selected social science researchers who study these users; that is, survey the surveyors. By interviewing researchers who conduct large sample surveys and who study issues of relevance to this user group, members felt that they would get a representative sense of the problems and opportunities facing that group. The team also reviewed the social science literature for published surveys and studies of users.

To supplement the technique of surveying the surveyors, a multidisciplinary list was prepared of selected individuals who team members felt were knowledgeable in societal and policy issues. A long tradition in this field is to establish expert panels and rely on their judgment (FEMA, 1993; National Academy of Public Administration, 1993; NEHRP Advisory Committee, 1993; Bernstein et al., 1989; Hays, 1988). The team used this technique for selecting interviewees.

The team also chose to interview most of the members of one group of NEHRP users—state earthquake program managers. These state officials develop and manage their states' earthquake programs, funded by FEMA with NEHRP funds. They are also aware of the activities of local jurisdictions in their state. The 15 program managers interviewed represent a cross section of states with moderate and high earthquake risk.

A general interview guide was prepared (see Appendix F.3). The professionals interviewed are included in the list in Appendix D. Each team member interviewed individuals from different fields, either in person or by telephone. In some cases follow-up interviews were conducted. All interviewees were assured that none of their comments would be for attribution without their permission.

Team members knew of published and unpublished documents that contained information useful in this assessment. These were reviewed for suggestions and for data important to the Societal and Policy Team's assessment, and pertinent conclusions and recommendations were extracted for detailed study. These key documents are included in Appendix B of this report. Nevertheless, team members used their professional judgment in interpreting the interview and written information and in reaching their conclusions and recommendations.

5.4 RESULTS OF INFORMATION GATHERING: IDENTIFICATION OF USER NEEDS

While each of the following sections presents relatively specific conclusions, recommendations, and supporting discussions, a few broad themes emerge, and they are discussed below. In sum they point to a fundamental but evolutionary change that has occurred in NEHRP over the last several years: **The shift of emphasis to implementation has created a need for support of the fragile and often long processes involved and a need to understand more fully the environments and forces that help or hinder implementation.**

Overview: The Evolving Context

Initial programs and budgets formulated in 1975–1977 culminated in the Earthquake Hazards Reduction Act of 1977, which subsequently has been amended and reauthorized. Early on, the major focus was on augmenting the research capabilities of the principal NEHRP agencies: NSF, USGS, and NIST. The principal mission of these three organizations is research, that is, the development of knowledge to be used by others.

The current NEHRP lead agency, FEMA, came into existence in 1979 and was designated lead agency by the 1979 amendment to the 1977 act. FEMA as an agency is more program management- and operations-oriented than it is research-oriented; therefore, its primary interests are in getting things done through an intergovernmental system characterized by shared powers.

FEMA's focus, understandably, is on implementation, and along these lines, the summer 1980 establishment of the innovative, locally driven Southern California Earthquake Preparedness Project provided a model for subsequent efforts. SCEPP and similar programs have resulted in the building of a national network of program managers, advocates, and constituencies that did not exist before in substantial form.

During recent years, when greater attention has been given by Congress to implementation, a fundamental tension has emerged in NEHRP between continued research on one hand and concern for accelerated implementation on the other. Congress has reflected this tension in recent biennial reauthorization and oversight hearings. At the November 1993 workshop, we noted with interest a comment by one federal official closely involved with the formulation of the original act. He stated that "[in 1976] we looked at scientific and technical aspects of the problem; other areas were not given much attention." According to another federal official, also with a long history of involvement in the program, the current trend by Congress is toward stronger accountability for results (cost-effectiveness), goal-oriented interagency strategic planning processes, and proactive efforts to achieve risk mitigation.

In the largely nontechnical user community, however, NEHRP tends to lose its identity. That is, the involved federal agency staff and the broader "earthquake community" know what NEHRP is, but users at other levels are more interested in information, advice, problem-solving, and other products and services than in how they are labeled. It is a major challenge to show Congress and other influential decision-makers that NEHRP has been of help in widely separated areas, even when successful outcomes depended critically on locally important factors.

5.5 STRENGTHS OF NEHRP

5.5.1 General Strengths

NEHRP has been in effect for fewer than 20 years, and in much of the United States a burgeoning awareness of earthquake risk has occurred only within that time. It is important to note that much of the research in the topic areas of this report has been funded through NEHRP. A primary strength of NEHRP, therefore, has been to set into motion many of the processes that have brought us to where we are today in understanding the nature of earthquake risk throughout the United States and the consequences of that risk.

State earthquake programs initiated by FEMA financial support have provided an important link between federal and local levels. Primary NEHRP-funded state and local earthquake program managers are aware of, and use, FEMA. They also make limited use of USGS information and resources. But NSF and NIST are rarely utilized, and this group of users knows little about the roles of those agencies in NEHRP.

The linkages that state program managers have made with universities and local emergency management agencies have been useful in promoting the goals of NEHRP. The linkages with universities are especially important, for they often have provided access to research information from other NEHRP agencies to the program managers, who then pass it on to their constituents. (See item 1 in Section 5.5.2.)

5.5.2 Discussion of Strengths

NEHRP has accomplished much in its relatively short life span. A list of recent accomplishments can be found in *Building for the Future, NEHRP Biennial Report to Congress, Fiscal Years 1991 and 1992* (December 1992). Those accomplishments are reflective of strengths and provide an overview of what has worked, or is working, well within the societal and policy issues arena. For example:

1. The decision by FEMA to seek active partnerships in states with moderate as well as high risk from earthquakes has resulted in a significant expansion of the role of NEHRP in promoting mitigation at regional and local levels. Earthquake program managers and regional consortia serve as liaisons between the federal government and the states and as links between FEMA and potential end-users. This linkage allows information from other NEHRP agencies to pass through FEMA directly to the

states. In addition, the linkages that state program managers have with universities and local emergency management agencies have been instrumental in promoting the goals of NEHRP.

Links with universities are especially important, for those contacts often have provided access to basic research funded through NEHRP that is not readily available through the federal agencies. For example, much earthquake research in the Central United States has been funded by NEHRP through universities (primarily Memphis State University and Washington University in St. Louis), which have disseminated the results to earthquake program managers, local public officials, and the general public.

2. The linking process has produced "earthquake advocates" at regional and local levels who help to promote the goals of NEHRP, even though those advocates may not be familiar with that acronym.

3. Support by NEHRP of professional groups (e.g., EERI), research institutions [e.g., the Energy and Environmental Response Center (EERC), NCEER, SCEC], and regional and state earthquake consortia (e.g., CUSEC, NESEC, WSSPC, California's Earthquake Program) has resulted in a variety of venues nationwide for the distribution of information about earthquake risk and mitigation.

4. An assortment of publications relating to earthquake risk, earthquake mitigation, and earthquake lessons have provided planning and policy tools at regional and local levels.

5. NEHRP's recommended provisions for seismic design and construction of new buildings have been instrumental in influencing model building codes and helping to achieve national consensus on design standards in earthquake-prone regions.

6. Federal initiatives through NEHRP have influenced local changes in building construction and thus have provided models for seismic design and risk mitigation for communities. Two examples are (1) the federal initiative to set earthquake standards for, and to strengthen veterans hospitals in, both moderate- and high-risk regions of the United States and (2) Executive Order 12699 requiring federal agencies to apply seismic design standards for new construction.

Strengths, however, are not static. What has worked well in the past should be built on for the future. User input is one component of this building process, and it is used in the Section 5.6 as a bridge between the past and the future of NEHRP in the societal and policy arena.

5.6 ASSESSMENT OF FINDINGS AND RECOMMENDATIONS

5.6.1 General

1. "It is time to do, not ask, anymore." Among the social science researchers interviewed, this message reflects two significant inputs. First, the topics covered by this Assessment have arisen before, and many interviewees have responded similarly before. Progress needs to be made in solving already identified problems, many of which are described in the reports reviewed by the Societal and Policy Team. Second, this comment also reflects a growing disenchantment among researchers and concern that relatively little of the knowledge they have provided is being translated into improvements in NEHRP.

2. Many interviewees noted that NEHRP tries to accomplish too much with too few resources. Spreading resources thinly leads to caretaker programs incapable of achieving significant objectives. Either NEHRP's funding should be increased substantially, or efforts with the same resources should be more focused.

3. Insofar as earthquake hazard reduction and preparedness are concerned, California is different from other states (and regions) because of the higher risk and the relatively well-institutionalized nature of its seismic safety programs. In fact, California is more nearly comparable to Japan or New Zealand than to other states. Thus, for the foreseeable future, NEHRP will have to continue to view California as one of a kind and consider separately and on their own merits the needs and performances of states in earlier stages of program development.

4. The majority of recommendations offered below focus on the need to strengthen NEHRP's knowledge transfer; educational, advocacy, and user level program development; and institution-building activities. These findings reflect the needs of those professionals recruited to the field to achieve higher levels of earthquake safety in their areas; many feel like orphans. They often work in environments that, regardless of objective risk, are characterized by apathy or overt opposition to earthquake hazard reduction and preparedness. These professionals depend on NEHRP-supported processes and networks for information and peer support.

5.6.2 Findings and Recommendations: Knowledge Transfer

Finding 5.1

> **In general, it can be difficult and frustrating to obtain earthquake information from the FEMA national office. The regional offices have proven more helpful.**

Discussion. Numerous state earthquake program managers reported difficulties in receiving information from the FEMA national office. Calls were routed repeatedly and/or information was never sent. To counter this problem, some program managers established lines of communication with their FEMA regional contacts and were able to receive information that way. Other state program managers felt isolated and were unable to receive the information they wanted.

Recommendation. As part of the pending reorganization of FEMA, place more emphasis on service and on personnel who have accurate information and know who within the agency can help.

Finding 5.2

> **While general earthquake mitigation and preparedness information is helpful, local users have a stronger need for information tailored to their local situations.**

Discussion: Many interviewees reported that current earthquake materials are too generic and are not helpful in addressing specific local issues. In particular, state earthquake program managers need localized risk information that can form the basis for vulnerability assessments. Without good risk information, it is difficult to "sell" earthquake hazard mitigation, especially in states and communities with moderate risk and long return intervals. During a discussion at the Washington, D.C., workshop, the earthquake program manager from Arizona pointed out that basic risk information is a prerequisite for action in his state. To convince policymakers that money or time needs to be spent on the earthquake problem, managers need hard data that prove they have a problem. A recent survey of users of earthquake hazards information in the high-hazard San Francisco Bay Area (Spangle Associates, 1993, p. 2), confirmed this finding. Researchers found that

> interpretive maps and reports going beyond hazard identification to *estimates of probabilities and vulnerabilities* are used more than most earthquake hazard information by all categories of users interviewed (emphasis added).

Peter May (1990), in writing about loss estimation studies, also emphasizes the need for more local vulnerability assessments that can inform decision-making and priority-setting.

FEMA tends to disseminate material developed in California without adequately adapting it to the circumstances of other states and communities. While the basic ideas in the California information may be relevant to other states, the fact that the material comes from California makes it less likely to be used elsewhere.

USGS identifies priority areas in the country for research, making it difficult to obtain research dollars to develop risk assessments in lower priority areas. The dilemma is that spending a few dollars in every city at risk will not generate good data, but not providing basic risk information on those areas means no advancement of NEHRP goals in those communities.

Recommendation: Make greater efforts to define user needs on a regular basis and to link local experiences, knowledge, and data to general information. Involve local users in (if they are not responsible for) the design, production, and dissemination of such information. In addition, encourage USGS to establish a policy of obtaining and maintaining at least a minimum level of basic earthquake data for all risk areas.

Finding 5.3

> **As capabilities have developed at state and local levels, so has interest in research. Users reported a desire to help define research needs, especially in the NSF and USGS programs.**

Discussion: Local and state government officials stated that they had numerous problems and questions they would like to see researched. They had strong opinions about what is useful research. In their minds, much NEHRP research is not relevant to their needs. In addition, some local officials saw large amounts of existing research, but not enough guidance on how to interpret and use it. The desire for more user input into research definition has been noted by authors and expert panels, including Cochrane, 1991; May, 1991; Schulz, 1993; and Bernstein et al., 1989. Because this recommendation has been stated previously in so many other forums, a certain amount of frustration exists among users as to why this recommendation has not yet been implemented.

From the perspective of state and local officials, the NEHRP research program needs to be more tightly focused on the types of policy issues important to them. The application of research to, and knowledge about, hazard mitigation is stressed, yet the perspective of the persons and organizations who will be applying the knowledge is often missing. Public officials want to help define and be involved in the research program.

Recommendations. (1) Increase efforts of the two principal research agencies to assess local user needs well in advance of the research to be done. (2) Include a user's advisory group in applied research projects to provide counsel in scope, direction, and utility of results and to help facilitate application of results.

Finding 5.4

> **Overall, the knowledge transfer processes within NEHRP need to be strengthened. It may be not be practical for the research agencies to be held responsible for the "translation" and dissemination of research into user-friendly formats.**

Discussion: This finding cuts across the four groups in this Assessment, and in the minds of the Societal and Policy Team members it is one of the most critical findings. Effective knowledge transfer is difficult, but extremely important, and all indications are that the process needs to be improved. This finding also has shown up in the literature, in previous forums, and in other assessments of NEHRP (FEMA, 1993; NEHRP Advisory Committee, 1993; Bakun, et al., 1992; Bernstein et al., 1989). Translation of scientific knowledge is not the same thing as dissemination, and more attention needs to be paid to effective ways of accomplishing translation. Are there some innovative ways of transferring and translating information that could be explored, including professional exchanges, fellowships and courses (e.g., placing users in the research environment and vice versa), mixing the disciplines more in the translation process, or using disciplines that have not been represented to date in the NEHRP program?

Attention needs to be given to what is meant by transfer, translation, and dissemination. More players need to be involved in this process. Scientists who develop the knowledge, for example, should not be expected to translate that knowledge into public policy. The scientific community does not reward scientists who have an interest in being involved in the translation function.

Recommendation. Ensure that NEHRP agencies recognize that the translation function is a key part of the knowledge transfer process. Support formal and informal mechanisms for this process.

Finding 5.5

> **Most users obtain earthquake information through professional associations and meetings, informal peer networks, newsletters, and on-line services. These are preferred and trusted sources of information.**

Discussion. Interviewees, state and local officials, and the research literature (May et al., 1989) cite professional associations and peer networks as their preferred sources of information. City officials in particular—organizations of building officials, city administrators, city managers, public works officials— seem to obtain information from their colleagues, either through personal contacts or through professional organizations. A survey of building and planning officials in the San Francisco Bay Area found that the two sources of information and technical assistance reported to be most useful, both before and after the Loma Prieta earthquake, were BAREPP and professional associations. This fact suggests that, at least for local-level planning and building officials, the most valued sources of information and technical assistance are those that are easily accessible, those that are locally relevant, and those provided by credible sources such as other members of their own profession (Bolton and Orians, 1992: p. 20).

These findings further suggest that earthquake risk mitigation information will be best received by local officials through the channels they regularly use. For example, specific earthquake conferences and newsletters, unless supported by the regular information networks used by local officials, may not be effective because the sponsoring agencies may not be viewed as credible and trusted sources of information.

Recommendations. (1) Identify professional organizations representing key user groups and make them partners in the research and information dissemination processes. (2) Give increased attention to supporting technical assistance cadres or expert peer matches, particularly among state and local officials. To their peers and constituencies, these experts can provide counsel and information in familiar and useful formats on such subjects as mitigation, preparedness, response, and recovery.

Finding 5.6

> **Almost universally, users gave high praise to focused earthquake projects such as SCEPP, CUSEC, and BAREPP and to formal and informal technical information services and clearinghouses (such as those at universities). These organizations function as information-providing, advocacy, network-building, agenda-influencing, and technical information-translating centers.**

Discussion. Interviewees in moderate-hazard states, particularly in the Midwest, cited informal clearinghouses (e.g., a professor at a local university) as preferred sources of information. Interviewees served by regional earthquake projects cited those projects as useful sources of information. All social science researchers and most state earthquake program managers cited the *Natural Hazards Observer* (a bimonthly publication by the Natural Hazards Research and Applications Information Center at the University of Colorado) and NCEER as important information sources.

The team believes that small size, as in the case of a local geology department or clearinghouse, or easy name recognition, as in the case of the regional projects or larger clearinghouses such as National Information Services Earthquake Engineering (NISEE) and NCEER, are factors in the success of these projects. The close working relationships those organizations are able to establish with their communities means that they are seen as credible and trusted. Supporting this idea, the NEHRP Advisory Committee stated in 1993 that,

> as part of an expanded implementation effort, appropriate institutional structures, such as California's BAREPP and SCEPP models, should be explored and developed to more effectively use collaborators.

A 1987 expert review committee also noted the importance of supporting and encouraging regional efforts (Bernstein et al., 1989). While budget limitations and other agency needs may be seen as more important, the team is concerned about the recent absorption of BAREPP and SCEPP into the main operating staff of the California Office of Emergency Services. The resulting possible loss of regional identity, relationships, and information dissemination pathways may have a long-term negative impact on earthquake-specific activities and technology transfer.

As some states and FEMA move in the direction of all-hazards rather than hazard-specific programs, it may prove difficult to maintain the focus and intensity of earthquake-specific programs. Attention needs to be given to how to continue the strong advocacy for earthquake hazard mitigation.

Recommendations. (1) Give attention to how to continue to support regional clearinghouses and information centers; they perform an important function for NEHRP and need to be bolstered.

(2) NEHRP agencies should advocate and continue to support the implementation and use of electronic information services such as e-mail, CD-ROM, GIS, and bulletin boards to facilitate the dissemination of information.

5.6.3 Findings and Recommendations: Regional Users' Needs

Finding 5.7

> **States vary significantly in their support for NEHRP goals; not all states are supportive of the program.**

Discussion. When a state earthquake program is established by FEMA, a state must agree to a 50/50 share of the cost within a number (3 to 5) of years. The current economic climate makes this difficult for states whose limited revenue has resulted in reducing or eliminating state programs and jobs. States with low probabilities for damaging earthquakes in the near future are especially prone to reduce or eliminate earthquake programs, and it is difficult to impress state legislators with the need to prepare for earthquakes when the risk is perceived to be low. In addition, some state programs may be eliminated because the 50% match is considered too costly in light of more urgent concerns.

Some users suggested a maximum match requirement of 35%, so that state legislators would not see it as too expensive, or a longer time span before a state is required to pay the 50% match. Other suggestions were to accept activities a state does on behalf of earthquake risk mitigation through other agencies as partial fulfillment of the match and to encourage multiagency involvement as an incentive to save money on the match—giving matching credit, in effect. All agreed that the goal should be to keep the programs operating ("earthquake awareness and mitigation is a long-term process"), for they often take decades to evolve.

Recommendation. Provide greater flexibility in funding state earthquake programs to facilitate increased and sustained state participation.

Finding 5.8

> **FEMA's administrative regulations and reporting requirements reduce the effective time available for real program work.**

Discussion. Responsibilities of earthquake program managers are multifaceted. They are responsible for communicating information about earthquakes to the widest possible variety of users in a state, and some have additional responsibilities with state emergency management agencies.

All of those interviewed considered FEMA paperwork requirements excessive, absorbing time that otherwise could be devoted to carrying out programs. Some believe the reports they are required to write never get read, as there is no feedback. Some also reported difficulties in obtaining information from FEMA headquarters (although there never seemed to be problems with receiving updated paperwork requirements).

Frustration was expressed with regulations governing state use of earthquake program money as well as with the number of changes in the Comprehensive Cooperating Agreements (CCAs). Rubin, in a 1993 report, discusses what she defines as control aspects of FEMA's management, rather than emphasis on capacity building, which she sees as a need.

Recommendation. Examine federal-state funding and administrative models, simplify the process, and change to a less control-oriented system.

Finding 5.9

> **Regional and local risk information is fundamental to achieving political support for NEHRP goals. Users repeatedly expressed a need for better risk information.**

Discussion. As scientific knowledge about earthquake source zones has grown, new areas of the United States have been identified as having a significant earthquake risk. Much information about earthquake hazard mitigation is generic or concentrates on well-known higher risk areas. For a mitigation program to be effective, information must be geared to the specific risk in a region, and it must include scientific information about causes and consequences of an earthquake, probabilities of damaging earthquakes, and mitigation with a regional focus. Finding 5.2 discusses this same situation, though in a somewhat different context.

Users interviewed in Arizona, Idaho, Montana, Utah, Missouri, Tennessee, Arkansas, Mississippi, Georgia, South Carolina, and New Hampshire indicated that a lack of appropriate information specific to their regions significantly hindered their ability to carry out earthquake programs effectively.

Recommendation. Risk and vulnerability analyses are essential to each region where an earthquake program is funded. Ensure that earth science research supports all of these areas, and that mitigation information reflects local earthquake risk and consequences.

5.6.4 Findings and Recommendations: Developing Incentives

Finding 5.10

> **Many state and local governments are under extreme financial pressure. Even programs considered feasible as recently as 3 years ago are being curtailed or eliminated. In the best of times, earthquake risk mitigation often has a hard time competing for political attention and resources; current fiscal conditions are reducing commitment to this activity.**

Discussion. Regional users addressed this problem. Earthquake awareness is a long-term, evolutionary process. While the major responsibility for driving awareness resides initially at the federal level, responsibility for continuing the awareness/mitigation process resides at the state and local levels.

In areas where earthquake risk is significant, though long-term, it is important in the current fiscal environment to develop incentives for state and local governments to continue earthquake programs.

Informal partnerships already exist in many states, but strictures in place concerning use of state and federal funds at local and private levels significantly lessen their impact. New partnerships need to be created among federal and state governments, regional consortia, universities, and the private sector to provide a variety of avenues to keep earthquake programs viable.

Some users expressed frustration that rules for using federal money prevented them from seeking creative ways to establish partnerships within their states that could foster local incentives for hazard mitigation. Other users thought that more how-to, hands-on information for specific audiences could act as an incentive for the formation of local hazard mitigation partnerships.

Recommendation. Give attention to developing incentives and alternative mechanisms for supporting state and local programs. Some user suggestions include federal-state-local matching funds for programs, reviewing current matching fund requirements for participation in NEHRP, providing direct federal technical assistance such as on-staff help, and supporting nongovernment advocates whose objective is to influence political agendas and create climates for formal policy actions. Encourage and support more public-private partnerships.

Finding 5.11

> **Based on California's experience and recent experiences elsewhere, demand for consumer-oriented earthquake information is increasing. Demand for such information has created a major opportunity for NEHRP agencies.**

Discussion. Demand for information about earthquakes is usually event-driven; as a result, large-scale information dissemination also tends to be event-driven. That is, the event creates the demand, which then triggers the supply. For example, thousands of calls were taken by the California Office of Emergency Services (OES) hot line after the Big Bear Landers earthquake, and the USGS post-Loma Prieta earthquake newspaper insert was so popular, funds were insufficient to meet reprint requests. The event/response interaction rarely results in a sustained demand for earthquake information. Successful marketing, however, can create a demand that is not event-driven, as has been shown repeatedly by campaigns for newly created commercial products that have resulted in remarkable levels of sustained consumer demand.

The use of marketing techniques for the dissemination of earthquake information has been often discussed, but no cohesive, long-term approach has ever been attempted. Marketing strategies can result in effective consumer-driven channeling of information and in an enduring consistency of demand. Users have been frustrated by the short-term nature of past marketing campaigns and the inability to maintain a consistent supply of materials. Several interviewees pointed out this deficiency in the Big Bird earthquake preparedness campaign; after the initial, generous offering of kits to the states, kits became very difficult to obtain. USGS has discussed its internal structure that makes it difficult to keep popular items in print (Bakun, et al., 1992).

Based on their study of the post-Loma Prieta earthquake newspaper insert, Mileti and his colleagues (1993) have recently made recommendations regarding how best to communicate earthquake risk information.

Recommendation. Give immediate attention to developing a long-range earthquake information marketing strategy to increase demand and to reduce the impression that people can do little to minimize losses. Develop a variety of localized strategies for different regions and ethnic populations. For instance, USGS should examine its marketing strategy in the context of improved outreach and reprint the acclaimed newspaper insert.

5.6.5 Findings and Recommendations: Policy Analysis and Social Science Research

Finding 5.12

> **NEHRP lacks an organized and consistent means for selecting policy strategies and evaluating the effectiveness of programs and activities.**

Discussion. Many agencies use formal policy analyses and program evaluations to support decisions about priorities and allocations of limited resources. Except for some periodic committee reports and intermittent assessment projects, interviewees familiar with policy analysis techniques and with NEHRP noted that such program management activities have not been institutionalized.

Policy analyses help to define objectives, suggest alternative strategies, evaluate the cost-effectiveness of alternatives, and identify likely and preferred outcomes. Program evaluations provide feedback about actual results of policy and program decisions, which can then be used to modify programs, including enabling legislation, if need be. Analytical and evaluative activities are common in federal agencies, and professionally trained people and well-developed methods are available. (May, 1991, discusses needed elements in a hazards policy analysis.)

Several interviewees noted a weak link between understanding facilitators/barriers and implementation. ("What works and why? What does not work and why not?") Rigor in research to add credibility to the findings of implementation research was indicated as an area for improvement. The need to strengthen policy and implementation research was noted in a recent evaluation conducted by the National Academy of Public Administration (1993). This report stated that

> FEMA's attitude toward sponsoring applied research using outside research, and incorporating research results into operational, training and educational efforts ought to be reviewed. FEMA has made little effort to use emergency management research results to improve state and local capabilities.

Recommendation. FEMA should organize and manage regular policy analyses and program evaluations (including supporting implementation research) to guide future planning and the allocation of resources for NEHRP. The results of such analyses will be important to the interagency strategic planning process.

Finding 5.13

> **Not only is FEMA NEHRP's lead agency, it is also the most politically involved NEHRP agency. That means it must respond, and be sensitive, to other than purely scientific or technical needs in carrying out its NEHRP responsibilities.**

Discussion. On a scale of 1 to 5 ("not familiar" to "very familiar"), all social science researchers interviewed indicated that they were either familiar or very familiar with NSF. Most indicated moderate familiarity with USGS. Half of the interviewees were familiar to very familiar with FEMA. Few were familiar with the National Institute of Building Sciences.

NSF was praised for being helpful, supportive, and understandable and was accorded high marks for the integrity of its peer review process. NSF staff was praised for its professionalism and cited as a source of stability in the research portion of NEHRP.

FEMA was widely held to be "unfathomable." Few of the social scientists interviewed expressed a clear understanding of how FEMA works. Several noted that NEHRP leadership remains difficult to assign because of structural and process problems with the program. The structural flaw of NEHRP is its multiagency nature with a lead agency (FEMA) that lacks the resource control to lead. Therefore, coordination is at best a negotiated minimum among separate bureaucratic fiefdoms (hardly a new observation).

FEMA is different from the other three principal NEHRP agencies. While in some ways it closely resembles other operating agencies, it also has several programs that depend on multiagency and intergovernmental coordination to achieve desired results. Traditionally, activities except in the case of major disasters (and then only for a short time) have received relatively little attention and little political support.

Several interviewees noted the diversity of jurisdictions NEHRP attempts to influence/encourage and the differences in their capabilities. Lack of adequate human and financial resources is the biggest stumbling block to effective risk reduction at the local level.

Consequently, FEMA officials have to take into account other than purely scientific or technical reasons when considering program decisions. At some level politics is governing, and it might be more important to NEHRP's success in the long run to foster and maintain a broad national constituency, including representatives in moderate to lesser seismic areas, than to be seen as a federal subsidy to just one or very few areas. In Japan, for comparison, political support for earthquake programs is strong partly because earthquake risk is seen as a truly nationwide problem.

Recommendations. (1) FEMA should do a better job of explaining the political contexts of major program decisions, and the other NEHRP agencies should recognize that political decisions often are necessary. (2) More thought must be given to incentive systems and how to mobilize and maintain political support as ways to accomplish NEHRP objectives at the local level.

Finding 5.14

> **Federal agencies not officially part of NEHRP have critical roles in earthquake risk mitigation. Some, such as the Departments of Veterans Affairs, Housing and Urban Development, Energy, Defense, State, and National Park Service, have postdisaster roles.**

Discussion. Reports show that some federal agencies are spending substantially more money to mitigate earthquake risk than is appropriated annually for NEHRP. Therefore, it is important to understand that the federal government's commitment to seismic safety is greater than NEHRP. While this fact is understood within the earthquake community, it is virtually unknown beyond it.

Giving greater recognition to the total federal commitment could strengthen NEHRP's perceived value, and it could help to support the activities of existing or latent "earthquake entrepreneurs" in other federal agencies. Coordination and information sharing between research and operating agencies could also strengthen the role of research and help to define research needs. This liaison could lead to greater recognition and advocacy of mitigation and recovery activities within the agencies. For example, formal recognition could give leverage to internal advocates to influence program management decisions. Perhaps a new council composed of the seismic safety coordinators designated under Executive Order 12699 (Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction) should be formed by FEMA to broaden agency participation. Such participation also could help advocates to promote stronger mitigation efforts through their agencies' regular loan, grant, and regulatory programs.

Recommendation. Current practice for involving other agencies should continue, as is done through the Interagency Committee on Seismic Safety in Construction (ICSSC). Possibly the NEHRP legislation should be amended to include or prominently recognize other agencies.

Finding 5.15

> **Greater balance between social science research and engineering and earth science research is needed.**

Discussion. Hypothetically speaking, if research areas have to be cut to fund more and better social science and economics research, where should the cuts be made? The few interviewees who chose (dared) to tackle this question indicated that such cuts should be in the earth sciences, at least in the short run. If funding changes are not made, the current asymmetry between earth science knowledge and social science/economics knowledge (with engineering essentially in the middle) will only worsen.

Not surprisingly, given that those interviewed were social scientists, all indicated a need for more funding to the societal aspects of NEHRP, but almost all indicated the need for more research on policy, incentive systems, and implementation—that is, on more focused applications-oriented research even within the social science and economics areas. This finding is supported in the literature as well (NAPA, 1993; Olson, et al., 1989; Schulz, 1993). Social science and economics (including financing and insurance) research should be enhanced, with special attention to integrating hazard information, loss estimation, engineering approaches, and public policy strategies.

All social science researchers cited their interpersonal network and the *Natural Hazards Observer* as their major sources of information about earthquake-related social science research. Most also added the annual Natural Hazards Workshop at the University of Colorado. Several mentioned information from EERI and NCEER. Standard university-style bibliographic searches, such as those available through NISEE, rounded out the information source category.

Recommendation. FEMA and NSF should jointly fund a short-term intense project to identify user needs that can be met by social science research. The results can be used to prepare a social science research plan that should contain priorities and funding levels to provide a coherent program that ends the "stepchild" status of social science research. This proposal is especially significant in that many questions now being raised relate to economics, policy development and implementation, emerging multihazard contexts, intergovernmental relations, and institution building.

5.6.6 Additional Suggestions

1. People are still searching for a more descriptive title for the NEHRP enabling legislation, especially as increased attention is given to implementation. While hazards cannot be reduced, risk can. Therefore, the Societal and Policy Team suggests that the act be retitled "National Earthquake Risk Reduction Act" and that the program be known as "NERRP" to reflect its multiagency and intergovernmental nature. Perhaps this change could be accomplished during a major overhaul of the (original and amended) legislation. Revisiting NEHRP's charter would provide an opportunity to reinterpret the context and needs of earthquake mitigation and preparedness, redefine agency and

intergovernmental responsibilities, take advantage of applicable research done since the legislation was passed, delineate program evaluation responsibility, and include other measures for increasing NEHRP's effectiveness.

2. Team members are aware of the continuing struggle within the executive and legislative branches to enact acceptable earthquake or natural hazards insurance legislation. While this team did not explore that subject, we wish to point out that such legislation could have major impacts on NEHRP. We are confident that members of the earthquake community and NEHRP agency staff members will monitor proposed insurance legislation to ensure that the intent of the Earthquake Hazards Reduction Act is maintained and that NEHRP continues to address adequate levels of mitigation and preparedness.

3. CD-ROM technology is an information storage and retrieval method whose cost is declining rapidly and which will be available soon to nearly everyone. CD-ROM can store huge quantities of information for relatively small cost. We encourage NEHRP agencies to consider providing their publications on CD-ROM and to press for its use in federally funded earthquake information systems, such as the NISEE and Quakeline systems.

6. USER NEEDS FOR IMPLEMENTATION OF MITIGATION MEASURES

6.1 DEFINITION OF IMPLEMENTATION AND MITIGATION

In helping to achieve the goals of NEHRP, the Implementation Team focused on two primary areas, the implementation of local mitigation measures in moderate- to high-risk seismic zones and implementation of mitigation efforts by federal agencies.

In this process, the team found it practical to define routine, but significant, terms so that team members would be consistent in their assessments and discussions. The team then defined implementation as putting into practice, and mitigation as actions taken to directly limit damage to the built environment through seismic resistant design and land use practices.

Implementation of earthquake risk reduction measures is an integral part of NEHRP. Mitigation of the built environment through design and land use practices forms a major part of the NEHRP goals and objectives, which include (1) development and improvement of design and construction techniques that resist earthquake damages, (2) development of model building codes and land use practices for earthquake risk reduction, and (3) application of research results.

Mitigation planning is also a key element of the disaster recovery process. The Stafford Disaster Relief and Emergency Assistance Act (PL 100-707, Section 409) requires the preparation of a mitigation plan as a condition for receiving some types of federal disaster assistance. The implementation of mitigation measures for the particular hazard addressed by the mitigation plan is part of the effort to reduce future losses.

Implementation of mitigation measures is, therefore, important to both the NEHRP and disaster assistance programs. While mitigation planning following a disaster focuses on efforts to reduce event-identified weaknesses, NEHRP focuses on a proactive approach to reduce the damaging impacts of earthquakes before the next one occurs.

6.2 IDENTIFICATION OF SELECTED USERS

The team focused on the relationship of NEHRP in two primary areas: (1) implementation of local mitigation measures in moderate- to high-risk seismic zones and (2) implementation of mitigation efforts by federal agencies. The two efforts are referred to in this section as "local assessment" and "federal assessment." State-level mitigation efforts were considered only from the perspective of the local assessment.

This assessment does not provide a statistically valid sample from which to quantitatively evaluate the relationship between the implementation of mitigation measures and NEHRP. Insight, however, can be gained into how NEHRP has assisted implementation in the past and where NEHRP might better assist in the future by selecting assessment participants associated with both strong and weak examples of implementation of mitigation measures at the local level. Similarly, interviews with key individuals involved in the implementation of federal mitigation actions provide insight into the ways NEHRP might better support that process. Finally, the issues and concerns identified by assessment participants provide input for the development of a quantitative evaluation tool to be used as part of an ongoing assessment process.

Assessment participants included selected local and federal interviewees, discussion group members, professionals, informal discussions with implementation researchers, participants in an independent workshop evaluation, and participants of a users' workshop designed to provide feedback to team members. The results of local assessment interviews are summarized in Table 6.1. (Note: Tables 6.1 and 6.2 are at the end of Section 6.) A total of 53 individuals (23 local and 30 federal assessment) were interviewed by phone or by scheduled face-to-face interviews. Their names are included in Appendix D.1 of this report.

6.2.1 Local Assessment: Selection of Users

Implementation of local mitigation measures is primarily a community-level responsibility. Although "state policy may shape local policy by mandating that certain practices be consistent with state policy" (Bolton, 1992), the authority to develop and administer mitigation programs resides primarily with local jurisdictions. The implementation team selected local study participants from four groups: planning departments, building departments, school facilities, and hospital facilities. Planning and building departments were selected because they are directly involved in developing and setting local land use and building practices. School and hospital facilities represent essential facilities for which NEHRP has developed specific materials and programs.

To help develop insight into factors that can enable NEHRP to best support local mitigation efforts, interviews were conducted, where possible, in cities identified as having relatively strong or relatively weak mitigation programs. In two states, Washington and Oregon, cities were selected by using the results of previous research on risk reduction policies and practices in Puget Sound and Portland (May et al., 1989). In other areas, team members selected appropriate city locations.

Political and economic characteristics as well as differences in perceived or real risk also influence local mitigation efforts (May et al., 1989), and thus had an impact as well on the Implementation Team's selection. The decision to select states to represent diverse geographic areas in which NEHRP programs have been active resulted in the addition to the study of 10 cities in five additional states. The seven states included in the survey are California, Idaho, Missouri, Mississippi, Oregon, Tennessee, and Washington. Ideally, a pair of cities from each state participating in NEHRP would have been selected, which would have resulted in 64 local assessment interviews. Because of the assessment schedule, however, interviews were limited to the 12 cities identified in Table 6.1. Table 6.2 shows selected characteristics of each of the 12 cities in which the 22 interviews were completed. Currently 28 states and three territories are funded under FEMA's State and Local Program.

Interview data were supplemented by individual and group discussions, with diverse participants representing broad areas of concern, at national conferences and regional workshops attended by team members. Participants in the discussion groups are listed in Appendix D.

Two group discussion sessions were held in California in the summer of 1993, bringing together approximately two dozen individuals with experience in the field of health care organizations and earthquakes. Hospitals, regulatory agencies, emergency services (emergency management), and emergency medical services agencies at state and local levels were represented, among other subgroups of this user category. The individuals invited all had a minimum of several years of experience in the emergency preparedness or earthquake hazard reduction aspects of medical systems; all of the local and state government representatives had participated in responses to at least two earthquakes; and several individuals had been active in the field since the 1971 San Fernando earthquake and had authored studies concerning medical systems and earthquakes. Thus, the groups were not composed of people representative of medical systems across the country, but of individuals very experienced in dealing with earthquake issues that affect the medical system. The intent was to assemble as much experience as possible and extract from that wisdom some forward-looking suggestions for NEHRP involvement in the medical field.

One group discussion was carried out as part of the Central United States Earthquake Consortium sponsored Seismic Design Workshop that brought together some 90 architects, engineers, urban planners, emergency managers, building codes officials, and contractors to address the impact and implications of seismic regulations on their respective disciplines. The group focused on a discussion of user needs, problems, and issues related to earthquake risk reduction and how NEHRP (and CUSEC) can best assist each group in identifying and carrying out its risk reduction responsibilities.

One group discussion was held during the 1993 Hazards Research and Applications Workshop in Boulder, Colorado. Participants included emergency managers and researchers involved in studies related to implementation of mitigation measures. Discussion centered on the participants' experience in identification of factors important to successful implementation.

FEMA delivers a number of workshops designed to stimulate the implementation of mitigation measures among selected local-level populations including schools, hospitals, lifelines. The Implementation Team wanted, and gained, deeper insight into hospital groups by having the appropriate workshop evaluated. Battelle Human Affairs Research Center, Seattle, completed an evaluation of the FEMA workshop entitled Nonstructural Earthquake Hazard Mitigation for Hospitals and Other Health Facilities. The evaluation focused on the effectiveness of the workshop to motivate participants to carry out mitigation measures.

A mail-out survey was sent to 865 participants representing courses offered in six states: Emmitsburg, Maryland (7), California (6), Washington (3), Alaska (3), Oklahoma (1), and Hawaii (1). The results of the evaluation given to the Implementation Team provide a cross-check on factors identified during interviews and group discussions as well as a measure of the usefulness of one particular workshop on the implementation of mitigation measures. A summary provided by Battelle of the implications of this evaluation is discussed in Section 8. The results of this evaluation are not intended to reflect on the effectiveness of other NEHRP workshops to foster the implementation of mitigation measures. Each workshop is individually designed, targets different audiences, and should be evaluated individually. Ongoing follow-up evaluations of NEHRP workshops would provide an indication of how well they achieve their objectives, help in course design, and identify barriers to mitigation that NEHRP might be able to address.

6.2.2 Federal Assessment: Selection of Users

The federal government has 3 billion ft^2 of owned and leased space (GAO, 1992) in 417,000 buildings and 68,000 lease locations. At least 44% of the buildings owned by the federal government are in areas of moderate- to very high-seismic hazard, according to the National Earthquake Hazards Reduction Program Seismic Map. The NEHRP seismic map is believed by some to underestimate seismic hazards in areas such as Oregon (Oregon Building Codes Agency). Therefore, an even larger percentage of federal buildings may be exposed to significant earthquake hazards.

The large property holdings by federal agencies make them an important potential end-user of NEHRP products and materials. The design requirements used in the construction of federal buildings also may influence local engineering practice. Therefore, 30 interviews were carried out with individuals from four subgroups involved in the implementation of Executive Order 12699, a directive on seismic design provisions for new federal construction. The federal interview participants are listed in Appendix D. The focus of the interviews concerned the implementation of Executive Order 12699 with respect to new buildings, in-process ICSSC policy-making with regard to existing buildings, and the federal effort to develop standards for lifeline systems. The following groups were interviewed.

Interagency Committee on Seismic Safety in Construction Representatives. The ICSSC was established in 1978 to help federal agencies involved in construction to develop and incorporate earthquake hazard reduction measures in their programs (Wright, 1992a, p.12). The 27 agencies each select a representative to the ICSSC, and those representatives constituted one of the three groups identified as users for this survey. In some cases, an agency alternate representative was interviewed instead, or also.

Federal Agency Seismic Safety Coordinators. The detailed guidance for carrying out Executive Order 12699 recommends that each agency appoint a seismic safety coordinator. This is sometimes the same person as the ICSSC representative.

Consulting Engineers Centrally Involved in ICSSC and Related Activities. A few interviews were conducted with nonfederal employees—consulting engineers who have recently provided and are currently under contract to assist the ICSSC or individual agencies regarding guidelines or policies for new and existing buildings and lifelines.

NEHRP Agency staff members.

6.3 PROCESS FOR INFORMATION GATHERING

6.3.1 Local Assessment

Interviews. Twenty-two local interviews were completed. Each individual was interviewed for about 1–2 hours, either face to face or over the telephone, by a team member using an interview guide prepared by the team (see Appendix F.2). The scope of the interviews for the local groups focused on identifying characteristics of strong examples of the implementation of mitigation measures and how NEHRP agencies might foster such characteristics among end-users. Factors included information needs (type, delivery, content), implementation support (state agencies, consortia, professional associations), participant characteristics (experience, education), and factors believed by participants to inhibit or enhance local implementation of mitigation measures. The interviews were not intended to assess the degree of implementation accomplished by end-users but to focus on how NEHRP might improve the level of implementation.

Group Discussions. Information collected during group discussions was generally more open-ended and diverse than that collected during individual interviews. Group discussion results reported in Section 6.4 focus on the implementation of mitigation measures. Summary reports on group discussions may be obtained from the Center for Natural Phenomena Engineering, Martin Marietta Energy Systems, Inc., Oak Ridge, Tennessee.

Incorporation of Implementation Research. While review of previous implementation studies and assessments can provide a broader context within which to assess interview results, time limitations prevented a systematic review of the literature collected by project management and team members. Nor has the validity of previous findings been evaluated. A systematic review of existing NEHRP funded studies, an evaluation of results, and a synthesis of findings would be a valuable contribution to future researchers. Where possible, previous findings help to inform the assessment of findings and recommendations in Section 6.6.

Hospital Workshop Evaluation. The central purpose of the workshop evaluation was to assess the effectiveness of FEMA's course entitled "Nonstructural Earthquake Hazard Mitigation for Hospitals and Other Health Care Facilities" in promoting the implementation of mitigation measures in health facilities. Battelle Human Affairs Research Center reviewed the Implementation Team's draft survey questionnaire, provided suggested revisions, prepared an analysis design, and conducted a mail survey using the 865 names and addresses of course participants provided to us. The survey questionnaire is included in Appendix F, and a summary of the evaluation findings is in Appendix E.

To evaluate the effectiveness of the course in promoting the implementation of mitigation measures in health facilities, the questionnaire focused on

- actions to reduce earthquake hazards or to become better prepared to respond to an earthquake, since the interviewee took the course,
- use of instructional material made available at the course, and
- dissemination of information learned in the course.

Other questions addressed background information on the participant's facility, his or her professional position within the facility, and an assessment of the principal motivations for, and barriers to, proceeding with mitigation activities.

As of December 5, 1993, 271 of the 865 questionnaires had been returned. Twenty-nine questionnaires were returned by the post office as undeliverable, and another five were returned because the person no longer works at that facility or the person claimed never to have taken the course. This yields a response rate of 33%. The response rate generally was higher than average for participants who took the Emmitsburg (train-the-trainer) and Oklahoma courses.

6.3.2 Federal Assessment

Interviews. Thirty interviews were completed with individuals drawn from each subgroup involved in mitigation by federal agencies: ICSSC, Federal Agency Safety Coordinators, consulting engineers, and NEHRP agency staff. The scope of the survey of these four subgroups was limited to the relationship of NEHRP to (1) the implementation of Executive Order 12699 and (2) related activities of ICSSC in dealing with the topics of existing buildings and lifelines—that is, how those surveyed have used NEHRP products and services and what they would like to see provided by NEHRP in the future. Interview questions are included in Appendix F.

The survey was not an attempt to summarize all activities under way or past accomplishments of ICSSC and its member agencies, nor was it an attempt to evaluate the effectiveness of the implementation of the executive order. A number of documents provide necessary background on these out-of-scope topics and should be consulted to obtain a broader picture of Executive Order 12699 and other topics that involve the ICSSC.

A number of federal agencies have extensive seismic programs that predate NEHRP that are funded and run separately (e.g., Veteran's Administration). Their activities may be considered part of "lower case nehrp"—that is, of the broader range of earthquake hazard mitigation activities carried out by individuals, organizations, and government agencies outside of those directly funded under NEHRP by FEMA, NSF, NIST, and USGS. The two primary topics relevant to the ICSSC user group (including agency seismic safety coordinators, consulting engineers, and NEHRP agencies) have been (1) standards for new construction and Executive Order 12699 and (2) seismic rehabilitation of existing buildings and a proposed executive order for existing buildings. NEHRP has made significant contributions to these two topics. With respect to NEHRP's effect on the development of standards for new and existing buildings, see Section 6.5. In addition, NEHRP agencies provide assistance to ICSSC by (1) providing FEMA funding for ICSSC work and support to the ICSSC in formulating policies and guidelines and (2) having NIST fulfill the secretariat function for ICSSC. While important and capable of being of greater assistance to the federal agencies, NEHRP activities must be seen within the context of long-term successful efforts to implement mitigation measures by other federal agencies.

6.4 RESULTS OF INFORMATION GATHERING: IDENTIFICATION OF USER NEEDS

6.4.1 General

This section present needs reported by interviewees and other study participants that they consider necessary to put risk reduction measures into practice. Findings and recommendations in Section 6.6 focus on issues that could be considered by NEHRP during program planning to respond to these needs and concerns.

6.4.2 Characteristics of Strong Implementation and Implementation Strategies

Before discussing specific user needs for implementation of mitigation measures, it is helpful to note two elements of concern expressed to the Implementation Team in interviews and discussions: (1) the characteristics of a strong implementation program and (2) the need for development of a strategy for stimulating the implementation of mitigation measures.

During the Assessment, characteristics of strong implementation were noted to include (1) available technical expertise, (2) mitigation advocate (champion), (3) mandates, (4) management commitment, and (5) personnel and financial resources. Discussing the characteristics at the User Needs Workshop (see Section 7) resulted in workshop participants reorganizing these five characteristics into the three following categories:

- information,
- capability (ongoing training and education, coordination of diffuse efforts, development and support of mitigation advocates), and
- commitment (mandates, incentives, resources, linked mitigation programs, and issues).

It was the consensus of workshop participants that concentrating on implementation needs within these three areas would prevent individuals from thinking only of information issues when dealing with implementation. While technical expertise forms the basis and motivation for mitigation, it appears insufficient alone to cause implementation to occur (Hays, 1988). In interviews and in the Assessment's User Needs Workshop, participants commented on the need not only to "feed" advocates with technical information, but to find mechanisms to help them gain commitment of decision-makers to take action.

Based on this Assessment, it seems quite clear that a focused strategy for stimulating the implementation of mitigation measures needs to be developed. May (1989) presented four implementation strategies: disseminate hazards information, seek mandate revisions, influence local government practices, and influence private professional practices. Each option is discussed below in light of the implementation assessment. The results of the implementation assessment tend to favor an implementation strategy of influencing private professional practices.

With respect to the dissemination of hazard information, interviewees noted the importance of information that defines a credible threat, but such information alone was not considered sufficient to motivate action. Some individuals mentioned the lack of capability to apply the information, an insufficient understanding of how to transfer information on the hazard into appropriate land use or design policies, a lack of management support, and the problem of competing issues. Nevertheless, the deficiencies in the means for disseminating information described below should be addressed, regardless of implementation strategy adopted.

Strategies to influence local government practice will need to address both the lack of local resources and the lack of priority. Local jurisdictions, even when highly motivated and supported by management, reported being constrained by limited funds and insufficient staff. Strategies targeting local governments will need to address the issue of limited resources to avoid reaching only the more capable jurisdictions. Many communities do not see earthquake hazard mitigation as a priority. A study by Berke and Wilhite (1988) of, primarily, planning departments in communities in 22 states noted that "a majority of respondents in California (59.7 percent), and all other communities (71.8 percent) indicated that earthquakes are a low or very low priority in their communities."

Mandates were frequently reported to be among the major reasons to implement mitigation measures, and the recommendation to seek mandate revisions has been common. In fact, a recent FEMA report (FEMA 237) concluded that mandates are required for mitigation. Building codes, comprehensive plans, and zoning and subdivision ordinances were noted in Berke and Wilhite (1988) as the top four mitigation measures used in communities, with California using a greater number of these measures than other states. The hospital evaluation showed that participants in higher risk zones and from larger hospitals were more likely to carry out nonstructural mitigation actions following the hospital workshop than lower risk areas and smaller hospitals. Using the 1992 NIST report, *Seismic Provisions of State and Local Building Codes and Their Enforcement*, 64% of the states have adopted statewide one of the three model codes (Building Officials and Code Administrators Association, Uniform Building Codes, and Southern Building Code) without major revisions. Of that 64%, 46% of the states apply the adopted code to all buildings, while the remaining 18% generally restrict the code to selected buildings types (e.g., state-owned buildings, all buildings except one- and two-family dwellings, or special-use buildings such as schools). Major local jurisdictions in states without a statewide building code generally have adopted one of the three model codes as a standard. For example, Oklahoma has no statewide building code, but Tulsa has adopted the 1990 BOCA. The mitigation issue for most areas, therefore, is not code adoption (mandate), but code enforcement and seismic zone assignment. (An area building assigned to a lower seismic zone than appropriate may inadvertently generate a population of at-risk buildings.)

A strategy focusing on influencing professional practice seemed particularly attractive to the Implementation Team—a view supported by a large number of interviewees—because of the importance of professionals when developing standards, advising clients, and interacting with local government agencies. For example, interviewees noted that professional engineers provide information to building departments that is related to proposed design approaches and retrofit methodologies; they have been active in the development of codes, and they have assisted school and hospital facility managers in design decisions. The continued influence of professionals, such as engineers' involvement in the Building Seismic Safety Council and engineers' associations which train their membership, would appear to be fruitful in increasing implementation of mitigation measures. As professionals understand the need for mitigation and develop the capability to form mitigation solutions, they will have opportunities to advocate the adoption of mitigation measures. Professionals who do not fully understand the hazard and/or have vested interests become particularly strong opponents to mitigation.

A number of NEHRP efforts (e.g., USGS ATC-35 seminars on ground motion, FEMA support of BSSC, FEMA support of some EERI activities) target professional practice, but they are not part of a clearly defined strategy. In a defined strategy, each agency would be responsible for identifying appropriate activities to further that strategy.

6.4.3 Discrete User Needs

Participants in interviews and group discussions and the hospital evaluation pointed out four discrete needs that are important to implementation: (1) financing and personnel, (2) access to and availability of information, (3) research, and (4) products.

The lack of funding and personnel resources was reported by a majority of interviewees in the local and federal interviews and in the hospital evaluation as the primary barrier to implementing mitigation measures. The reasons for the inadequate resource support were attributed by many to the low priority of mitigation programs, by some to recent budget cutbacks, and by most to the high costs associated with mitigation actions. Building departments indicated budget cutbacks and reduced staffing (government streamlining) were occurring when the work load was increasing (e.g., more building permits). One interviewee noted that a recent consultant report included a $72 million seismic mitigation estimate for one city building. While staff expertise in larger jurisdictions generally includes structural engineers, construction expertise is lacking in smaller jurisdictions.

Access to NEHRP information and training and education programs were cross-cutting needs identified in most interviews. Interviewees believed there is an urgent need to develop an improved NEHRP dissemination process and continuing education programs. Some interviewees noted the need for a NEHRP bibliography arranged by subject and region. Regional organizations (BAREPP, CUSEC, etc.) and professional and trade associations should play an important part in the design of an effective dissemination program. In particular, interviewees in Salem, Oregon, and Everett, Washington, reported little or no awareness of NEHRP information or activities. Seattle and Portland, Oregon, participants generally indicated an awareness of only a limited number of products or programs, which they then had to aggressively seek out. A large number of study participants in the central United States and in California reported that NEHRP information and activities were helpful to them in carrying out their mitigation programs. Interviewees in these areas also often indicated that they received information and assistance from both state agencies and regional preparedness programs (CUSEC, BAREPP). Many interviewees in all areas noted that they receive much of the information they need to carry out their responsibilities (often including mitigation) from either their professional associations or from project consultants. In addition, two interviewees from California stressed the importance of information provided to them from non-NEHRP sources.

Federal interviewees noted that the ICSSC is the funnel through which most earthquake information reaches federal agencies. Strengthening the dissemination capabilities of ICSSC would assist NEHRP in distributing information. One federal interviewee, however, noted that lack of information isn't holding back implementation, but lack of budgets and policies is.

Participants in FEMA's hospital course on the mitigation of nonstructural earthquake hazards in health care facilities indicated that lack of funding, not lack of information, is the primary barrier in carrying out earthquake hazard mitigation. This result is important because even when relevant information is developed and delivered in an effective manner, information alone is inadequate to overcome the lack of action. While a number of weaknesses have been identified in the information dissemination process, strategies to encourage implementation of mitigation methods need to go beyond a strengthened information dissemination plan.

The majority of products requested and subjects proposed for research were problem-focused rather than requests for basic research. This fact reflects both the occupational needs of interviewees and the perception by some that existing research already provides an adequate program basis. The CUSEC and hospital group discussions showed a low level of tolerance for current research directions and stressed the importance of involving research end-users in the identification of research needs. Many interviewees said that, to be useful to them, research results had to be clearly stated, directly applicable, concrete, and delivered through their normal professional information pathways.

The need for research on effective methods to generate political commitment is reflected in the frequent mention by interviewees from the Central United States as well as from smaller communities in Washington and Oregon of the lack of political support as a barrier to initiating mitigation efforts. Their comments reinforce May (1989, p. 23), who states that the

> challenge for future risk reduction effort for this group of cities (restrained examples of mitigation) is building both a supportive political-economic climate and the capacity to undertake relevant measures.

A number of interviewees from the Central United States indicated that they needed to overcome active opposition to mitigation programs. Even in a California community with a strong implementation program, one interviewee reported that he lacked political support to go beyond mandated actions.

A research need noted by federal agency interviewees, even in cities with strong implementation programs (e.g., Seattle, Palo Alto, and Portland, Oregon), and echoed in group discussions was the development of cost-effective retrofit methods and technologies. The hospital discussion group was concerned about the recommended level of retrofit required for hospitals; upgrading all parts of a hospital to an immediate occupancy performance level seemed an inappropriate use of limited medical resources. One interviewee felt that more attention should be given to incremental, elemental, low-cost mitigation measures.

Federal interviewees noted a need for additional research on lifeline systems and the rehabilitation of existing buildings. Several persons indicated that the knowledge to rehabilitate buildings exists, but issues of dissemination of information and standards are undetermined. Others asked that information be shared regarding the experience California and federal agencies have had in upgrading buildings.

While cost-effective approaches were noted as a critical research need by most participants, establishing political or upper management commitment to initiate mitigation programs was often given higher priority, particularly by interviewees in areas with restrained or nonexisting mitigation programs (where action is not usually mandated). It was felt that if earthquake hazard mitigation were a priority, then funds would be made available.

A product need for a number of interviewees in Washington and Oregon was mitigation program management guidelines for facility managers and building officials. Such a management guide would include a discussion of key program issues (e.g., retrofit level), a brief review of existing methodologies (e.g., FEMA 178), and the selection of appropriate consultants. Detailed engineering information would not be included.

6.4.4 Selected End-User Needs

While all interviewees noted concerns in information access, resource support, and problem-focused research, this section lists specific needs identified by selected end-user groups interviewed.

Building officials' needs cited include

- retrofit standards and guidelines for the upgrade of existing buildings;
- mitigation program management guidelines that specifically address the role of building officials;
- benefit-cost methodologies to determine which facilities need to be upgraded, based on issues such as length of occupancy, vulnerability, appropriate performance levels for specific uses, and "social-cost avoided" through implementation of a mitigation program; and
- products targeting home builders that can be distributed at the building department (like the energy and ADA brochures).

Planners' needs cited include

- localized definition of the hazard (map scale 1:24,000),
- translation of hazard information into specific land use policy options,
- compilation of model ordinances and case histories, and
- digitized data for input to GIS.

School facility managers' needs cited include

- program management guidelines that specifically address the role of the school facility manager,
- compilation of model school mitigation programs, and
- information on how to balance education program needs vs risk reduction actions.

Hospital facility managers' needs cited include

- information on how to balance community medical care needs against the implementation of risk reduction measures,
- information on how to link the identification of priority postevent functions to mitigation actions,
- information on recovery, and
- information on development of programs that are more cognizant of hospital needs and interests.

Federal agencies' needs cited include

- interagency coordination and information exchange (focus on ICSSC);
- products designed to manage mitigation programs for nationally distributed properties such as
  - how to address mitigation in low and moderate seismic zones,
  - risk assessment procedures to compare levels of risk to specific types of buildings in different geographic areas, and
  - one code that applies to all federal facilities;
- hazard data needs such as
  - ground motion data in a form engineers can use to calculate demands,
  - improved NEHRP maps, and
  - strong motion instrumentation programs;
- tools to identify and assign priority to buildings that need to be retrofitted;

- an executive order for existing buildings;
- enforcement issues;
- more information on lifelines; and
- lifeline standards.

6.5 STRENGTHS OF NEHRP: IMPLEMENTATION OF MITIGATION MEASURES

6.5.1 Overview

Significant progress has been made under NEHRP during the past decade to develop and disseminate research and information on earthquake hazards and strategies to reduce the risk in regions throughout the United States. The following programs and activities have been undertaken to further the goals of NEHRP.

1. Production and distribution of special publications and education materials: NEHRP has contributed substantially to the body of knowledge for use by practitioners.

2. Support for agencies and organizations that actively foster implementation of earthquake risk reduction: CUSEC and the New England States Earthquake Consortium are examples of organizations funded by NEHRP that provide direct technical assistance to a wide range of practitioners.

3. Collaboration with professional and trade associations to disseminate information: BSSC (whose primary funding has been from NEHRP), for example, has made major contributions to seismic safety.

4. Support for educational outreach to the general public and to specialized agencies: The Center for Earthquake Research and Information in Memphis has been a valuable source of credible earthquake information and educational services for the Central United States.

5. Sponsorship of workshops, seminars and conferences: NEHRP has directly supported activities contributing to the implementation of risk reduction policies, strategies, and programs throughout the nation.

Important to the overall NEHRP program are efforts to coordinate research, disseminate information, and promote collaboration among researchers such as NCEER. While the latter groups are critical to the production of information for the design of mitigation approaches, they had a low level of recognition by users targeted for the implementation assessment. These users are candidates for digested and problem-focused versions of results produced by the research centers. They also benefit from the mobilization of professionals (e.g., engineers) who work toward the development of mitigation programs at local and state levels. It was not expected that participants in the implementation assessment would be familiar with the products and services of the larger, research centers. Greater communication to typical end-users of the contributions of the major research centers toward the development of appropriate mitigation solutions may help to tone down the antagonism toward research that was evident in interviews and group discussions.

6.5.2 Strengths

Interviews and group discussions identified NEHRP accomplishments, including

- the development of tools to assist in the implementation of mitigation measures (standards for new buildings and the current development of standards for existing buildings),
- the definition of an earthquake hazard,
- an awareness of earthquakes and their impacts, and
- the development of regional capability.

Some participants indicated that they were most familiar with NEHRP activities defining earthquake hazards and developing awareness of the impact of earthquakes on communities. A few indicated that NEHRP provided detailed information on mitigation methods.

NEHRP efforts were considered to be uneven. For example, while considerable resources have been focused on defining earthquake hazards in a variety of locations, they have had to focus on high-priority regions. So some local jurisdictions in California may have hazard maps at a scale suitable for the development of land use policies, while others may not. Similarly, awareness in a state with relatively frequent and damaging earthquakes may relate more to the events themselves than to NEHRP awareness programs. In less seismically active areas, NEHRP was reported to play a strong role in developing awareness of potential earthquake impacts. NEHRP has had a strong role in the development of regional consortia to assist in earthquake hazard mitigation and preparedness at the local level (e.g., CUSEC, BAREPP, SCEPP). Yet, many other areas have weak or no regional assistance programs. This unevenness of effort should be kept in mind when considering NEHRP strengths.

NEHRP, however, has positively affected two critical areas, (1) standards for new buildings and (2) standards for existing buildings. Though many "lower case nehrp" contributions are involved, these efforts nevertheless represent the strength that NEHRP brings to the implementation of mitigation measures.

Figure 6.1 illustrates the way the NEHRP has flowed into the process of achieving the adoption of seismic regulations in the model codes. Prior to passage of the National Earthquake Hazards Reduction Act in 1977, the UBC contained seismic provisions in various editions dating back to 1927. The Structural Engineers Association of California (SEAOC) has essentially authored the UBC seismic regulations over the years on a voluntary, unpaid basis. The Applied Technology Council established by SEAOC to conduct research, had as one of its first projects ATC-3-06 (Applied Technology Council, 1978), which is the forerunner of *NEHRP Recommended Provisions for the Development of Seismic Regulations for Buildings* (FEMA 95 and FEMA 96). The primary contribution of USGS in the development of seismic building codes has been ground motion maps. The lineage of research studies evolving through the years into code maps is documented by Hays (1988). USGS has also organized broadly attended workshops on seismic hazards in several regions of the United States. NSF has supported engineering research that resulted in the revision of code provisions and in the development of new provisions that deal with new structural systems developed under NSF research grants. Forexample, research at the University of California, Berkeley, by Igor Popov and others on eccentric braced frames led to use of that system by practicing engineers on special projects and then to the integration of provisions for such systems into building codes. To a lesser extent, NIST has conducted engineering research and physical tests.

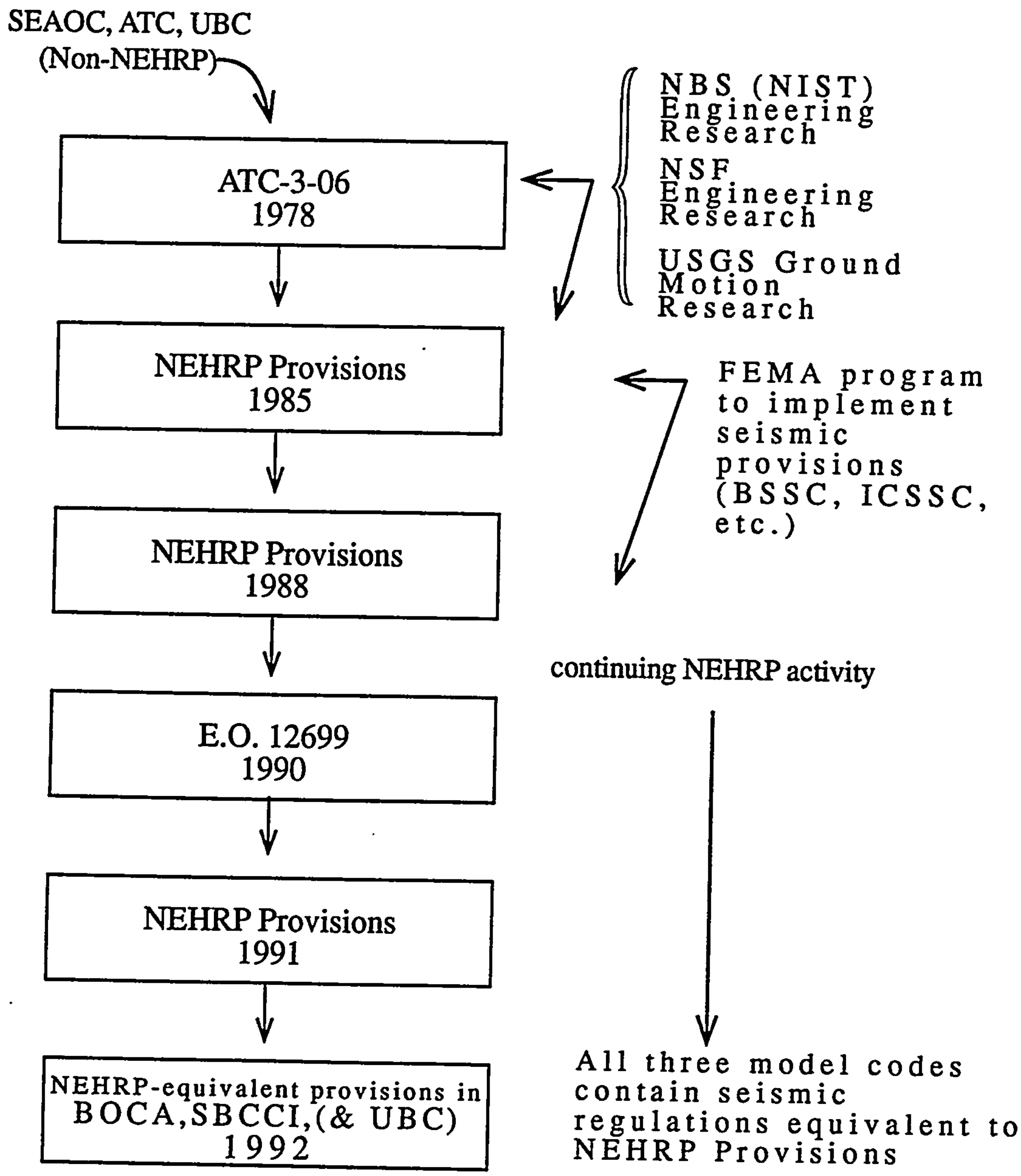

Fig. 6.1. Tracing the NEHRP lineage in the development of model code seismic provisions and the implementation of Executive Order 12699.

FEMA has a plan for facilitating the development of the NEHRP recommended provisions for new buildings. FEMA has funded BSSC to develop consensus versions of the provisions, to revise them, and to facilitate and encourage their adoption into codes and standards. FEMA has also funded studies on the cost of using the provisions in technical training courses and in other reports in its series related to NEHRP provisions.

UBC pioneered the development of U.S. building code seismic regulations and had earthquake provisions long before NEHRP, but its recent revisions borrow from the NEHRP provisions. More extensive contributions from NEHRP have been made with respect to BOCA and SBC, which incorporated provisions very similar to NEHRP provisions in the BOCA 1992 supplement and SBC 1992 Amendments.

The establishment of the NEHRP provisions as the minimum standard for carrying out Executive Order 12699 and the determination that the three model codes are equivalent to the NEHRP provisions (Council of American Building Officials, 1992) have led to NEHRP influence on the design of buildings, including federal buildings.

A parallel path for the development and implementation of standards for existing buildings has been charted by FEMA. A series of reports on overall strategy, rehabilitation techniques and costs, incentives, and other topics have been funded since the mid-1980s. Local and federal interviewees frequently referred to FEMA 178, a manual to evaluate a building to determine if seismic upgrading is necessary to meet a specified life safety objective. NSF has funded an ongoing seismic rehabilitation research program directed by the University of Texas. NIST has conducted some rehabilitation research, and USGS ground motion mapping work relates to both new and existing construction. FEMA funded the Applied Technology Council's development of a report resolving basic issues involved in the development of guidelines for seismic rehabilitation. FEMA has contracted with BSSC (with the ATC and ASCE as subcontractors) to produce a report on guidelines and commentary for the seismic rehabilitation of buildings.

Although UBC (in its companion Uniform Code for Building Conservation) contains seismic rehabilitation provisions for unreinforced masonry buildings (which are derived from NSF-funded research efforts), the in-process guidelines and commentary mentioned above will expand the realm of guidelines for seismic rehabilitation. In the case of provisions for new buildings, as shown in Fig. 6.1, non-NEHRP California accomplishments preceded the evolution of the NEHRP provisions, whereas with existing buildings, NEHRP influences constitute a strong role as the originator of design provisions.

As a measure of the effectiveness of workshops to motivate the implementation of mitigation measures, Battelle Human Affairs Research Center completed an evaluation of FEMA's course entitled "Nonstructural Earthquake Hazard Mitigation for Hospitals and Other Health Facilities." The evaluation indicated that the workshop format appears effective in encouraging mitigation actions, in disseminating mitigation information, and in providing relevant materials to guide mitigation. Findings are summarized in Section 8. Of particular interest are these results:

- Two-thirds of the health facility respondents reported that they took action to reduce nonstructural earthquake hazards after they took the course. This percentage is impressive even though it is likely biased toward the high end, since those who returned the questionnaire (33%) are probably those with the greatest interest or the most to report. In addition, 82% reported that one or more enhancements had been made to the facility's emergency preparedness and planning since they took the course.

- Almost all the health care facility respondents remembered receiving the student manual prepared for the course, and just over two-thirds said they had made practical use of the manual in implementing some hazard reduction or preparedness planning action.

- Almost 90% of the respondents reported having passed along information from the course to someone else by at least one way (e.g., gave a course, gave a talk, photocopied material), and just over half reported having passed information along in two or more ways. There appears to be a relationship between feeling the course was very relevant and passing information along to others. Battelle's findings also indicate a relationship between a person's reporting that his/her facility had taken some action and in reporting that he/she had shared information in several ways.

While workshops were frequently noted by local interviewees as sources for defining the hazard, generating awareness, and, to a lesser extent, providing detailed mitigation information, attendance—even awareness—of the workshops was uneven. Generally, professionals from the larger jurisdictions had attended. The hospital evaluation also noted that interviewees were more likely to be from the larger, acute-care hospital facilities. Therefore, while workshops appear to be effective in disseminating information and stimulating action, they tend to be more readily available to end-users in the larger jurisdictions.

Follow-up of other NEHRP workshops should be completed to evaluate their effectiveness to motivate actions, the appropriateness of materials provided, and the types of audience most benefiting from the course.

6.6 ASSESSMENT OF FINDINGS AND RECOMMENDATIONS

6.6.1 General

The interview findings revealed a clear pattern of concerns and issues that need to be addressed to strengthen NEHRP:

- improved access to NEHRP-generated publications and services;
- input of potential users into the development of risk reduction programs and products;
- incentives for implementation of earthquake risk reduction programs;
- enhanced state, local, and regional capabilities to implement risk reduction policies and programs; and
- focused effort on selected end-users most capable of achieving NEHRP goals.

The findings and recommendations call for a NEHRP program that (1) places greater emphasis on the needs of the user (from identification of priorities to formatting of products), (2) reexamines existing information flow and use patterns to capitalize on successful models (e.g., greater use of professional associations for dissemination, training, and education), and (3) focuses on the complex problem of creating conditions and environments (social, cultural, financial, and political) that are conducive to implementation of risk reduction programs.

The repeatedly identified importance of tailoring programs and products to meet the needs of potential users and accommodating variations in geographic, social, political, and economic conditions critical to successful implementation underscores the necessity for the NEHRP agencies to identify and assign priority to those user groups with the greatest capability of achieving program goals. Of the multitude of potential users, from individuals to corporate executives, those with the greatest opportunity and authority to maximize risk reduction actions must be targeted. Limited program resources demand selective, focused, and ongoing efforts, rather than piecemeal, or partially developed attempts to hit all possible users. Evaluation and assessment of programs need to become standard tasks to check the effectiveness of programs in meeting end-user needs.

6.6.2 Findings and Recommendations

Finding 6.1

> **NEHRP information on earthquake risk reduction is not easily and readily available to practitioners at the local or federal level. Existing dissemination pathways are often ignored.**

Discussion: A recurring theme among building officials, urban planners, and hospital and school facility managers was that NEHRP research and information were not reaching them. Information dissemination appears to occur on an ad hoc hit-or-miss basis among those interviewed as part of this Assessment. Little follow-up by federal or state agencies has occurred to determine if information actually reaches intended target audiences and whether distribution is carried out in a timely manner. In many instances, NEHRP publications and reports (e.g., FEMA yellow-covered report series) end up in storage rooms and basements of state offices or in federal files (e.g., USGS External Grant Reports). Those familiar with NEHRP publications found them difficult to obtain, but most of those interviewed were unaware of NEHRP products and services. An Oregon school facilities manager said, "Someone somewhere once sent me something but I don't remember who or what." "Getting publications out of FEMA is difficult," said an Oregon building official. A federal agency representative stated,

> If it's funded by NSF and you ask them for it they say don't bother us, it's not our job to tell you what research we've funded or where to get results. If you go to the trouble and manage to track down the professors who got the grants—and there's no good way to do that, no bibliography—they sometimes say it's not their problem to give you the results either.

"As a facility manager, I haven't heard of any [NEHRP publications or workshops]," said a Washington school facility planner. A past state president of the Oregon Building Officials Association acknowledged, "NEHRP may be doing good things, but I'm not aware of it." "We don't know enough about what NEHRP does and/or how to apply it most effectively," commented a Mississippi planner. One Tennessee hospital plant operations director said, "I do not know enough about what is being done to make a qualified comment." A California school risk manager reported that "no yellow books [were] used. Where do you get them?" A federal agency representative inquired, "How do you order the various NEHRP documents? Why isn't there some central clearinghouse or ordering system?"

Existing information pathways to key user groups are often ignored. While NEHRP agencies have developed information transfer products and services such as publications and regional workshops, they are frequently advertised and disseminated through NEHRP pathways unfamiliar to the end-users interviewed. A Washington building official said,

> Only know about it if it shows up in the mail. The Association of State Building Officials like the Washington Association of Building Officials is an excellent source of information. ICBO [International Conference of Building Officials] some information and inspiration.

Hospital facility managers have too little time to go outside specific health care contacts such as the Association of Hospital Engineers, said a Washington hospital facility manager. A federal agency representative had a suggestion on dissemination:

> Out of all the NEHRP funds, there should be enough for an ICSSC newsletter. We get most of our earthquake information from ICSSC, and making that source more efficient, such as having a frequently published newsletter, would help.

"FEMA should advertise earthquake publications, training, etc. in ICBO's Building Standards if building officials are to be reached," said an Idaho building official.

Recommendation: Priority should be given to developing a user-focused information dissemination strategy for local and federal end-users that (1) involves coordination of information accessibility among NEHRP agencies, regional consortia, hazards centers, state agencies, professional associations, and other potential distribution centers; (2) identifies and repairs significant breaks in information dissemination pathways; and (3) outlines key information transfer points that can be used to reach intended groups. An information dissemination strategy to reach local government and private practitioners should make use of existing professional and trade associations as vehicles for reaching local government and private sector users. The role of ICSSC in communicating information and formulating policies among federal agencies should be strengthened.

Finding 6.2

> **More hazards research and information is being generated than ever before. For practitioners, this can result in information overload, which can be counter-productive to implementing risk reduction measures.**

Discussion: With each new disaster comes volumes of research and lessons. More disciplines are devoting increasing attention to hazards and their consequences. For those local and federal practitioners that are able to access earthquake risk reduction information, the overload problem can be characterized as follows: (1) Hazards information is often organized by subject, not geographic region, making it difficult to identify pertinent information for specific local problems; (2) the sheer volume of information can create sorting problems for the practitioner; and (3) information is fragmented, dispersed among many unfamiliar sources, including separate publication lists in each NEHRP agency; and (4) information quality is difficult for the end-user to assess. Federal agency representatives had several questions and comments: "Is there a list of NEHRP publications? FEMA publications? Can you order them by phone?" asked one. "It's hard to find out what NEHRP research is underway. NISEE and NCEER searches usually turn up information that is three years old," noted another. "Is there an index or listing of research on specific lifeline systems?" asked one. "There should be a Washington DC library of essential earthquake publications for reference by ICSSC members," one representative advised.

Recommendation: NEHRP agencies should select a subset of agency publications considered a "must" for the development of an earthquake risk reduction program. NEHRP should establish index categories consistent among agencies. One interviewee suggested organizing information according to end-user application needs (e.g., mitigation, preparedness, response, and recovery) and geography. More attention needs to be given to periodic review and synthesis of research results to provide additional quality assurance. Information mature enough for application needs to be distinguished from emerging information needing additional verification.

National and regional hazards research centers and information clearinghouses should organize information by subject, application, and geographic region. At the state or regional level, a "research triage" function needs to be performed to assist practitioners in the identification of useful publications. Advances in computer communications can be used in this process. Consortia can serve a valuable function, for example, in identifying, analyzing, screening, sorting, and disseminating useful publications to a range of practitioners.

Finding 6.3

> **Not enough attention is given to the involvement of local and federal users in the development of implementation strategies. Types of information and research, presentation (e.g., handout vs workshop), training, and style requirements vary among users and among regions. Resources and expertise of users are uneven, with some having a long history of implementing mitigation programs while others have not begun. Programs to foster implementation must incorporate these differences in needs and capabilities into program and product design.**

Discussion. Some respondents perceive that the NEHRP research agenda has been influenced more by grant applicants from universities than by either intended users or by NEHRP agencies. As a consequence, much of the research seems to provide piecemeal answers to questions of interest to some researchers rather than tools to foster implementation. Assessment participants reported that research results are often perceived as irrelevant to their needs and in a format that inhibits use of the information. A number of respondents indicated that practical how-to information and hands-on technical training that clearly addresses their particular concerns is needed to foster implementation of risk reduction measures. If risk reduction programs are to be implemented at the local level and in federal agencies, research is needed that focuses on "real-world" problems, translates research into tools that can be easily applied, and accommodates variations in implementation feasibility. "Research results are too esoteric," noted a Washington building official. A federal agency representative suggested:

> Diskettes with ready-to-use applications or information, or briefings, should be produced. You could have an overall flow chart of the implementation of Executive Order 12699, for example, and then click on a particular box and go into that step in detail.

"Research results need to be pragmatic, realistic," urged an Oregon building official. "God spare me from the theorist. Need a nationwide list of mitigation priorities, steps, manuals, and tools." A member of a California hospital group lamented:

> Most of us who have gone out of our way to try to get hold of the last decade's research on casualties—and it isn't easy to do—have been frustrated that it isn't very useful. This will always be the case with NEHRP research until the intended users help select the projects to be funded, until there are review committees during the research, and unless the researcher has it in the grant requirements to communicate the results.

A Tennessee planner reported that "[we] need updated data in layman's terms." Research results are easiest to use "when presented as a case study," reported a Tennessee building official. An Oregon school facility manager noted that it is "easiest to apply research results that are 'tried and true.' Not on the leading edge. Not into experimentation." A federal agency representative suggested that, "Expertise built up by the agencies with the most experience with seismic programs could be shared with the other agencies, especially with regard to the non-technical aspects."

Recommendation. Two-way communication channels should be established between intended users and NEHRP agencies to better identify research questions that need to be addressed in order to achieve improved implementation of risk reduction measures. Researchers would then be invited to submit proposals that would best further NEHRP implementation goals. Regional consortia such as CUSEC could facilitate communication between intended users and NEHRP by providing a focus for coordinating participants into user feedback groups and by providing a mechanism to address geographic variations in needs. Such structure would also help to identify resources that already exist among some user groups that could benefit a wider audience. The ICSSC could provide a similar focus for federal agencies.

Finding 6.4

> **The most frequently mentioned impediment to implementation of risk reduction measures in areas where earthquakes were not considered to be a priority concern was the lack of commitment and political will to translate the information into meaningful policies and practice. In areas with greater concern about earthquake hazards, the number of measures that could be implemented is related to commitment and support.**

Discussion: A recurring theme in the interviews, particularly in regions with few earthquakes, was that seismic risk reduction was a low-visibility, low-priority issue not clearly understood by policy-makers and met with apathy or opposition from the public, developers, and others. While information defining the hazard was considered the basis for obtaining consideration among decision-makers, such information was not considered sufficient on its own to generate commitment to an earthquake hazard mitigation program. With little or no political constituency, mitigation is easily overlooked by elected officials in the face of competing priorities and issues with higher visibility. Earthquake advocates in these areas need help in reaching the decision-makers. Without support and direction from upper management, resources will not be allocated to earthquake mitigation efforts. One interviewee noted that opportunities to publicly recognize elected officials is important to obtaining their commitment and support.

An Oregon planner inquired, "How do you sell the problem to politicians?" "Don't just tell me to talk to the mayor. He doesn't even know my name," replied a Washington building official. A Washington planner expressed his thoughts this way: "Lack of direction from above [to carry out mitigation]. City Council members interested, but provide no direction. The mayor is concerned, but [mitigation] is not [his] focus." An Idaho building official recommended:

> Convince elected officials they will reduce earthquake losses if they adopt mitigation measures. But the elected official needs to see an incentive, or [that action is] extremely cost-beneficial. Show how losses from past earthquakes could have been prevented, especially in government buildings.

According to a California building official, "Political bodies are supportive to a point, but not beyond mandatory." "More contacts need to be made to local City officials," said a Tennessee building official.

Recommendation: NEHRP agencies, particularly FEMA, need to develop risk reduction marketing strategies based on a wide range of incentives, incentive-based mandates, and cost-effective options to encourage the implementation of earthquake mitigation measures, particularly in areas where earthquake mitigation is a low priority. These initiatives must be developed in cooperation with elected officials, states, consortia, professional associations, and other key groups. To gain broader support for implementation, initiatives should emphasize constituency building. For example, one technique mentioned by a veteran hazard manager was to identify opportunities to piggyback onto other programs that have established constituencies and broad political support (for example, economic development), the strategy being to integrate mitigation goals and priorities into the mainstream of these programs.

Finding 6.5

> **All end-users interviewed, including those where earthquakes are considered a high priority, indicated that funding was the number one barrier to implementing risk reduction measures.**

Discussion: Some interviewees indicated that mandates (codes, executive orders, ordinances, etc.) were useless if funding was not available to implement mitigation measures. In some cases the lack of funding was related to the lack of priority by decision-makers (noted in finding 6.4). Some end-users felt they were being forced to choose between providing vital community services (health care, education) and reducing possible risks from earthquakes. In other cases, the high costs of some mitigation approaches prevented action. Additional funding sources need to be developed to assist in managing earthquake mitigation programs. A Washington State building official suggested a financial and technical assistance program similar to one being initiated to implement the state energy code. Funding for that program will be obtained from utility companies. Funding of actual mitigation would require substantial new revenues.

A federal agency representative said, "NEHRP puts the cart before the horse. Mere guidelines or information won't accomplish any hazard reduction without the commitment to spend the money to do the actual work." A California hospital group member reported, "The estimate for retrofitting all California hospitals up to current standards is $21 billion. That won't happen, and if it did, it would be a misuse of resources in the health care industry." "Financial limitations [and] competing for funding against direct patient care are barriers to implementation," said a Tennessee hospital facility manager, and an Oregon building official added, "Overriding problem with respect to implementation is lack of resources and lack of time." A California building official noted, "Seismic upgrades too often trigger sprinklers, handicapped, etc. and it's too costly. Need incentives for voluntary upgrade."

Recommendation. Greater attention needs to be given to developing incentives and other potential revenue sources to fund the implementation of mitigation programs. Also, innovative programs like the Washington State Energy Code Assistance Program need to be identified as possible models for providing financial assistance. Information on mitigation alternatives as a function of funding availability and incremental approaches to achieve mitigation goals need to be developed to prevent an all-or-nothing mitigation policy.

Finding 6.6

> **Earthquake risk reduction programs, activities, and responsibilities are highly diffused, which leads to difficulty in fostering implementation.**

Discussion: An inherent limitation in developing and implementing risk reduction programs is that the responsibility for mitigation is spread among a range of groups—government, nongovernment, voluntary sector, professional and trade groups, financial and insurance sector, and the general public. This fragmentation inhibits the development of comprehensive risk reduction policies and strategies at the local level. A number of interviewees noted the need to provide stronger connections and better coordination among end-users. A number of respondents in the Pacific Northwest and the Central United States indicated that they did not rely on any state agencies to carry out mitigation measures, and several indicated they had to interact with the state emergency management agency. While several California respondents noted state agencies as important to their ability to implement mitigation measures, the two sources of information and technical assistance reported (Bolton and Orians, 1992) as most useful to agency staffs representing 39 California jurisdictions are BAREPP and professional associations. (BAREPP, although now part of the California Office of Emergency Services, originated as a regional earthquake preparedness project jointly funded by FEMA and the State of California). The Bolton study also noted two state agencies, the California Specialized Training Institute and the California Seismic Safety Commission, as useful sources of assistance after BAREPP and professional associations. Several respondents noted that some coordination difficulties among city agencies are outside the ability of NEHRP to address. Individual agencies have their own budgets and priorities that limit the setting of cross-cutting mitigation policies and even impede the sharing of information. Finally, some state agencies were noted as helpful in implementating mitigation measures: the Tennessee Emergency Management Agency, the Idaho Bureau of Disaster Services, Memphis State University, and the Department of Oregon Geology and Mineral Services. State agencies, however, were perceived by some as the source of regulations to be enforced at the local level, rather than sources of technical assistance.

An Oregon building official noted, "The City carries the ball with respect to building code enforcement and interpretation. State agencies are more in tune with checking plans for small cities without building departments." A Washington building official declared, "State agencies are a waste of money." Discussion in a Memphis focus group brought out that a study by the Center for Earthquake Research and Information (CERI) determined that an average of two out of three local building code officials in the Central United States were not aware that they were in a code adoption region; furthermore, very few thought that seismic provisions would play a prominent role in future code adoption and enforcement activities.

Recommendation: Regional consortia, defined as organizations linked by common goals of risk reduction (e.g., CUSEC, NESEC), can serve as brokers to bring together key local practitioners (e.g., design, construction, and code enforcement officials) and technical experts from throughout a state or region. Regional centers can involve key user groups through jointly sponsored and designed symposia and workshops to expand constituencies, reach a broad audience, and ultimately change hazard management practice. The involvement of professional associations and other locally focused groups, technically experienced staff (planners, earth scientists, and engineers), and a focus on preparedness and mitigation at the local level make regional centers an attractive vehicle for achieving the type of coordination and regional capability cited as important by respondents. The effectiveness of regional centers to foster mitigation should be assessed in greater detail than is possible in this report. The success of individual state programs in fostering implementation at the local level should be reviewed to identify the elements contributing to success.

Finding 6.7

> **Training and education programs to foster implementation must acknowledge differences in local implementation feasibility, the delivery needs of intended users, and levels of authority and responsibility. Ongoing programs delivered by locally credible sources are needed to support implementation.**

Discussion: A general feeling is that significant progress has been made during the past decade in education programs that focus on awareness of the hazard and basic response planning (particularly for schools). To a lesser extent, education programs have made some progress on the implementation of mitigation measures. (See Section 8 for evaluation of the effectiveness of the FEMA course on the mitigation of nonstructural earthquake hazards in health care facilities.) Concerns identified by respondents and in studies (May, 1989) center on the irregular delivery of NEHRP training and education programs, the tendency for participants to be from larger and more capable jurisdictions, the lack of attention to the local implementation context, the lack of follow-up evaluation of effectiveness to achieve mitigation, and the sometimes indirect attempt to influence those with the authority to implement mitigation measures, as in, for example, the development of seismic design handbooks and workshops for engineers without programs to address the training and education needs of the building officials responsible for negotiating and/or enforcing final design requirements. Another example is the development of materials on the reduction of earthquake hazards in schools for teachers without addressing the needs of school facility departments. (In many states, union laws and liability issues prohibit anyone but school facilities from anchoring book shelves to walls.)

One Washington building official said, "I never knew I was an 'intended' target for NEHRP materials." Another had concern for national vs local programs.

> I'm apprehensive about national programs. A state program would be more appropriate - tailored to local needs and delivered by individuals like [the President of the Washington State Structural Engineers Association who is also a building official from a large jurisdiction] that are recognized as credible at the local level.

A California building official opined,

> [We] need a training course for building departments on enforcing seismic regulations delivered across the United States like the California state training course for building officials developed by CALBO [California Building Officials] and the California Seismic Safety Commission.

An Oregon planner noted that it's

> hard to convince public officials to act on information based on dissimilar communities or groups. [Implementation of mitigation measures] is a local community issue not a state issue. Have the administrative ability to apply. Need localized information.

Another interviewee noted that the federal government does not understand how school districts work in the sense of reduction of exposure to seismic problems. "It is a terribly complex responsibility to schools. Earthquakes are probably not the greatest hazard schools face."

Recommendation: NEHRP agencies and intermediaries or transfer points (e.g., NEHRP-funded state earthquake programs, consortia, professional associations) should place greater emphasis on training and education programs that address implementation of risk reduction programs tailored to intended users' requirements and implementation context. The following examples were provided by interviewees: (1) hands-on technical training; (2) delivery of NEHRP publications through information application workshops; and (3) presentation of case studies of successful application, with emphasis on the mechanics or process of implementation, not engineering details. Training and education should be offered as part of the continuing education programs of intended users' professional associations. Consideration of smaller, less capable jurisdictions needs to be incorporated into the delivery system.

Table 6.1. Results of interviews completed in 13 U.S. cities.

Pacific Northwest

Questions	Salem/OR Planning	Seattle/WA Planning	Portland/OR Planning	Seattle/WA Hospital			
1. How long in present position? How long in related work? What is your education/training?	16 yrs; 24 yrs; Masters City Planning (Georgia Tech) B.S. Oklahoma; Planning Adminstrator	11;22;Master planning; Senior Planner	1; 1; Phd Urban Regional Planning: Emerg. Mang. Program Co-ordinator (9 yrs as a planner)	6yrs; 20yrs; B.S. E.E. Industry training health care/safety; Safety Director Facilities (2/5 yrs ago)			
2. What percentage of your total position responsibilities concerns the activities related to earthquake hazard mitigation?	1%; Safety committee	30-50% (because of USGS grant)	> 50%	5% - 10% now, 50% 2-3 years ago			
3. What specifically is your role?	On Emerg. Prep. Team	Coordinate interdept. mitigation prog.; share info; devel. priorities: balance expenditures (bridge vs. bldg) hard to priorities across depts.; 90% of Comp. Plan part of GMA req.; Focus has been internal pri.; no dept. emerg. plans	Emergency Management Program Coordinator: METRO (Regional Gov't: 4 counties Multnomah; Clackamas, Washington, Columbia))	Mitigation Coord. Official liaison to emerg mgt EOC operates.; Training specialist, S. area Hospital Council tour for CEO's, All Hospital Facilit Mgr duties but does not devl. mit. plan, struct. invent. or dev. seis. design.,			
4. In general, where do your other responsibilities come from?	Devel. land use plan, maintenance, implementation through zoning codes; detailed plans parks, water, sewer, traffic, trans; administration	Environmental planning section (critical areas, water quality, open space); some comprehensive plan)	Entire goal = reduce risk; non-mitigation activities include education, response & recovery planning	Facilites Planning, Construction Safety			
5. What are the major reasons why your department gives attention to earthquake hazards reduction?	Recognition from eq in March (Scott Mills) of eq potential; Emerg. prep. com. aware of potential problem;	NEHRP grant extends City involv. beyond critical areas req. by Growth Mang. Act: allow coor. of city agencies.	Mainly to manage growth (#1 function of agency is regional growth management); co-op. effort	Prev exp in CA, Looking for different model to assemb disaster plan; Requests by emergency manager; Federal agency programs-FEMA Training program, FEMA regional prog, Invitiation to come.			

Table 6.1 (cont.)

Pacific Northwest

Questions	Salem/OR Planning	Seattle/WA Planning	Portland/OR Planning	Seattle/WA Hospital			
6. What mitigation techniques have been used by your department to reduce future earthquake hazards?	Avoid steep areas; urban growth boundaries; removed an area from urban growth boundary because of slip haz.; have open space tax benefit prog. not now oriented to eqs	Critical areas info. & disclosure; acq. lands for open space; urban villages takes landslides into account;inventory and seis. analysis of city bldgs; looking at benefit-cost model; downzone steep slope areas; $ sm wetlands used to build replacements	UBC + amend; Zone 4 for METRO bldg renovation.; CAP next budget yr; use NEHRP studies for landuse mitigation program	UBC State adoption, Adope seis. resis. bldg standards(only UBC), NS EQ haz mit for bldg. Struc. vuln. inventory, NS vuln. inventory; Critical-tertiary care hospital patients can't be taken care of anywhere else; Personnel EQ haz info. program.			
7. Of the mitigation techniques in question 6, what special problems do you have with respect to their implementation?	Lack data to define areas of potential hazard; If info. not localized, hard to move elected officials; must be localized to make regulations	Long term time frame, short-term benefit; Overload on bond issues (set priorities); Lack of retrofit guidelines; don't want proscriptive info, more factors to consider; Good support today from City Council;	No special problems so far. If regional body dealing w/policy & tech. issues, should reduce risk Foresee financing as prob. Need financial incentives; Legal issues. Getting all local govts to build to plan hard(fin. impact; scare away devel.)	Restriced by city ord. major mitigation must comply in terms of building, eg. height restrictve 10hr monitor, can't add new bldg. until master plan complete, city planning contraints			
8. What kinds of information or activities and which of the NEHRP agencies has helped you carry out earthquake hazard mitigation activities?	Won't attend workshops, classes etc. until info specific to area	Summaries of Seismic Conditions in PNW, helpful (obtained from Weaver USGS); own contacts w/USGS(Tar & King); workshops main source of pubs.; obtained Shannon & Wilson USGS liq. study from Water Dept. not USGS	Eval. Study of NEHRP Program: Mitigation should be focus of emerg. mang. prog; FEMA yellow books; Damage & loss Assessments for bldgs & lifelines;FEMA grant train-the-trainer publs: Handbk Public Ed. to train voln. (used info)	Guidebooks Chem Hospital Review, NEHRP, Basic HO Class Train then train hospital course ; EMI Comm. Emerg. Class using what FEMA publishes; Attend some workshops put on by AE firms (Dames & Moore)			

Table 6.1 (cont.)

Pacific Northwest

Questions	Salem/OR Planning	Seattle/WA Planning	Portland/OR Planning	Seattle/WA Hospital			
9. How did the NEHRP information or activity listed in question 8, help you carry out earthquake hazard mitigation activities?	poorly; not at all; some help to define hazard, but not local enough	Info to define hazard, aware; haven't seen mitigation techniques applicable to planning	Info to define haz (bldg. vuln studies somewhat); on agenda;awareness; impacts; co-or among jurisdictions	All items on item 10 (on quest. frm) Still feel thinking provides more advanced than most. looked at it more from function standpoint than facilities, performance goals			
10. In what ways could the NEHRP agencies/program help you to better carry out earthquake loss reduction activities?	1) state the problem 2) outline what to do about it	How hazard info translates into new codes; What is appropriate regulatory response; Better job of distributing info (now word of mouth); Now involved w/FEMA, NIST, NSF; USGS shy about mitigation, implementation; few funds; What do we do with the data?	Information and funding	Preventative:slides course nor current, publications with concepts need to be current, further publications outdated; connect with financial portions to work in paper work for recov.; All ignorant of what to do afterward, need 1mil/day to stay in business,			
11. What state agencies do you most rely on to help you develop/carry out earthquake loss reduction activities?	Don't know personally; not a lot of communication w/state; some data on gravel resources from State Geol. Survey	DNR-DGER (State Geol. Surv.); Representative Bldg. Code Council; Some contact State Emerg. Planning; State Wildlife Dept. very helpful; sends out info. Nothing on Geol. Haz. sent out; no outreach	DOGAMI (St. Geol. Sur.) for mitigation; Emerg. Management initially got METRO interested (State retreat w/Myra Lee), but not on mitigation; University to some extent (Un. of O. to do inventory Portland bldgs)	In general: Fire Dept, Chemical repair capability common and constant expertise often go to for information			

Table 6.1 (cont.)

Pacific Northwest

Questions	Salem/OR Planning	Seattle/WA Planning	Portland/OR Planning	Seattle/WA Hospital			
12. What professional associations do you most rely on to help you develop/carry out your earthquake hazard mitigation responsibilities?	no answer	Amer. Planning Assoc. (don't do much with them; some brown bags, newsletter) More contact between jurisdictions; GMA County-wide groups	EERI very helpful	No; FEMA courses region X National Hazard Specialist; Dev of Emerg Mgt, Sytare geologic Survey, or Univ-NO, Joint Comm-EQ not specifically in requirements mostly struct, Prov. legetinary to planning effort, Require bldg structure			
13 What professional associations do you most rely on to help you develop/carry out your other (non earthquake hazard) responsibilities?	APA; American Institute Certified Planners (AICP); publications regularly (every 2 months); State Assoc APA newsletter	none	Amer. Planning Association				
14 What professional association or other groups do you most rely on to provide training, education, and technical assistance in your field?	same	none	same				
15. As you reflect on your ability to perform your earthquake loss reduction activities, what factors and forces help you get the job done? Why are they helpful?	1) Earthquakes - especially localized in the Valley; 2) specific info. on the area	#1 = NEHRP (USGS) Grant - gives presence in planning dept. City would support attendance at annual eq. haz. workshops, useful; City Council Support	Co-operative attitude; co-ordination skills; training as a regional planner (have the big picture)	•			
16. Which of these helpful factors can you attribute directly to NEHRP, including any of the four principal agencies responsible for elements of the program?	Not applicable	USGS money and data; remains to be seen if significant change in devel of haz. policy; has become focus for city & improved inter. dept co ord.	None at this time				

Table 6.1 (cont.)

Pacific Northwest

Questions	Salem/OR Planning	Seattle/WA Planning	Portland/OR Planning	Seattle/WA Hospital			
17. As you reflect on your ability to perform your earthquake responsibilities, what factors are barriers to you? Why?	Lack of earthquakes; lack of info; uncertainty	Lack of direction from above; City Council members interested & Mayor concerned, but no focus; Public awareness more important for regulatory actions (need support then)	Main barrier = financial; w/o cannot hire extra people to help do work well and fast; Plan now for eq tomorrow; could have event at any time; also need incentives and experience				
18. Of these barriers, which do you attribute directly to the NEHRP or any of the four agencies responsible for element of the national earthquake hazard reduction program?	Lack of localized information on the nature of the hazard	1) Information distribution - lack of outreach, except for workshops; true for most haz. info. must seek out; 2) Examples of transfer of haz. info to planning actions	Information access: ex. vuln. study, estimation of damage, look at bldgs come up w/ % relative to survival; can't find out how to relate bldg type to haz. info; how to tie to hazard data; how to relate info. to different types of haz.				
19. If you could, what would you do to lessen or remove these barriers?	If info is there, then put to use; What is the info scale: e.g. how old a fault? Planning a priority on haz. on potential for impact; how concerned or responsive should we be?	To improve city direction, need champion in Mayor's Office	Provide info needs, funding; Focus on haz. i.d. & mitigation. Sponsor studies to define resp actions w/eq. Prepare for eq vs storm; How to access info that is avail: categorize info into different phases of emerg. manag (resp. mitig. reco. prep) Multihaz				

Table 6.1 (cont.)

Pacific Northwest

Questions	Salem/OR Planning	Seattle/WA Planning	Portland/OR Planning	Seattle/WA Hospital			
20. How do you find out about and obtain the results of research of interest to you?	Usually to to national APA, give subject, provide everything they have; PAS member	Workshops, gen'l USGS pubs; contacts wUSGS people; USGS grant (contacted by consultant to apply); Would like to know more about what's going on	Word of mouth; don't think they (NEHRP) have computer line; use groups and associations more				
21. What makes it easiest for you to use research results in your present position?	in area of interest; localized; level of comfort; local community issues not state; administrative ability to apply	Access; hard to get information out of usgs; charging for publications that are then billed to grants	access				
22 What makes it difficult for you to use research results in your present position?	hard to convince public officials to act based on dissimilar community or group	Ramifications not easily understood; what does the haz. info mean to us	Lack of Access: Mail out current , updated list of publications to emerg. planners and all state agencies; encourage wide distribution				
23. What are some subjects on which you need more knowledge that should start being addressed by researchers now so you have the results in the next three to five years?	How do you sell the problem to politicians; political decision making; how to handle infrequent events	magnitude, recurrence interval, freq, attentuation of 3 source zone types; better understanding of crustal eqs. How we deal w/major, infrequent eqs? What's appropriate action	1) Damage correlated to hazards; 2)Mitigation tools: model land use ordinances, retrofit guidelines; legal tools that have incentives built in				

Table 6.1 (cont.)

Pacific Northwest

Questions	Salem/OR Planning	Seattle/WA Planning	Portland/OR Planning	Seattle/WA Hospital			
24. In the next five years, what should be emphasized more strongly?	Influencing political decision making	Translation into codes, regulations, mitigation measures	Emphasis on mitigation & prep. example: recent emphasis on mitigation still feel neglecting prep. e.g. relative to vuln. i.e. response issues such as are roads wide enough to access areas; self-eval of program; effective public education				
25. In the next five years, what should be continued about as is?	no answer		Continue to have 4 agencies work together; not break-up				
26. In the next five years, what should receive less emphasis or be terminated?	no answer		Military preparedness				
27. Do you have any concluding thoughts?	When presenting data, need digitized data for input to system not just hard copy; e.g. census data; scale 1:24,000 ok	Need more effort to involve local government; What does FEMA do?	Have regional wrkshps broad in scope; try to define diff. types of eq. planning activities as related to 4 phases of emerg. manag. relate eq planning to each of 4 phases; soc. sci. need to work w/sci. &eng.; planners can give fresh approach				

Table 6.1 (cont.)

California

Questions	Palo Alto/CA Anonymous Building	Palo Alto/CA Anonymous School	Palo Alto/CA Anonymous Building			
1. How long in present position? How long in related work? What is your education/training?	5yrs; 5yrs; Engineering Degree	5yrs; Non-Engineering Business Degree	15yrs; 21yrs; engineering			
2. What percentage of your total position responsibilities concerns the activities related to earthquake hazard mitigation?	Hard to separate	20% on emergency preparation overall; a few years ago % was higher to beef up after 1989 earthquake.	0'20%			
3. What specifically is your role?	All Hospital Facility Manager duties	All School Facility Manager duties	All Building Department duties/ Building Official			
4. In general, where do your other responsibilities come from?	Unclear question - Don't know		Building Department Operations			
5. What are the major reasons why your department gives attention to earthquake hazards reduction?	Past disaster/hazard damages (originally 1971 EQ motivated origination of program); Federal agency programs, Federal agency technical assistance- VA has its own seismic program apart from and predating NEHRP;	Executive Influence, School board has put $200,000 into EQ hazard reduction since 1989. Approx $50,000 from 1980-1989; Past disaster damages; BAREPP publications	Past disaster damages; Prof. Train.; State mandates; State agency prog - SB 547 law on haz bldgs, Alquist-Priolo fault zones; Spacial Reg Prog - BAREPP; Personal interest			

Table 6.1 (cont.)

California

Questions	Palo Alto/CA Anonymous Building	Palo Alto/CA Anonymous School	Palo Alto/CA Anonymous Building			
6. What mitigation techniques have been used by your department to reduce future earthquake hazards?	Adoption of building code - VA H8-08 Handbook; Adoption of special seismic resistant bldg standards; Structural retrofit of existing bldg; NS EQ hazard mitigation for bldgs; Structural vulnerability inventory; NS vulnerability inventory	Adoption of bldg code, state field act; Adoption of special seismic resistant bldg standards, NS; Struc. retrofit of exist bldgs, field act; NS EQ hazard mitigation for bldgs, Struc. vulnerability inventory, filed act; NS vulnerability inventory	Adopt of bldg cd - 1991 UBC; Adopt of spec. seismic resist. bldg standards (triggered seismic ceiling upgradefor any commercial remodel); Struc. retrofit of exist city bldg(1 8-story, 3-4 lg comm. ctr); Struc. vuln. Inv.All city owned			
7. Of the mitigation techniques in question 7, what special problems do you have with respect to their implementation?	No particular problems	No special problems. Much also accopmlished.	Seismic upgrades too often trigger sprinklers, handicapped, etc. & it's too costly. Need incentives for voluntary upgrade.			
8. What kinds of information or activities and which of the NEHRP agencies has helped you carry out earthquake hazard mitigation activities?	Nothing directly. Everything comes from the VA's internal hospital seismic safety program, which pre-dates NEHRP.	NS Guide of BAREPP & OSA; San Jose State Univ Schools Seminar, 1992; Tremor Troops Workbook; BAREPP , EQ Preparedness for Schools; FEMA schools & EQ's Guidebook, district made implementation video, (See verblage)	FEMA Yellow Books, FEMA funded ATC reports, CA OES Post EQ Training Partly paid for by FEMA; NEHRP-worked on several projects. (see verblage)			

Table 6.1 (cont.)

California

Questions	Palo Alto/CA Anonymous Building	Palo Alto/CA Anonymous School	Palo Alto/CA Anonymous Building			
9. How did the NEHRP information or activity listed in question 9, help you carry out earthquake hazard mitigation activities?	N.A.	Prov. info to define hazard; Prov. detld hazard mit. tech; Supported devel. of haz mit. policies; Helped get mit. on the agenda; Prov. info to prepare mit. plans; Made us aware of EQ haz. in community; Made us aware of possible impacts of EQ on our facilities	All items in item 10. Mitigation to agenda - city haz. bldg. ord. preceded state's; had to narrow down list of hazardous builidngs, used EERI publication's reports on EQ's.			
10. In what ways could the NEHRP agencies/program help you to better carry out earthquake loss reduction activities?	VA already has what is needed.	No, just need to know these material exist. BAREPP served that function. Need an index of resources, easy to order, has to be broken down (schools need to know if video is for teachers, students, etc.)	Do mass mailings to building departments.			
11. What state agencies do you most rely on to help you develop/carry out earthquake loss reduction activities?	We don't rely on state. Occasional useful info. from state office of Statewide Health Planning and Development (Technical, Engineering, Code Info); Div of Emerg Mgt - No; Dept of Ed Assist - No; Joint Commission assist - No	Office of State Architect, Office of Emergency Services - Very Helpful; We do use reports from Div. of Emerg Mgnt, State Geologic Survey, & Univ.; St. Dept of Ed developed task force suggestions.; Joint Commission assist - N.A.	CA Seismic Safety Commission, CA Office of Emergency Services; Interact with Div of Emerg. Mgnt., and informal contact with Stanfors. State dept of Ed - No assist; Joint Commission assist - No			

Table 6.1 (cont.)

California

Questions	Palo Alto/CA Anonymous Building	Palo Alto/CA Anonymous School	Palo Alto/CA Anonymous Building			
12. What professional associations do you most rely on to help you develop/carry out your earthquake hazard mitigation responsibilities?	Professional associations aren't relied on at all.	CADRE(Santa Clara County), Community Agency Disaster Relief Effort, coordinates schools, non-profits, etc, with related problems and resources. Info comes from BAREPP, not prof. assoc. Outreach to poorer school districts, with business sponsors.	EERI, ATC, ICBO, CALBO(CA Bldg Officials), SEAOC			
13. What professional associations do you most rely on to help you develop/carry out your other (non earthquake hazard) responsibilities?	Professional associations aren't relied on at all.	Few or none	Underwriters Labs, International Associates of Elect. Inspectors, International Association of Plumbing & Mech. Officials (IAPMO), ICBO			
14. What professional association or other groups do you most rely on to provide training, education, and technical assistance in your field?	Professional associations aren't relied on at all.	Few or None	Same			
15. As you reflect on your ability to perform your earthquake loss reduction activities, what factors and forces help you get the job done? Why are they helpful?	The fact VA has a strong (mandatory) and comprehensive (new and existing buildings, utilities, and nonstructural) program.	Cooperation - Board of Ed., Parents' concerns, Teachers, Local Agencies, has to be cooperative. 1989 EQ helped boost efforts.	Supportive political leaders who passed haz bldg ord. even with prop. owner resistance. Adequate funding for train. plan checkers * Inspectors. City Mgt sees seismic as important function for bldg dept.			

Table 6.1 (cont.)

California

Questions	Palo Alto/CA Anonymous Building	Palo Alto/CA Anonymous School	Palo Alto/CA Anonymous Building			
16. Which of these helpful factors can you attribute directly to NEHRP, including any of the four principal agencies responsible for elements of the program?	None	None	None, Indirectly, Yes - See #8			
17. As you reflect on your ability to perform your earthquake responsibilities, what factors are barriers to you? Why?	None	No real significant barriers. Have done everything up to 100% self-sufficiency (no doctors on school district staff etc.)	Same as 15; Political bodies are supportive to a point but not beyond mandatory, house seismic rehabilitation upon sale not approved. Lack of budget.			
18. Of these barriers, which do you attribute directly to the NEHRP or any of the four agencies responsible for element of the national earthquake hazard reduction program?	N.A.	N.A.	None			
19. If you could, what would you do to lessen or remove these barriers?	N.A	N.A	Educate leaders			
20. How do you find out about and obtain the results of research of interest to you?	N.A.	BAREPP, OSA	EERI Newsletter & Spectra, NCEER Newsletter			
21. What makes it easiest for you to use research results in your present position?	N.A.	Practical Innfo. usable	Question doesn't make sense			
22. What makes it difficult for you to use research results in your present position?	N.A.		Lack of time			

Table 6.1 (cont.)

California

Questions	Palo Alto/CA Anonymous Building	Palo Alto/CA Anonymous School	Palo Alto/CA Anonymous Building			
23. What are some subjects on which you need more knowledge that should start being addressed by researchers now so you have the results in the next three to five years?	No suggestions	Have spent a lot of time researching food/water storage - need practical guidelines; Need spec's on cargo containers for storage of supplies (temp. Etc); FEMA should develop tight spec's/guidelines for supplies & storage.	Cost effective methods & tech. to encourage private sector strengthening of existing bldgs. Must be a simpler way to upgrade URM to life safety level.			
24. In the next five years, what should be emphasized more strongly?	No suggestions	Nothing in particular needs to be done locally, there's already enough info.	Move toward one national code means NEHRP provisions more important. See 23. NEHRP provisions should be written in code enforcement format. (see verblage)			
25. In the next five years, what should be continued about as is?	No suggestions		...			
26. In the next five years, what should receive less emphasis or be terminated?	No suggestions		...			
27. Do you have any concluding thoughts?	The VA set up an effective EQ hazard program prior to and with separate funding from NEHRP. VA Hospitals get what they need from the VA directly. Most of the actual EQ hazard reduction going on in the US occurs outsite NEHRP and not because of it.	Received the questionnaire in advance &" tried to go through it, but it's too long.	Stop studying prob. & start solving them. We need more info on how to retrofit URM's. Need incen. for priv. sector to seis. rehab. , Public Outreach: PBS - type program like "This Old House"			

Table 6.1 (cont.)

Pacific Northwest

Questions	Seattle/WA Buildings	Everett/WA Buildings	Salem/OR Buildings	Portland/OR Buildings	Portland/OR Schools	Everett/WA Schools	Salem/OR Schools
1. How long in present position? How long in related work? What is your education/training?	3 yrs; 17 yrs; BS & MS Civil Engineering; Licence: Civil & Structural;Bldg. Official	5.5yrs;24 yrs; B.A. Economics; Building Official	10 yrs; 10yrs; MS, PHD Counseling Psychology; Bldg. Official	6 yrs; 20 yrs; Chief Engineer	4 yrs; 24 yrs; Civil Engineering; Director: Physical Plant Division	3.5 yrs; 14 yrs; architecture deg.; worked construction; Co-ordinator of Construction	13 yrs; 25 yrs; architect; Coordinator Planning and Construction
2. What percentage of your total position responsibilities concerns the activities related to earthquake hazard mitigation?	10%	1%	3% (could be 25% for a plans examiner)	35-40%; perhaps 50% (change in state code to zone 3 + earthquake)	10% (integrated approach; upgrade & improve as opportunity allows)	~1%	1%
3. What specifically is your role?	Regulations, local and national code devel; enforce building retrofit; plan review; dept's response to earthquakes; focus on next 100 yrs, not 10-20yrs	Coordinate Staff	Administrator	Balance practical w/achievable; political; variety: coord. existing bldg. mitigation; train/outreach specialist; tech. advisor	Work w/ea school on annual exercise; state req. emerg. instruct./ Educational specifications;coordination of facilities construction program	Coordinate retrofit projects; new construction	Planning; prepare plans to provide enough & appropriate space to carry out education; Construction: new facilities and renovation
4. In general, where do your other responsibilities come from?	Administration; non-seismic code issues	Administration bldg. dept.; State bldg. code	Bldgs, licensing, admin, nuisance, airport superintendent	Admin. personnel management; Non seismic regs; code interpretation	General Facilities Management;bldg. maint., ops, reno.; environ. services (e.g. asbestos); manage all outside contracts	Administration; capital projects; construction and modernization program	Contracted services for construction issues e.g. if re-inforce parapet walls; if state mandates retrofit, would have to do
5. What are the major reasons why your department gives attention to earthquake hazards reduction?		Responsibility to assure safe bldgs = #1; Past disaster, damage to others, influence prof. assoc., code, FEMA training (DSR's); minimal citizen influence; influence of Seattle Bldg. Dept., SEAW	liability; potential damage to community; code	main reason = state Bldg. Code	"Spring Break Quake" #1; City Task Force; no citizen infl before qk.; teachers union; influence prof. training/info got us moving to begin with; DOGAMI outreach	#1 = conformance to UBC (new constrc); No defined level of upgrade mandated, follow recommenations of consulting engineers and architects;	Provide safe facilities for students

Table 6.1 (cont.)

Pacific Northwest

Questions	Seattle/WA Buildings	Everett/WA Buildings	Salem/OR Buildings	Portland/OR Buildings	Portland/OR Schools	Everett/WA Schools	Salem/OR Schools
6. What mitigation techniques have been used by your department to reduce future earthquake hazards?	Local building Code(seismic prov. 1942); adopt UBC code & amend; negotiate retrofit requirements; beyond state code, more effective, clearer; spec. inspect. prog.	UBC&St.Amend.;some retrofit (dispatch); seismic not in CAP;location w/r bluffs	UBC & OR amend; vuln. study if grd. failure probs; CAP no seismic; yes on reuse; no public info prog. some internal memos, , haz. mitigation edu. for developer/builders	UBC 91w/state amend; retrofit of some city bldgs (not mandated); remodel; unwritten mitigation policy; some public info, personnel handouts	UBC (State Req.); struct. vuln. inventory; nonstruct. on-going; some nonstruct. mitigation; bldg. replacement	UBC; retrofit of school bldgs; each school has emerg. plan; $ for seismic upgrades in facility plan	UBC; retrofit. when remodel: taget of opportunities; then would do; actually do very little; seis.safety not consid. in replacement; some parent info; not direct. in Fac. Plan
7. Of the mitigation techniques in question 6, what special problems do you have with respect to their implementation?	Lack of retrofit standards; money	Level awareness; lack of experience to handle seismic issues; no formalized mitigation plan; no upgrade policy	Overriding problem = resources & time; treated better by city council than any bldg. official in state. But can't keep up; never caught up; additional requirements pile up (ADA, energy, seis) put out fires only	Lack of code dealing specifically w/existing buildings; resources: personnel & money	Funding. Integrated approach allows consideration of not doing upgrade because doesn't effect enough of bldg.	1)Funding to do work; 2) For new bldg. requirements clear, for modernization requirements unclear	Political process; 1) fiscal problems 2) Competition w/other district needs; retrofit a negotiated process
8. What kinds of information or activities and which of the NEHRP agencies has helped you carry out earthquake hazard mitigation activities?	FEMA (178/ATC-22)biggest impact; Influence on local practice; Seattle code not proscriptive	FEMA(DSR); no info	very little; Seattle UW workshop; Univ. of Or. workshop; Or. Bldg. Officials (ATC-20)	USGS probabilities, research in area; FEMA yellow books; FEMA & USGS workshops; haz. info (USGS); indirectly benefit from grants	EMI Nonstruc. Mit. for schools (info too easy); DOGAMI; NSF contractor contact (Haddis); received some info on hazard	None; Started work here 3 1/2 yrs ago, struct. eng. eval. of facilities; now required to implement those repairs; New = code; old = whatever can do/haven't heard of any NEHRP info	"About three years ago someone sent me something. Not useful". Inlfuence on bldg. codes helpful; impacts of eqs. on school fac.; info may go to risk management?
9. How did the NEHRP information or activity listed in question 8, help you carry out earthquake hazard mitigation activities?	Incr. number of priv't prof.use FEMA 178 & present it as the methodology to use in a retrofit; gives an approach for design professional; use of 65-75% UBC forces	Info to define haz.; detailed planning info, not mitigation; raised consciousness	None; can't think of any	most listed; not passage of haz. mitigation regs yet	Defined haz.; Internal mitig. policies;; awareness; no detailed mitigation techniques; some inc. coordination; no regs. passed	NA	Not at all

Table 6.1 (cont.)

Pacific Northwest

Questions	Seattle/WA Buildings	Everett/WA Buildings	Salem/OR Buildings	Portland/OR Buildings	Portland/OR Schools	Everett/WA Schools	Salem/OR Schools
10. In what ways could the NEHRP agencies/program help you to better carry out earthquake loss reduction activities?	publications & methodologies on exiting buildings (e.g. houses); relate info to applications; target Building Officials; practical education	Support on-going education by State professional associations; help get policy makers attention (Mayor doesn't even know my name)	Provide more resources (time & money)	Make it easier to obtain information like FEMA yellow books	Info & workshops; effort by local agencies after quake (Scott Mills); DOGAMI (Ian Madin); Provided assurance "Not dumping money down a rathole"	Only thing that helps is having enough money and having qualified structural engineers; clear code requirements	Financial support and information support
11. What state agencies do you most rely on to help you develop/carry out earthquake loss reduction activities?	No State agencies assist us with Seismic Mitigation; some contact Emerg. Mang. on post-eq response	none; waste of money	State Bldg. Code Agency promulgates the code; don't help, horrendous; some contact w/DOGAMI	None; City carries the ball w/r to bldg. code enforcement & interpretation; few good people at state; more in tune with checking plans for small cities w/o bldg. depts. Some contact w/DOGAMI & Univ.	DOGAMI/no mitigation interaction w/state emerg. management; local task force/Dept. Education has state drill req. Little how-to guidance	Some money from SPI (State Dept. Ed.); haven't funded specifically seismic issues; full modernization; no contact emerg. management	Building Codes Agency; do interaction w/State Emerg. Manage. w/respect mitigation; district may;
12 What professional associations do you most rely on to help you develop/carry out your earthquake hazard mitigation responsibilities?	WABO, ICBO, SEAW	Asso. w/statewide prof. org (WABO);excellent; some info & inspiration ICBO;SEAW	Oregon Building Officials;everyone intersects w/bldg. officials; 99%	Struc. Eng. Asso.Or., SEOC, EERI	Association of Physical Plant Administrators; Council of Educational Facility Planners	Architects and Engineering Assoa: WABO, AIA	Contracted services - consultants
13. What professional associations do you most rely on to help you develop/carry out your other (non earthquake hazard) responsibilities?	same	WABO admin/code enforcement; Oreg. Bldg. Officials	same; 1% much lesser extent Architects & Engineers (SEOW)	ACI, masonry society; AISC; workshops, seminars; some pubs	above + ASCE some	None	Council of Educational Facilities Planners; probably reaches most large districts (>30,000 students)
14. What professional association or other groups do you most rely on to provide training, education, and technical assistance in your field?	WABO, ICBO, SEAW	same	Oregon Building Officials	Oregon Building Officials	same		same

Table 6.1 (cont.)

Pacific Northwest

Questions	Seattle/WA Buildings	Everett/WA Buildings	Salem/OR Buildings	Portland/OR Buildings	Portland/OR Schools	Everett/WA Schools	Salem/OR Schools
15. As you reflect on your ability to perform your earthquake loss reduction activities, what factors and forces help you get the job done? Why are they helpful?	Eqs elsewhere; publ. available to help private design firms; length of time that Seattle has had. retrofit requirements (becomes normal)	Statewide prof. associations. WABO excellent; some info & inspiration from ICBO	Having an earthquake ("Designer Eq"); Attitudinal changes; upgrading state law	Contact w/other profn'ls, geotech, geol; exchange of info on personal level; broader view of prob. better understanding; realization not just one wacko thinks there's a problem	Information and education; having a "designer" earthquake	Only thing that helps is having enough money and having qualified structural engineers; clear code requirements	Structural engineers (contracted services)
16. Which of these helpful factors can you attribute directly to NEHRP, including any of the four principal agencies responsible for elements of the program?	FEMA publications (178)	none	none	workshops, meetings	Info and workshops; effort by local agnecies	none	none
17. As you reflect on your ability to perform your earthquake responsibilities, what factors are barriers to you? Why?	Funding; lack of on-going training (contractors, eng., & bldg. officials), enforcement; lack of retrofit standards;	Budget, awareness of decision makers (so far off, hard to make priority)	lack of resources & time; development community (bigger is better; all standards = impediment to progress)	Resources:personnel & $; overcoming political barriers (haven't pushed hard);difficulty obtaining NEHRP documents	Cost, budgeting process need to go through relative to annual plan; needs significant planning	Lack of money and lack of standards	1) cost 2) competition with other priorities
18. Of these barriers, which do you attribute directly to the NEHRP or any of the four agencies responsible for element of the national earthquake hazard reduction program?	Workshops on earthquake hazards "interesting", but not applicable to policy or practice; information access & availability	More continuing education on regular basis vs. only after eqs. like water conserv., fire safety: beat on constantly	Not the problem	Difficulty in obtaining NEHRP documents	None; What they have told us to do is expensive; Not many options though w/r to student safety	Unaware of NEHRP so not seen as a barrier	none (not familiar with NEHRP program)
19. If you could, what would you do to lessen or remove these barriers?	Relate materials more to applications; disseminate (sell) mat'ls to building officials	Apprehensive about national programs; State program more appropriate: tailored; remove logistics & $ probs.; use guys like Kinsman,more credible	What's new; What are we learning; Is it real to plan; Use prof. assoc. to deliver & disseminate info	Make information (research, papers, etc.) more accessible; improve dessimnation systems	Not applicable; money not NEHRP is major barrier	Not in my control; state or ICBO must establish seismic requirements	1) passage of capital improvement bond 2) Make State or Federal funds available

Table 6.1 (cont.)

Pacific Northwest

Questions	Seattle/WA Buildings	Everett/WA Buildings	Salem/OR Buildings	Portland/OR Buildings	Portland/OR Schools	Everett/WA Schools	Salem/OR Schools
20. How do you find out about and obtain the results of research of interest to you?	Workshops, word of mouth	Only know about if shows up in mail; copies of studies of seismic activity (unknown source)	Through Oreg. Bldg. Offic. Assoc.; by monthly; occasionally state bldg. code agency (mini-mags)	Flyers; newsletters from prof. organizations	Usually when its ancient history; some APPA periodicals tough on some research; no direct conduit	Not involved	Most districts don't have specialists; Give big book of technical stuff to the engineers; we hire specialists who have impact on ed. program
21. What makes it easiest for you to use research results in your present position?	Make information better related to applications	Translate into more readable format; some out of city of San. Fran. = practical & applicable	Pragmatic, realistic; God spare me from the theorist	Must be comprehensible; usually ok; some journal material difficult	Tried & true; not on leading edge; not into experimentation	Not involved	Facilities planners = coordinators; need overview of issues; hot approach problem; how to take on; how to find technically qualified consultants
22. What makes it difficult for you to use research results in your present position?	Can't tie info directly to daily work	esoteric	No applicability; no specific examples	Access; not directly applicable; Interesting but not applied to own situation	Risk related to trying research results; public funds; k-12 applications	Not involved	Too technically detailed; too long & cumbersome presentation
23. What are some subject on which you need more knowledge that should start being addressed by researchers now so you have the results in the next three to five years?	Info/methodologies for retrofitting existing bldgs (esp. houses)	Practical ways to implement disaster plan; tips on how to see it to decision makers; help in the sale; family vs public responsibilities	Nationwide list of mitigation priorities, steps, manuals & tools; how to find funding	What does it mean to my buildings?; Effect of a subduction zone event on bldg. stocks; capability of older steel frame 13 story bldgs on corners (how react)	Techniques by which seismic retrofit can be accomplished; incremental implementation	Clearer standards; requirments on latching on upper cabinets	Selection of new school sites; some kind of screening guide that discusses issues conceptually and identify families of construction bldg. types;
24. In the next five years, what should be emphasized more strongly?		preparedness; analysis how practical retrofit is	don't know enough about NEHRP programs to answer	More applied knowledge to existing bldgs; How does current sci. info apply to guidelines for existing bldg. currently underway	Not broad enough info on what amount of effort needed	Don't know	Don't know
25. In the next five years, what should be continued about as is?		What are they doing? Continue providing info; improve distribution	don't know enough about NEHRP programs to answer	Funding research of various kinds - geotech as well as applied to bldg. types;good job	don't know	None	Don't know
26. In the next five years, what should receive less emphasis or be terminated?		Not aware	don't know enough about NEHRP programs to answer	Convoluted delivery mechanism	don't know		Don't know

Table 6.1 (cont.)

Pacific Northwest

Questions	Seattle/WA Buildings	Everett/WA Buildings	Salem/OR Buildings	Portland/OR Buildings	Portland/OR Schools	Everett/WA Schools	Salem/OR Schools
27. Do you have any concluding thoughts?	Wa. State Energy Code Implementation Model: a complicated code, locals lack ability to enforce, understand - training prog. for bldg. officials, contractors, eng.; $ for jurisdictions (special inspection, plan review)	Assessment of users is a long overdue effort	State wide Bldg. Officials care; go to any length to require changes for safety; willing to take the heat; Problems: hardest part = re-use or intensification of use; Find low cost means to make a bldg safer; no time	How to justify allowing retrofit measures to have a lower target load (65-85% of new bldgs); May be appropriate for mandatory retrofit. Fire/life safety must be to current code; Is public duped to think safe as new bldg? Load level design wrong approach;	Attention given by agencies to accommodate target group needs · commendable; Effort to deliver information important; issues dealt with thoroughly in pockets; need networking, dissemination; can't always lift and apply Calif. models to OR; some = poor fit	none	Fed. Gov't doesn't understand how school district works w/r to risk reduction; Feds viewed as unsympathetic & w/o understanding impact. Primary goal = education; need trust not threats; e.g. asbestos: terribly complex for schools;prob. not greatest hazard

Table 6.1 (cont.)

Central U.S. Responses

Questions	Memphis/Tenn. Bob Raby Schools	Memphis/Tenn. Terry Hughes Buildings	Cape Grandeau/MO Pam Davidson Building	Memphis/Tenn. Wm. Huntington Building	Germantown/Tenn. Bill Edwards Building	Memphis/Tenn. Stan Seay Hospital	Union City/Tenn. Sonny Hutchens Planning/Building
1. How long in present position? How long in related work? What is your education/training? What is your title?	10 yrs.; 24 yrs./ B.S. Economics/ Business; Deputy Administration, Building Official	6 yrs.; 20 yrs.; A.S. degree in Architecture	1 1/2 yrs; registered architect; Code Inspector	5yrs.; 28 yrs.; B.S. Architecture; Chief Construction Officer for University of Tennessee	4 yrs.; 20 yrs.; B.S. Civil Engineering; City Engineer	5 yrs.; 18 yrs.; B.S. Engineering; Director, Facility Services/Plant Operations	6 yrs.; 9 yrs.; B.S. Criminal Justice, SBCCI Certified; Director of Planning and Code Enforcement
2. What percentage of your total position responsibilities concerns the activities related to earthquake hazard mitigation?	1 - 2 %	8%	?	Virtually None	5%	3 - 5 %	25%
3. What specifically is your role?	EMA liaison; has perfromed all of the roles	EMA Liaison; Has performed most of the roles	code inspector/plans review		Plans Development and Review	Mitigation coordinator; EMA liaison	EMA Liaison; Training, awareness, outreach
4. In general, where do your other responsibilities come from?	Safety & Security Coordinator; Real Estate Agent; Liability Insurance	Building Official metro. area of four municepilites (700,000 + pop.); Administrative duties; plans review, development of codes, land use planning and zoning	City Mayor & Assistant; Supervisor Building Code Dept.	Capital outlay and Capital maintenance program	Board of Alderman & Mayor; Planning Commission	Day to day operations of a 2 million Sq. Ft. hospital and education facility	Plans review, code development, site inspections, (elec. plumb, mech. inspections), adminsitrative duties
5. What are the major reasons why your department gives attention to earthquake hazards reduction?	EMA Request; State Agency Programs; Federal Agency Programs; Citizen Influence;	Building codes; Federal Programs; Regional Programs; Past Disaster, personal experience		Professional Training networks; State mandates	Professional Training Netwroks; State Mandates; Interests from other Dept.	Executive influence; manage growth; prof. networks; request by EM; Special regional programs; interest from other dept.'s	Prof. networks/training; State mandates; Special regional programs

Table 6.1 (cont.)

Central U.S. Responses

Questions	Southhaven/Miss. Iris Robertson Planning/Building	Collierville/Tenn. B.J. Watson Building	Bartlett/Tenn. Bob Jacobson Building	Jackson/Tenn. Lynn Hicks Director, Code Enforcement
1. How long in present position? How long in related work? What is your education/training? What is your title?	6 mos.; 10 yrs.; B. A. Geography, MCRP; Director of Planning and Building	9 yrs.; 25 yrs.; B.F.A.; Director of Development Services	2 yrs.; 21 yrs.; SBCCI certifed, A.D. Applied Science Construction Tech.; Director of Code Enforcement	3 yrs.; 16 yrs.; B.S. Engineering Tech.; CABO certifed, SBCCI certified
2. What percentage of your total position responsibilities concerns the activities related to earthquake hazard mitigation?	1%	10%		5%
3. What specifically is your role?		Mitigation Coordinator; EMA Liaison; Training & awareness	Mitigation coordinator	EMA Liaison; Training/awareness
4. In general, where do your other responsibilities come from?	Director; Bldg. Dept.. Planning, Site Inspection, Plans Exam, Architectural Control, Board of licensing	Mayor & Board of Alderman; Director of Development Services - Town of Collierville	Director Code Department; Adminstrative; site inspections, plans review	Adminstrative duties; rehab. official; Elec., plumb. insp.; Zoning admin., Housing official,
5. What are the major reasons why your department gives attention to earthquake hazards reduction?	Useful to manage growth; Federal mandates/Executive Order; Potential for future hazards	State agency programs; FEMA programs; Influence from other Depts. & Citizens	Executive influence; professional networks/training; state programs; regional programs (CUSEC); SBCCI	Professional Training; TEMA programs; FEMA small business mitigation project; Regional Programs (CUSEC)

Table 6.1 (cont.)

Central U.S. Responses

Questions	Memphis/Tenn. Bob Raby Schools	Memphis/Tenn. Terry Hughes Buildings	Cape Grandeau/MO Pam Davidson Building	Memphis/Tenn. Wm. Huntington Building	Germantown/Tenn. Bill Edwards Building	Memphis/Tenn. Stan Seay Hospital	Union City/Tenn. Sonny Hutchens Planning/Building
6. What mitigation techniques have been used by your department to reduce future earthquake hazards?	Adoption of Code (1988 SBC); Nonstructural Mitigation (Offices); Structural Vulnerability Survey (MSU-CERI); Public EQ Hazard Info.; Personnel EQ Hazard Info.; Real Estate Disclosure Transactions	Adoption of 1988 SBC with amendments, looking to adopt 1994 SBC; Relies on the building Code to incorporate EQ hazard mitigation techiniques	Adoption of Building Code (BOCA 1993); information dissemination	no answer	Adoption of 1988 SBC; City Buildings now required to incorporate seismic design; location of capitol facilities; land use and zoning ordinance; public EQ hazard info.; personnel EQ hazard info.; Comprehen. Planning	Nonstructural mitigation; structural vulnerability inventory; nonstructural vulnerability inventory; personnel EQ inof.; seismic safety priority consideration of building placement; Business Resumption Planning	Adoption of 1991 SBC; Seismic safety priority considerations; Personnel EQ hazard info.; building relocation
7. Of the mitigation techniques in question 7, what special problems do you have with respect to their implementation?	Inconvenient for people; maintain level of consciousness of EQ risk; Funding concerns	Lack of support from superiors and elected officials; opposition of developers and builders; Lack of Funds	Local resistance; There seen as too costly	no answer	Budget constraints; lack of understanding & interest	Financial restraints; apathy from users	Lack of knowledge & info. to city council; State needs to have law requiring inspection and certified code inspectors.
8. What kinds of information or activities and which of the NEHRP agencies has helped you carry out earthquake hazard mitigation activities?	Publications; Workshops (EMI School Prep. Course); Training/Educ. Videos & Films	Publications; Workshops (ATC-BSSC); Code development	Demonstration projects; publications FEMA "Yellowbook Series"; Workshops	ATC 20; Workshops at Memphis State Univ.	Code development; hazard information	Workshops/training: Nonstructural hazard mitigation (EMI); Hazard Information (local EMA, MSU)	Publications - FEMA 232; Workshops - SBCCI; Code development
9. How did the NEHRP information or activity listed in question 9, help you carry out earthquake hazard mitigation activities?	Defined hazard; hazard mitigation info.; mitigation on agenda; prepare mitigation plans; awareness of EQ hazard and possible impact; increased coordination	Define Hazard; provide hazard info.; all possible answers to the question checked	Provide info. to define hazard; detailed hazard mitigation techniques; made aware of EQ hazard in community	Provided basis for formation of postearthquake evaluation on campus	Define EQ hazard; Helped get mitigation agenda; increased coordination	All options Available	Define hazard; detailed hazaard mitigation info.; awareness of EQ hazard; possible impacts; increased coordination; Iben Browning prediction

Table 6.1 (cont.)

Central U.S. Responses

Questions	Southhaven/Miss. Iris Robertson Planning/Building	Collierville/Tenn. B.J. Watson Building	Bartlett/Tenn. Bob Jacobson Building	Jackson/Tenn. Lynn Hicks Director, Code Enforcement
6. What mitigation techniques have been used by your department to reduce future earthquake hazards?	Adoption of 1988 SBC; adoption of special seismic resistant building standards under consideration; Comprehensive Plan considerations	Adoption of 1991 SBC; Location of critical facilites; Seismic safety priority for bldg. replacement; public EQ hazard info.; personnel EQ hazard info.; working on recovery & recon. plan	Adoption of 1988 SBC with amendments; location of critical facilities; public EQ hazard info.	Adoption of 1988 SBC w/ 1989 revisions; Seismic safety priority for bldg. reuse; Public EQ hazard information; Personnel EQ hazard info.
7. Of the mitigation techniques in question 7, what special problems do you have with respect to their implementation?	Public & Developers are opposed to many/most planning procedures	no answer	No answer	Establishing concern with public and the contracting community
8. What kinds of information or activities and which of the NEHRP agencies has helped you carry out earthquake hazard mitigation activities?		Workshops (Seismic design); Training and education (EMI courses)	Publications; Code development	Publications (FEMA Yellowbooks); Training Education; Workshops; Code development; NEHRP grant (Small business outreach campaign)
9. How did the NEHRP information or activity listed in question 9, help you carry out earthquake hazard mitigation activities?		Define hazard; detail hazard mitigation tech.; develop mitigation proram; mitigation on agenda; awareness of risk; awareness EQ to facility; increased coordination	All possible answers provided	Define hazard; detail hazard mitigation tech.; info. for mitigation plan; awareness of EQ hazard; increased coordination

Table 6.1 (cont.)

Central U.S. Responses

Questions	Memphis/Tenn. Bob Raby Schools	Memphis/Tenn. Terry Hughes Buildings	Cape Grandeau/MO Pam Davidson Building	Memphis/Tenn. Wm. Huntington Building	Germantown/Tenn. Bill Edwards Building	Memphis/Tenn. Stan Seay Hospital	Union City/Tenn. Sonny Hutchens Planning/Building
10. In what ways could the NEHRP agencies/program help you to better carry out earthquake loss reduction activities?	grants/funding opportunities; assist in completing nonstructural inventory of schools	Training and local workshops; provide technical assistance	eliminate the knowledge gap for city officials.	provide specific information on nonstructural hazard mitigation (handbook); promote the need in the community	Education at the political level (i.e. get elected officials interested in the problem)	Establish a matching grant program in high risk areas (similar to the energy grant programs)	useful publications for local seminars; information dissemination; hazard/risk identification
11. What state agencies do you most rely on to help you develop/carry out earthquake loss reduction activities?	None/Memphis State University-Center for Earthquake Research and Information	TEMA; State Fire Marshall's Office; memphis State Univ. CERI	State EMA	Tenn. Higher Education Comm.; State Fire Marshall's Office	State Fire marshall's Office; Memphis State Univ.- CERI	none	none
12. What professional associations do you most rely on to help you develop/carry out your earthquake hazard mitigation responsibilities?	Nat. Assoc. of School Security & Law Enforcement Officers; Tenn. Assoc. of School Business Officials; Southeast ASBO	Applied Technology Council; BSSC	BOCA; SEMSU- EQ Education Center; FEMA/SEMA	AIA National; AIA Memphis Chapter	NFPA; FEMA	Amer. Soc. of Hosp. Eng.; Tenn. Assoc. of Hosp. Eng.	TEMA, CUSEC
13. What professional associations do you most rely on to help you develop/carry out your other (non earthquake hazard) responsibilities?	Same As Above	Tenn. Building Offcials Assoc.; SBCCI; West Tenn. Code Enf. Assoc.	Red Cross; National Guard; DNR	Same As Above	State Planning Office; ASCE; MSU; MTAS	Amer. Soc. of Hosp. Eng.; Tenn. Assoc. of Hosp. Eng.	SBCCI; WTCEA; TBOA; APA
14. What professional association or other groups do you most rely on to provide training, education, and technical assistance in your field?	Same As Above	CUSEC; TBOA; WTBCEA; SBCCI		Same As Above	MSU	TEMA; Local EMA; Civil Air Patrol; IEEE	SBCCI; WTBCEA; TBOA; APA
15. As you reflect on your ability to perform your earthquake loss reduction activities, what factors and forces help you get the job done? Why are they helpful?	Local EMA & other emergency response agencies; Individual School Initiatives; PTA interests	Local EMA; CUSEC; SBCCI; TEMA-Workshops and training	Seminars; technical training; hands-on training	Earthquake Publicity and Public Concern; This causes laws to be passed and funds made available		Senior Management Support	training through NEHRP sponsored agencies, SBCCI; understandable information

Table 6.1 (cont.)

Central U.S. Responses

Questions	Southhaven/Miss. Iris Robertson Planning/Building	Collierville/Tenn. B.J. Watson Building	Bartlett/Tenn. Bob Jacobson Building	Jackson/Tenn. Lynn Hicks Director, Code Enforcement
10. In what ways could the NEHRP agencies/program help you to better carry out earthquake loss reduction activities?		Training & Education; Coordination of resources	Training workshops & technical assistance	Seismic design task forces established to visit local comm.; provide input to problem solving; meet with elected officials; provide more general assistance w/ education
11. What state agencies do you most rely on to help you develop/carry out earthquake loss reduction activities?	none	TEMA; local EMA; MSU-CERI	No answer	TEMA; State Fire Marshall's office
12. What professional associations do you most rely on to help you develop/carry out your earthquake hazard mitigation responsibilities?	APA; State of Mississippi; Metropolitan Planning Organization	SBCCI; TBOA	SBCCI; TBOA; WTCEA	SBCCI; TBOA; WTCEA
13. What professional associations do you most rely on to help you develop/carry out your other (non earthquake hazard) responsibilities?	MSU; APA; Memphis/Shelby County Government	SBCCI; TBOA	SBCCI; TBOA; WTCEA	SBCCI; TBOA; WTCEA
14. What professional association or other groups do you most rely on to provide training, education, and technical assistance in your field?	Same As Above	SBCCI; TBOA	SBCCI; TBOA; WTCEA	SBCCI; TBOA; WTCEA
15. As you reflect on your ability to perform your earthquake loss reduction activities, what factors and forces help you get the job done? Why are they helpful?		Education/Training/ Budget (available funding)	SBCCI programs	State Mandates for code adoption

Table 6.1 (cont.)

Central U.S. Responses

Questions	Memphis/Tenn. Bob Raby Schools	Memphis/Tenn. Terry Hughes Buildings	Cape Grandeau/MO Pam Davidson Building	Memphis/Tenn. Wm. Huntington Building	Germantown/Tenn. Bill Edwards Building	Memphis/Tenn. Stan Seay Hospital	Union City/Tenn. Sonny Hutchens Planning/Building
16. Which of these helpful factors can you attribute directly to NEHRP, including any of the four principal agencies responsible for elements of the program?	Local EMA (FEMA)	Local EMA; CUSEC; FEMA; BSSC		Doesn't Know		None	FEMA/CUSEC workshops; publications
17. As you reflect on your ability to perform your earthquake responsibilities, what factors are barriers to your? Why?	Declining Interest in Community; Change in Administration; Budgetary impacts-higher priorities.	Public Awareness; dual role as city - county agency	Education of influentials	Lack of Public & governmental Commitment; Lack of Funding; Lack of Knowledge & experience on my part as to what to do	Lack of awareness	Financial limitations; competing for funding against direct patient care	code language is a barrier- written on engineering level not inspector level.
18. Of these barriers, which do you attribute directly to the NEHRP or any of the four agencies responsible for element of the national earthquake hazard reduction program?	None	Public Awareness	Knowledge (Public Awareness)	Doesn't Know	no contact to local elected officials on the need to initiate mitigation programs	None	
19. If you could, what would you do to lessen or remove these barriers?	Better communication with schools; keep promoting EQ threat to citizens	Advertise NEHRP programs; hands-on training /workshops; do not give up		Encourage commitment by public & gov.; study & attend seminars	Educate on the real threat that exists	Set up matching grant programs	NEHRP inofrmation providied to locals; meet more on the local level
20. How do you find out about and obtain the results of research of interest to you?	FEMA publications; local EMA	Serving on Committees; DRC-U. of Del.; MSU-CERI; CUSEC; BSSC; (being involved)	Useful in referral/technical assistance	Professional trade magazines; seminars & workshops		CUSEC sponsored seminars	CUSEC workshops
21. What makes it easiest for you to use research results in your present position?	Broad dissemination to schools by local EMA	MSU-CERI; location; applicability		Printed guides & manuals with seminars on how to use them	When presented as a case studies	Applicable to location; personal education	availability; in layman terms
22. What makes it difficult for you to use research results in your present position?	Too technical; doesn't make an impact	Lack of funds		Lack of funds	when presented as an abstract with broad generalized conclusions	Time and access	Results differ from public opinion and perceptions

Table 6.1 (cont.)

Central U.S. Responses

Questions	Southhaven/Miss. Iris Robertson Planning/Building	Collierville/Tenn. B.J. Watson Building	Bartlett/Tenn. Bob Jacobson Building	Jackson/Tenn. Lynn Hicks Director, Code Enforcement
16. Which of these helpful factors can you attribute directly to NEHRP, including any of the four principal agencies responsible for elements of the program?		Education/Training	No answer	No answer
17. As you reflect on your ability to perform your earthquake responsibilities, what factors are barriers to your? Why?		Communication (lack of); Lack of coordination between FEMA, TEMA & Local government	Lack of information and communication	Lack of understanding of EQ hazard; Complacency in regard to EQ risk
18. Of these barriers, which do you attribute directly to the NEHRP or any of the four agencies responsible for elements of the national earthquake hazard reduction program?		FEMA Coordination & communication w/ lower level gov.	No answer	No answer
19. If you could, what would you do to lessen or remove these barriers?		No answer	No answer	Initiate a tie to insurance programs to mandate compliance or pay higher insurance premiums
20. How do you find out about and obtain the results of research of interest to you?	Consult with experts; Public Documents; Library Resources; Professional publications	MSU; FEMA; Local media	Engineers	Publications from FEMA, SBCCI
21. What makes it easiest for you to use research results in your present position?	Support of legislative body	No answer	No answer	Accessibility of research info.
22. What makes it difficult for you to use research results in your present position?	Public opposition to change	No answer	Lack of information	Accessability of research info.

Table 6.1 (cont.)

Central U.S. Responses

Questions	Memphis/Tenn. Bob Raby Schools	Memphis/Tenn. Terry Hughes Buildings	Cape Grandeau/MO Pam Davidson Building	Memphis/Tenn. Wm. Huntington Building	Germantown/Tenn. Bill Edwards Building	Memphis/Tenn. Stan Seay Hospital	Union City/Tenn. Sonny Hutchens Planning/Building
23. What are some subjects on which you need more knowledge that should start being addressed by researchers now so you have the results in the next three to five years?	type of support to expect following a disaster; case studies on impacts to schools systems; response times for assistance to schools	Public Awareness; research findings in layman terms		Mitigation of hazards in existing buildings, particularly chemical research laboratories	Retrofitting utility structures	Dynamics of multiple building complexes and their support systems	EQ vulnerability of New Madrid with results in layman's terms
24. In the next five years, what should be emphasized more strongly?	Communication; public awareness; Doesn't have enough info. on NEHRP to further comment	Publications for general public		Existing buildings retrofit (nonstructural included)	The need for mitigation programs	More concentrated education and mitigation effort aimed at health care and public education facilities; publicity for EMI	update research data; building retrofits; stronger code requirements; public awareness; more publications
25. In the next five years, what should be continued about as is?	Doesn't have enough info. on NEHRP to further comment			New building design		Don't know enough about NEHRP	Don't know enough about NEHRP
26. In the next five years, what should receive less emphasis or be terminated?	Doesn't have enough info. on NEHRP to further comment			nothing		Don't know enough about NEHRP	Don't know enough about NEHRP
27. Do you have any concluding thoughts?	need more time and resources to address EQ risk reduction; Top level commitment and support	Access to funds or grants for training workshops		Good luck!	More contact needs to be made with local officials	Don't know enough about NEHRP	Don't know enough about NEHRP

Table 6.1 (cont.)

Central U.S. Responses

Questions	Southhaven/Miss. Iris Robertson Planning/Building	Collierville/Tenn. B.J. Watson Building	Bartlett/Tenn. Bob Jacobson Building	Jackson/Tenn. Lynn Hicks Director, Code Enforcement
23. What are some subjects on which you need more knowledge that should start being addressed by researchers now so you have the results in the next three to five years?	Applicability of earthquake code for our community	Retrofit; Hazard identification; Residential code enforcment	No answer	Refine risk maps in building codes; need to be more specific
24. In the next five years, what should be emphasized more strongly?		Education & communication	Public awareness; Training of public officials	Local input and involvement
25. In the next five years, what should be continued about as is?	Don't know enough about NEHRP	Not much- Need to address NMSZ issues	No answer	Promotion of education and awareness
26. In the next five years, what should receive less emphasis or be terminated?	Don't know enough about NEHRP	California history	No answer	Nothing
27. Do you have any concluding thoughts?	Don't know enough about NEHRP	Devise a plan for W. Tenn; Wants real seismic probabilities; Emphasis on Hands on training	No answer	Help!

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Table 6.2. Jurisdictions contacted

Jurisdiction	1990 Population[a]	Seismic Risk Zone[b]	State Building Code[c]
California	29,760,021	3-4	Yes
Palo, Alto	55,966		
Idaho	1,006,749	2B-4	No
AOA County			
Missouri	5,117,073	1-3	No
Cape Girardeau	34,475		
Mississippi	2,573,216	0-2A	No
South Haven	17,949		
Oregon	2,842,321	2B-3	Yes
Portland	438,802		
Salem	107,793		
Tennessee	4,877,185	1-3	Yes
Germantown	32,893		
Union City	10,513		
Bartlett	26,989		
Jackson	49,115		
Collierville	14,429		
Memphis	610,337		
Washington	4,866,692	2-3	Yes
Seattle	516,259		
Everett	19,961		

[a] The World Almanac and Book of Facts 1992, New York, pp. 79-82,110, 1991.
[b] Estimated from the 1988 UBC Seizmic Zone Map of the United States.
[c] From NIST Seismic Provisions of State and Local Building Codes and their Enforcement, NIST GCR 91589, 1992.

7. USER WORKSHOP

7.1 SCOPE

As noted in Section 2, a user workshop was held on November 17–19, 1993, in Washington, D.C., to review the findings and recommendations of the project to further validate the Assessment and to fill any gaps that might have resulted.

The workshop included users who had participated directly in the team surveys and some who had not. Those in the latter group were chosen in order to provide additional checks and balances to the Assessment results. In addition, members of the NEHRP agencies and the Project Steering Committee participated. In advance of the workshop, all workshop participants were provided a 70% draft of the report to review and to obtain initial impressions of the results. All 65 workshop participants are listed in Appendix D.2.

At the workshop, CNPE staff provided an overview of the Assessment, background, purpose, and scope. The participants then were divided into four NEHRP assessment areas ("breakouts") to evaluate and reassess the results of the Assessment. At the end of the workshop, each team presented its respective breakout session results to all workshop attendees.

Following the workshop, the Assessment Teams prepared the final versions of their chapters and summarized the results of the workshop as discussed below.

7.2 A SUMMARY OF WORKSHOP RESULTS

7.2.1 Seismic Hazard Team Summary

The Seismic Hazard breakout sessions at the NEHRP Assessment User Workshop provided a valuable opportunity for interactions with a knowledgeable group of seismic hazard researchers, hazard analysts, and hazard-product users. The sessions were attended by individuals from several federal agencies (including the USGS, DOE, and COE), from regional and state agencies, and from private industry. During the sessions, the 10 high-priority findings and recommendations that the Seismic Hazard Team had previously identified were reviewed and discussed. These issues had been developed on the basis of the 42 individual interviews conducted previously. Although no additional significant issues were identified, the findings and recommendations were brought into better focus through the discussions. The findings and recommendations contained in Section 3.6 reflect comments made during the breakout sessions.

Highlights of the discussions follow:

- A strong recommendation from the interviews was that NEHRP products be indexed and made more easily available to the user community. It was found that individuals within the USGS are currently developing more effective methods for providing information on NEHRP-supported projects such as preparing open-file reports that contain indexes of studies being conducted and making some research data available in computer formats. Some procedures followed by the Corps of Engineers were described (e.g., final reports are submitted to the National Technical Information Service where they are made available on microfiche or hard copy).

- A balance is needed between basic research and applied research efforts of NEHRP. It was unanimously affirmed that the basic research conducted by NEHRP is very valuable, and would not be duplicated by other organizations, such as the Corps of Engineers, whose research is completely end-user driven. The applied research efforts of NEHRP, however, could be strengthened by cooperative efforts with other public and private organizations. It was stressed that it is important for research applications to be developed within NEHRP, and that they not be allowed to be obtained completely outside the program. Strategic planning needs to cover the complete seismic hazard mitigation process. In this process, it will be found that some research activities, although less exciting from a scientific point of view, are vital to seismic hazard assessments. An example discussed at the workshop is the need to characterize geotechnical site conditions of strong motion instrument sites in the United States.

- Conducting cooperative ventures with private and other public organizations was discussed as a means of leveraging NEHRP funds to achieve more program objectives. The need for cooperation to achieve mutual benefits was stressed (i.e., federal agencies such as DOE and COE are frequently asked to donate the use of field equipment, to provide funding, etc.), and possibilities for leveraging were considered (e.g., providing matching funds for state and local agency projects). It was stressed that the success of cooperative ventures would depend on the willingness of both NEHRP agencies and non-NEHRP agencies to share in the development of project objectives as well as project support.

- Considerable discussion centered around the national seismic hazard maps—methodologies used in their development, ongoing programs to develop hazard methodologies, and mechanisms for achieving scientific support for the maps. The national seismic hazard maps are used extensively and should have a broad base of support within the scientific community. The process followed in adopting current maps can be considered a consensus process, since committee members cast votes. The process of providing scientific input and producing the maps, however, is widely considered **not** to be a consensus process. Further, the translation of a seismic hazard map into a design values map should involve the cooperation of both earth scientists and engineers. It was generally agreed that the issue should be recognized in this NEHRP Assessment report and that the recommendation should note that an opportunity exists to develop an approach to obtaining broad scientific support for the next generation of maps in 1997.

7.2.2 Built Environment Team Summary

The Built Environment breakout sessions were conducted over a period of 1.5 days to review the findings and recommendations developed by the team and to provide further validation to the assessment. The breakout session attendees were asked to assist in providing prioritization to the original 24 individual findings and recommendations for the 90% draft findings and to assist in filling gaps that might have occurred.

The breakout sessions were participated in and by end-users and collaborators, some of whom participated in the built environment team surveys and some of whom did not. The breakout sessions were also attended by individuals from NEHRP agencies and members of the steering committee, all of whom provided active participation in the breakout session process.

The atttendees reviewed each finding and recommendation on the first day. The participants recommended areas of clarification in the finds, refinements in presenting findings, and the merging of similar issues. It was recommended that the findings be merged into five or six findings and consolidated to provide focus on significant issues of the resulting findings.

The second-day workshop was devoted to the process of more clearly defining the resulting five findings and recommendations. Specific recommendations by the attendees were categorized as Action Notes during the workshop and recorded in the discussion summary included in Appendix E.2.

7.2.3 Societal and Policy Team Summary

Societal and Policy group discussions at the workshop contributed significantly to sharpening the focus of Section 5 of this report, adding some new ideas and adding emphases. Wherever possible, those suggestions are reflected in this chapter.

Major substantive suggestions encompassed (1) adding a discussion of the benefits and costs of mitigation to Section 5.13, (2) explaining the difference between it and cost-effectiveness and using risk and benefit/cost information to help defend against short term view-driven budget cuts in "marginal" earthquake safety programs; (3) reviewing Section 5.14 to ensure that identification was made of the real issue of defining that information needed and the sources of it; (4) noting that although theoretically simple and apparently linear, the real policy development, adoption, and implementation process is a mish mash and subject to the influence of major, unrelated variables; and (5) reinforcing the need to emphasize the importance of integrative processes that tie geological, built environment, and societal information together to explain risks and to promote mitigation and preparedness.

In some less-seismic areas, the group noted, earthquake mitigation actions taken by local federal installations, such as a Department of Veterans Affairs (DVA) hospital, influence local attention. Moreover, some internal federal agency technical materials, such as the Tri-Services Manual and one used by the DVA, have been disseminated widely and are well-regarded. Procedural, financial, and administrative impediments to making publications and other information more accessible were briefly discussed, and the idea was explored of adding to appropriations bills language that authorizes agencies to establish revolving funds to support printing and dissemination (in lieu of the income's reverting to the Treasury's general fund).

A number of more general suggestions were made, and to the extent possible they or their intents are included in Section 11 or help to support the strategic recommendations presented in Section 10. The general suggestions summarized here include (1) building earthquake hazard mitigation issues into software regularly used for other purposes, such as city planning, capital planning, property management, and building design; (2) encouraging USGS to fund more county geologists to solve problems and to help bring awareness and commitment to earthquake safety; and (3) emphasizing the importance of understanding that earthquake risk reduction is a long-term process subject to peaks and valleys of support and attention, but that institutional capability can mobilize to achieve significant results during occasional "windows of opportunity."

The team and discussion group members identified NEHRP strengths in policy, program operations, and social science research areas that were added to Section 5. Examples include recognizing that NEHRP's support has helped to develop and expand the program's constituency and local advocates; recognizing that the long-term investment in social science research has provided an important base of knowledge on which to build program activities and to help define future research needs; and reaffirming our knowledge that actual earthquakes, predictions, and related highly publicized events create opportunities for mitigation and preparedness actions.

Strengths and areas for improvement in programs were also identified. Many activities helped to promote knowledge transfer, but more needs to be done. In many areas, state governments provide important links between the federal agencies and local governments and communities, but this linkage is uneven and needs to be developed on a case-by-case basis. It must be clearly acknowledged that multijurisdictional (e.g., regional, interstate) earthquake projects provide effective foci and partnerships.

The NEHRP's yellow-covered series of reports and those of the ATC are highly regarded, especially in areas outside of California where knowledge and practice are less well developed and the availability of information is limited. These documents have found their way into the hands of influential local officials and practitioners. While not always used formally, they contribute to local knowledge and informal regulatory and administrative processes. To further strengthen their value, however, the group recommended that questions of availability, format, marketing, and dissemination be examined.

The continuing investment in the Learning From Earthquakes Project through EERI was highly regarded as adding realism, knowledge, and experience to the field.

7.2.4 Implementation Team Summary

The NEHRP Assessment User Workshop provided an opportunity for participants in the implementation assessment to review and discuss the Implementation Team's results and findings to determine if they are representative of the information provided during interviews and group discussions. The workshop also enabled additional individuals to provide input to the Implementation Team concerning the Assessment. The combined perspectives of participants and nonparticipants (those who had participated directly in the Assessment and those who had not) indicate (1) that the final report's results and findings reflect the data collected (rather than express personal opinions of team members) and (2) that critical issues related to the implementation of mitigation measures have been identified. Ongoing efforts of the NEHRP strategic planning process will better define the fabric in which these issues are embedded, clarify interrelationships, and more clearly link options to address concerns to responsibilities of NEHRP agencies. The results of this study can be used as a resource in the design of an ongoing process to assess the influence of NEHRP on the implementation of mitigation measures.

The following review summarizes the original assessment findings and recommendations, workshop participation and format, and workshop results.

The assessment of findings and recommendations prepared by the Implementation Team through a series of individual interviews, group discussions, and the results of previous studies are presented in Section 6. It reveals a clear pattern of concerns and issues that need to be addressed to strengthen the NEHRP Program:

- improved access to NEHRP-generated publications and services;
- input of potential users in the development of risk reduction programs and products;
- incentives for implementation of earthquake risk reduction programs;
- enhanced federal, state, local, and regional capabilities to implement risk reduction policies and programs; and
- focused effort on selected end-users most capable of achieving NEHRP mitigation goals.

The User Workshop included overview presentations from each project team leader, small work group sessions, and a final summary of work group results. The implementation work group included five participants: two from the target groups selected for the implementation assessment, building officials and a school facilities manager; a city safety officer; and a state emergency manager. Representatives from federal agencies, the steering committee, CNPE, project management, and a representative from the National Governors' Association participated intermittently or observed the process. The primary participants represent diverse geographic regions: Massachusetts, South Carolina, Washington, and California. Two participants had been interviewed previously, and all but one had extensive experience in mitigation programs and knowledge of one or more NEHRP agencies. No planners or hospital facility managers were present. Issues relating to the implementation of Executive Order 12699 were not discussed.

Work group participants reviewed material prepared by the Implementation Team concerning characteristics of strong implementation, strengths of NEHRP, challenges to the implementation of mitigation measures at the local level, and the findings and recommendations. In general, the work group suggested changes to the order and groupings of materials, rather than changes to content. Overall concern focused on how to develop greater institutionalization of earthquake hazard mitigation to replace the present heavy reliance on the actions of motivated individuals. That transition would involve more program emphasis on gaining management commitment through actions such as incentive-based mandates and more support of mitigation "champions" in the process of obtaining commitment of management.

The major contribution of the work group was to categorize the findings into three general areas: (1) information systems, (2) intermediary organizations/structures to support implementation, and (3) commitment. Each area was considered critical to successful implementation of mitigation measures. The major contribution of the work group was to categorize the five characteristics of a strong implementation program and the corresponding findings into three general areas of commitment, capability, and information. See Fig. 7.1.

1. **Information.** Past NEHRP activities by all agencies have focused most strongly on information systems, including such areas as research, publications, workshops, and presentations. Workshop participants reiterated general concerns about accessibility, appropriateness, clarity, and usefulness of NEHRP materials that were also noted in interviews. The importance of user participation in the development of products and dissemination plans generated a request that NEHRP initiate an interactive, two-way information system instead of focusing on one-way delivery of materials. User input should be established as part of the NEHRP organizational structure.

2. **Capability.** A variety of intermediary organizations (fostering direct links between federal programs and local users) receive support from NEHRP agencies: NCEER, CUSEC, and SCEC. These organizations have different missions and objectives, with primary emphases on either coordination and dissemination of research or on facilitating preparedness on a regional, state, or multistate basis. The organizations were most familiar to the participants as sources of mitigation assistance. They were often cited by interviewees and in the literature as sources of information and technical assistance for local-level groups. They provide a focus for diffuse efforts and a means to incorporate local expertise and professional associations into the earthquake program. The levels of support, effectiveness, and activities vary widely among the existing intermediary organizations involved in preparedness activities (CUSEC, BAREPP, SCEPP, NESEC, WSSPC). Professional and trade associations were also cited as a frequent source of assistance by interviewees in each of the groups in the assessment. While NEHRP supports activities of some professional associations (EERI, ATC, AIA), most interviewees indicated that information on mitigation was not carried by their standard association newsletters or presented at association meetings. The limited use of existing professional

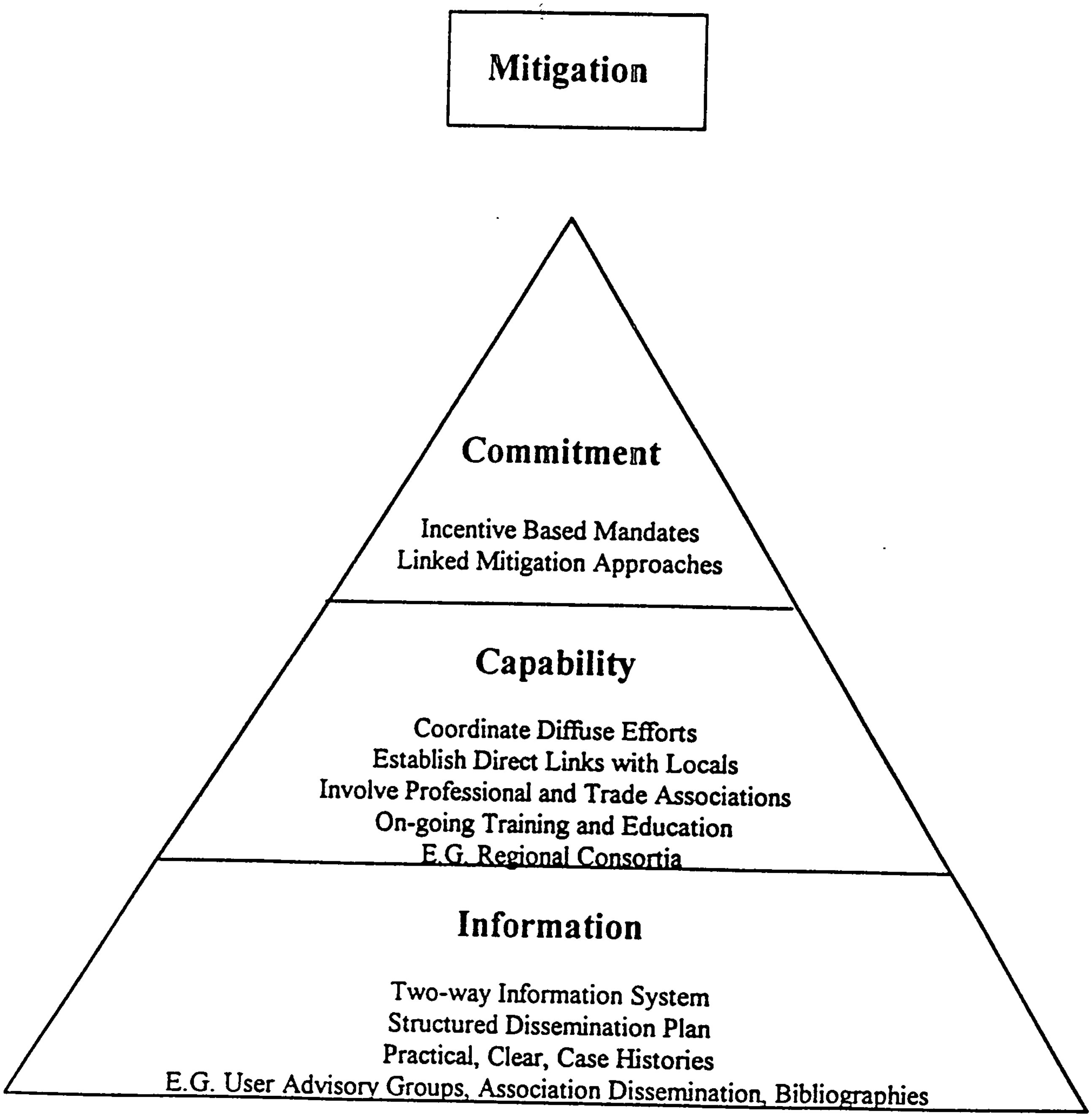

Fig. 7.1. The three critical areas for successful implementation of mitigation measures.

associations to deliver training and education programs and to provide information to members was noted frequently.

3. **Commitment.** Considerable discussion centered around the issue of obtaining management's commitment for the implementation of mitigation measures. While participants recognized the need for information to clearly define the hazard by a credible source and the need to have capacity-building intermediary organizations to focus diffuse efforts and foster technical capabilities, participants in the workshop, interviews, and group discussions also recognized the need to obtain commitment from managers, CEOs, mayors, and other leaders before a sustained, funded, and staffed mitigation effort can be achieved. While mandates were frequently cited as critical to obtaining management support, mandates alone were considered inadequate for motivating commitment. One workshop participant noted a national trend away from mandates on local agencies and individuals. Possible levers to encourage commitment include incentive-based mandates, linking issues (e.g., wetlands preservation and potential liquefaction zones), linking mitigation actions (e.g., wind and earthquake), and developing information products for decision-makers and disseminating them through appropriate professional associations.

NEHRP agencies need to recognize that earthquake hazards must compete with a number of other hazards capable of causing loss of life, economic disaster, and social disruption. Knowing that a particular mitigation measure is economically feasible with respect to potential earthquake damage provides little motivation if competing losses from other natural, technological, medical, or sociological hazards generate greater concern.

In summary, workshop participants provided the means by which assessment observations and recommendations were grouped around three general themes. The Implementation Team has focused on a selected group of organizations with direct responsibility to implement mitigation measures. Recommendations reflect those actions the team believes foster the ability of those organizations to carry out mitigation. Mitigation champions from outside these organizations may provide a lever for them as well. For example, many of the FEMA school programs promote mitigation indirectly through awareness and education programs for teachers and students, rather than through programs that target school facility managers. While outside champions were not identified in this assessment, their potential importance was noted. Activities to generate action among those selected groups with clear responsibility for carrying out mitigation measures, however, appear fragmented and often only indirectly aimed at them. A NEHRP strategy to foster mitigation needs to be more focused and incorporate each of the three areas important to implementation: information systems, intermediary organizations, and commitment.

7.3 CONCLUSIONS

The user workshop provided valuable input to the Assessment and furnished the teams with checks and balances each needed before finalizing their particular chapters. The participants were quite interested in the preliminary findings and recommendations of the Assessment and gave extremely lively input. As an example, summary comments and recommendations of participants at the Built Environment Team breakout session are given in Appendix E.2. The workshop participants also added insight into the quality of the Assessment that gave the Assessment teams, Project Lead Team, and Steering Committee greater confidence in the accuracy of the findings and recommendations presented herein.

7.8

8. SPECIFIC MAIL SURVEYS

8.1 INTRODUCTION

In addition to interviews and mail surveys conducted by the teams, as identified in Sections 3-6, two specifically targeted mail surveys were conducted to address (1) user satisfaction with NEHRP-generated materials, and (2) effectiveness of NEHRP courses conducted for hospital and health care professionals in seismic implementation.

The survey to determine user satisfaction with NEHRP-generated materials was conducted by two Project Team members. This survey was limited to determining if the needs of users of FEMA technical publications were being met. This area was chosen since existing buildings represent a significant source of earthquake hazard. This survey could have been part of the Built Environment Teams' activities, but because of the amount of additional effort to conduct a survey of this type and the fact that the Built Environment Team was already conducting a mail survey (with a focus to support the interview process), it was agreed that this mail survey would be a complement to Section 4 and the results would be considered in Sections 4 and 10 when developing findings and recommendations. The results of this specific survey are discussed in Section 8.2.

The survey to attempt to determine the effectiveness of NEHRP courses conducted for hospitals and health care professionals was done at the request of the Implementation Team by the Battelle Human Affairs Research Centers under contract with CNPE, as noted in Section 6. The detailed results of this survey are discussed in Section 8.3. As with the other specific surveys, the results described have been taken into consideration in the findings and recommendations of Sections 6 and 10.

The mail survey conducted by the Built Environment Team and the interview surveys conducted by all teams did not attempt to provide statistically valid samples. These two surveys, however, do represent a statistically valid sampling process per the guidelines of Dillman (1978). The results of these two mail surveys give the reader further insight on user needs targeted at specific products of NEHRP and the success of those products.

8.2. USER NEEDS AND THE SUCCESS OF FEMA TECHNICAL PUBLICATIONS FOR REHABILITATION AND RETROFIT

8.2.1 Parallels Between Surveys: Intent

The primary intent of both surveys was to determine if information generated by FEMA was being used to mitigate against potential earthquake hazards. A practitioner uses four major methods to obtain information: examining current literature, attending instructional seminar (workshops, seminars, training sessions, classes, etc.), conducting research or related activities (evaluation of peer work, review, etc.), and/or personally communicating with knowledgeable others (key informants or experts). The survey on NEHRP-generated materials examined how FEMA documents on retrofitting were viewed and used by those requesting those documents, while the Battelle survey examined how workshops (instruction) assisted in promoting the adoption of nonstructural mitigation strategies in hospitals and health care facilities.

8.2.2 Parallels Between Surveys: Methodology

Both studies used mailed surveys to generate data on specific topics relating to the tasks assigned to the group. Determining the populations from which to obtain information differed, however. Battelle was tasked to get information from health care providers and managers who had attended workshops in any of the 21 locations over a 2-year period on nonstructural mitigation measures. Many of the courses offered at the workshops were train-the-trainer wherein participants were expected to return to the home facility and disseminate information to others. The Battelle survey mailed questionnaires to attendees at workshops. The response rate was 33% of the 865 mailed questionnaires. (See Appendix F.)

The population of the user satisfaction survey was defined as building design professionals who had requested a NEHRP publication on seismic retrofitting. This survey used a list of people developed by a subcontractor to FEMA who has disseminated NEHRP documents on seismic safety of existing buildings for that agency over the past 2 years. It was assumed that those requesting documents from FEMA had received them. The Lead Team's survey response rate was 65% of the 318 questionnaires that reached recipients. The initial survey was followed by a postcard, then by a follow-up letter requesting the survey's return. Table 8.1 presents a summary of key survey characteristics.

Table 8.1 Summary of survey characteristics

	Lead Team Survey	Battelle Survey
Population	Building design professionals requesting FEMA earthquake documents on retrofitting the built environment	People attending FEMA course on nonstructual mitigation for health care facilities
Sampling frame	Saturation	Saturation
Original N (mailed questionnaires)	387	865
Modified N (minus questionnaires not delivered/returned)	318	831
Questionnaires returned	207	271
Return rate	65%	33%

8.2.3 Parallels Between Surveys: Types of Mitigation

Although both groups of respondents have recourse to mitigation actions, the types of mitigation actions each group can influence are different, even when motivations are similar. For example, both groups have two basic challenges in applying mitigation strategies: (1) the return to normal operations and activities following an earthquake as quickly as possible and (2) the reduction of loss of lives and property from an earthquake.

Conceptually the greatest similarity is that both groups were exposed to an intervention expected to enhance mitigation activities. Secondly, both surveys were conducted of persons who received information over the last 2 years and likely had a chance to determine its usefulness in earthquake mitigation strategies. Thus the surveys were not asking what respondents intended to do with the information but what they had actually done with the information, a more reliable measure of effectiveness of use.

In the Lead Team survey, respondents had requested and received technical documents on retrofitting from FEMA. In the Battelle survey, respondents had taken a course in nonstructural mitigation measures for hospitals and health care facilities. Thus both groups should have been motivated, but some were more likely to be self-motivated (owners/presidents, CEOs, project leaders in the Lead Team survey, and managers/operators in the Battelle survey). By and large, those attending workshops would be expected to have a higher level of participation and greater interaction simply through group participation. This participation would likely lead to greater actions to disseminate the information to others, a process known as diffusion.

The mitigation measures that each group could instigate or even implement, however, are vastly different. Retrofitting a building requires a substantial investment in resources that implementing nonstructural measures would require. The resources expended to retrofit, however, may be captured later by the increased number of lives saved as opposed to nonstructural measures that are limited in distribution. For example, a building that has been structurally retrofitted will protect all residents whether or not they are well-informed about an emergency plan of evacuation (a nonstructural measure).

8.2.4 Parallels Between Surveys: Survey Instruments

It is difficult to use a generic instrument to capture the differences in respondents' opinions of information and use of publications disseminated by FEMA. Thus both surveys focused on different topics.

Some comparisons can be made, however, between the surveys on the types of information received. Both surveys identified respondents by geographical area. The Lead Team survey identified respondents by census region; Battelle identified respondents by earthquake risk zones, collapsing all of California into zone 4. Both surveys measured actual dissemination of information, not intentions. Both measured opinions on the usefulness of information, although the Lead Team survey was more specific in queries on amount of use for individual documents. For example, the Lead Team asked respondents how many times they had used the information, not a dichotomous question on usefulness having a yes or no response. One of the questions used on the Battelle survey examined the length of time since the course was taken, the assumption being that a longer time interval would permit more actions to be taken. A similar version on the Lead Team survey would likely have given a comparable response. Table 8.2 compares the variables used in the surveys.

8.3 EMPIRICAL RESULTS OF LEAD TEAM SURVEY

This section describes responses to questions on the Lead Team survey, including the categorization, percentages, and the use of data imported from other sources. For reasons associated with the selection of population, the qualitative responses to open-ended questions may not be representative of a larger population. Overall, the data appear robust enough to provide a cross-section analysis of design professionals' preferences and needs in acquiring information on retrofitting measures.

Table 8.2 Comparison of survey variables

Variable	Lead Team	Battelle
Location of respondent	x	x
EQ risk zone		x
Sources of EQ information	x	
Effectiveness of alternative mitigation strategies	x	
Sufficiency of technical information	x	
Need for improvement in EQ information	x	
Frequency of contact for information	x	
Relevancy of information		x
Use of information	x	x
Usefulness of information	x	x
Actions taken	x	x
Motivation for action		x
Constraints to action		x
Further dissemination of information		x
Attitudes towards information source	x	
Organization type		x
Organization size	x	x
Effort spent on mitigation	x	
Position	x	x
Discipline	x	
Peer exposure to information		x
Vulnerability/risk	x	
Education	x	
EQ experience	x	
Membership in professional organization	x	
Ways to improve information/dissemination	x	x

8.3.1 Definition of Users

The population of users was derived from a list of persons requesting FEMA publications. To determine the disciplines of those requesting FEMA publications on retrofitting structures, respondents were asked to classify themselves. The question was open-ended and the categories were not intended to be mutually exclusive. For example, a president or manager could also be a structural engineer and/or a consultant. By far the greatest number of those requesting FEMA publications (by discipline or job title) were design professionals (engineers and architects). See Table 8.3. Engineers accounted for over 66% of the respondents. Of these, 23% were non-structural engineers, and 43% were structural engineers. Architects contributed 11% (23) of the responses. Two respondents were both architects and engineers. Since architects require longer training and internship, we classified those two as architects when necessary to classify by disciplines. Three (1.4%) listed themselves as teaching professionals; 16 (8%) listed themselves as consultants. The 28 (14%) included in the other category designated themselves as engineering geologists, designers, planners, property or real estate managers, researchers, or data acquistors for libraries.

Table 8.3. Job titles by category and percentage of total
(Note: Numbers not mutually exclusive; numbers do not add to 100%)

Title	Number	% of total (207)
President/owner/principal	66	32%
Project type/midlevel management/senior/vp	59	29%
Non-structural engineer	47	23%
Structural engineer	89	43%
Architect	23	11%
Teaching professional	3	1.4%
Consultant	16	8%
Other (engineering geologist, designer, planner, property manager, research, library, unclear)	28	14%

Respondents were asked to categorize current work tasks into specific job descriptions. Of the 200 responses, 52% described themselves as employees of private companies while 34% stated they were self-employed. Not many respondents worked for governmental agencies; only 8% (15 persons) worked for the federal government and 2% (4 persons) for state governments. One person (0.5%) worked for a local county government, and four persons (2%) were employed by local city governments. Five respondents (almost 3%) listed themselves as working in other categories.

One hundred twenty-five respondents (60%) indicated that they held some type of managerial positions. To further define managerial status, that group was divided into two categories, upper level management (owners, principals, presidents) and midmanagement (project managers, midlevel management, vice presidents). Fifty-three percent of the managers indicated upper level management status, with 47% indicating middle management status. The categories would probably include more of the respondents had the discipline and job task categories been structured instead of open-ended questions. Discussion with colleagues indicated that state licensing requirements may have interacted with job description categories. For example, in some states an individual classified as an engineer can design structures, sewer lines, and the like, but in other states only an individual certified as a structural engineer can perform structural design analysis.

8.3.2 Geographical Distribution

Because saliency of hazard had been related to information seeking behavior, respondents were further classified by state and then region (using census definitions of region). Respondents' locations were developed from the original addresses that had been matched to respondent number. Thus confidentiality of participants was maintained, but the geographical information was used to advantage. As expected, the greatest number of requests (53%) were from the Pacific region. California topped the list with over a quarter of all requests (54 or 26%). The second largest number of requests came from the state of Washington (46 or 22%). Surprisingly, only six requests came from the state of Oregon, one from Alaska, and two from Hawaii.

As expected, the next largest category of requests came from the region at risk from the New Madrid fault. Kentucky headed the regions' count with 18 requests. In descending order were Missouri (14 requests), Indiana (10), and Tennessee (9). Together the requests for the midwest totaled 26% of the whole. Of note were the 18 requests from Massachusetts, the only new England state to request publications on retrofitting.

8.3.3 FEMA Publications Use

Another question asked how often FEMA had been contacted in the past year for information on seismic hazards. The answers were interesting considering the source for user names came from a list prepared from those requesting FEMA publications (stated in the cover letter to the questionnaire). Thirty-nine percent indicated that they had not been in contact with FEMA within the past year, 22% had contacted FEMA once in the last year, and another 36% had been in contact with FEMA from two to five times in the past year. Seven respondents (almost 4%) had contacted FEMA more than six times in the past year for information on retrofitting for seismic hazards. Table 8.4 describes frequency of contact with FEMA in past year.

Table 8.4. Frequency of contact with FEMA in past year for information on retrofitting

Frequency	Percentage
Never	39
Once	22
2–5 times	36
6–12 times	4
More than 12 times	0

To determine which publications were most used by practitioners, a question asked about specific FEMA publications. Table 8.5 describes specific use of selected FEMA publications on earthquake retrofitting. Surprisingly, the FEMA publication dealing most with costs on retrofitting (FEMA 157) was reported as the least used FEMA documents.

Table 8.5. Use of selected FEMA publications on earthquakes (results in percentage of those responding)

The information in this document is used:	Never	Once a year or less	2 to 5 times a year	6 to 12 times a year	More than once a month
FEMA 154, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook*	21	36	32	8	2
FEMA 155, *Rapid Visual Screening for Potential Seismic Hazards: Supporting Documentation*	3	40	22	4	1
FEMA 156, *Typical Costs for Seismic Rehabilitation of Existing Buildings, Volume 1—Summary*	41	37	18	3	1
FEMA 157, *Typical Costs for Seismic Rehabilitation of Existing Buildings, Volume 2, Supporting Documentation*	50	32	15	3	0
FEMA 172, *NEHRP Handbook of Techniques for the Seismic Rehabilitation of Existing Buildings*	30	26	32	10	2
FEMA 178, *NEHRP Handbook for Seismic Evaluation of Existing Buildings*	27	30	28	8	8

To further analyze the results, T-tests were run to compare retrofitters with nonretrofitters. People who have performed retrofit use the FEMA publications with significantly greater frequency than those who have not.

8.3.4 Assessment of the Usefulness of FEMA publications

Two questions assessed usefulness for each publication FEMA has on retrofitting. The first asked respondents how useful the information was for their needs, and the second assessed the sufficiency; that is, was the information sufficient for the respondent's needs. A space was provided for respondents to elaborate or comment on how the information could be improved. Table 8.6 summarizes the respondents' opinions of the usefulness of FEMA publications.

Table 8.6. **Respondents' opinions on usefulness of FEMA publications**
(percent of those responding)

How useful is the information?	Not useful	Somewhat useful	Useful	Very useful	No opinion
FEMA 154, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook.*	2	22	45	22	8
FEMA 155, *Rapid Visual Screening for Potential Seismic Hazards: Supporting Documentation*	5	27	45	8	15
FEMA 156, *Typical Costs for Seismic Rehabilitation of Existing Buildings, Volume 1—Summary*	16	34	23	10	18
FEMA 157, *Typical Costs for Seismic Rehabilitation of Existing Buildings, Volume 2, Supporting Documentation*	18	31	23	9	20
FEMA 172, *NEHRP Handbook of Techniques for the Seismic Rehabilitation of Existing Buildings*	5	18	39	23	15
FEMA 178, *NEHRP Handbook for Seismic Evaluation of Existing Buildings*	5	18	40	25	12

T-tests were also used to examine the usefulness of FEMA publications to those who had performed retrofit and those who had not. People who have performed retrofit have perceptions of the usefulness of FEMA publications similar to those who have not.

8.3.5 Where People Get Information

The Lead Team survey examined the sources used by people to gain information on earthquake mitigation strategies. Multiple categories were offered for respondents' selection. The results were as expected, given the disciplinary backgrounds of respondents. Over three-quarters of the respondents received their information from professional meetings or by attending seminars, classes, or workshops. Sixty-six percent relied on journal articles. Over half stated that information came from federal agencies. What was surprising was the number that reported receiving no information from insurance agents (97% stated no information came this source). Nine-four percent said radio was a source. Eighty-seven percent indicated that television was not a source of information. Receiving information from coworkers was divided in half; slightly more than 49% said no and 50% said yes. Information from local agencies was low (only 27% of such information had been received) but state agencies received 40%. Information from brochures was generally low; over three-quarters (77%) of the respondents never received information from brochures. Even more (84%) did not receive information at informal meetings or from exhibits or demonstrations (87%). Table 8.7 describes the percentage of respondents using the listed sources for information gathering.

Table 8.7. Sources for information gathering

Possible sources	Received information
Co-workers	50
Local agencies	27
State agencies	40
Federal agencies	6
Insurance agencies	03
Informal meetings	16
Professional meetings	77
Seminars, classes, workshops	76
Brochures	23
Journal articles	65
Reports	34
Radio	06
Television	13
Exhibits, demonstrations	13

8.3.6 Familiarity with Sources of Information

Familiarity with information sources often indicates how versed in the professional literature a practitioner is. A number of prominent organizations and agencies were on a list to analyze familiarity. Although some organizations were region-specific, such as the Bay Area Regional Earthquake Preparedness Project, others, such as the National Center for Earthquake Engineering Research at SUNY Buffalo, provide more global data. The questions were organized in table form using a five-point Likert scale of very familiar, moderately familiar, familiar, somewhat familiar, and not familiar. Table 8.8 describes the percentage of respondents familiar with sources. For the most part, respondents were generally not familiar with the information sources listed.

8.3.7 Rating Effectiveness of Mitigation Strategies

Motivation to accomplish a task can be based on individual or legal determinants. To learn if some earthquake mitigation strategies were rated more effective than others, a list was presented for evaluation. A Likert-type scale was used to rate effectiveness of mitigation techniques as very high, high, moderate, low, or very low. The list had been developed from work by Burbee and others on evaluation of

Table 8.8. Familiarity with information sources
(percentage of respondents)

Source	Very familiar	Moderately familiar	Familiar	Somewhat familiar	Not familiar	No response
National Information Service for Earthquake Engineering at UC Berkeley	19	3	15	17	35	1
National Information Service for Earthquake Engineering at Cal Tech	4	6	10	19	58	2
Natural Hazard Information Center at University of Colorado	4	3	10	15	66	2
Loma Prieta Information Center at UC Berkeley	7	6	12	17	57	1
National Earthquake Information Center at Golden, CO	4	5	15	15	59	2
National Earthquake Information Center at Albuquerque, NM	0	1	4	8	84	3
National Center for Earthquake Engineering Research at SUNY Buffalo	15	6	14	10	50	5
Earthquake Engineering Research Institute	37	9	16	10	26	2
Bay Area Regional Earthquake Preparedness Project	10	8	6	12	61	2
Southern California Earthquake Preparedness Project	6	6	10	13	63	2
Central United States Earthquake Consortium	7	7	8	11	61	5
Western States Seismic Policy Council	2	3	6	11	73	6
National Center for Earthquake Engineering Information Service News	18	10	12	17	38	4

floodplain management techniques. To be as comprehensive and as exhaustive as possible, 21 mitigation techniques were listed that communities could use to reduce earthquake hazards. Table 8.9 presents the percentages of responses.

Table 8.9. Summary of effectiveness of mitigation techniques
(percentage of respondents)

Mitigation technique	Very high	High	Moderate	Low	Very low	No response
Building codes	38	39	19	3	0	1
Special seismic resistant building standard	29	44	17	4		5
Retrofit of existing structures	29	30	32	4	2	2
Capital improvements programs	7	18	43	18	5	9
Location of critical facilities (hospitals, schools) to reduce risk	17	36	29	11	3	4
Location of capital facilities (streets, water) to discourage development in hazardous zones	10	28	30	21	7	4
Zoning regulations	7	26	35	18	11	3
Subdivision ordinances	4	16	36	24	15	6
Fault setback ordinances	10	22	37	20	5	6
Public information programs	11	24	33	22	7	4
Hazardous disclosure requirements	6	18	37	26	7	6
Transfer of development from hazardous to non-hazardous sites	5	20	39	25	7	4
Acquisition of undeveloped lands	2	7	31	33	16	10
Acquisition of development rights	1	8	29	33	18	10
Building relocation	2	13	33	30	17	6
Recovery/reconstruction plan	4	18	38	25	7	8
Impact tax to cover additional public costs of building in hazardous areas	4	13	30	30	17	5
Reduced or below-market taxation for open space or nonintensive uses in hazardous areas	4	8	38	29	15	7
Acquisition of damaged buildings	1	9	30	31	20	9
Comprehensive or land use plan	7	24	26	20	8	6
Earthquake component of comprehensive plan	12	30	35	11	6	5

The responses that generate some concern are those that indicate respondents do not consider some innovative mitigation measures generally effective. For example, assessing an impact tax to cover additional public costs of building in hazardous areas, establishing a reduced or below-market taxation structures for open space or nonintensive uses in hazardous areas, requiring hazardous disclosure statements, and public acquisition of damaged buildings were generally regarded as being moderate to low to very low in effectiveness as mitigation techniques. Eleven percent thought zoning regulations to mitigate against earthquake hazards were very ineffective; 15% thought subdivision ordinances were very ineffective. Close to a fifth of the respondents rated acquisition of development rights (18%) or building relocation (17%) as very ineffective.

Measures receiving high marks as effective strategies included building codes, standards, retrofitting, and locating capital facilities and infrastructure away from hazardous zones. Almost 38% rated building codes as very high in effectiveness and another 39% rated such techniques as moderately high; thus more than three-quarters of the respondents ranked building codes as highly effective. Likewise, building standards were ranked very high in effectiveness by 29% of the respondents and as high by 44%; thus more than three-quarters of the respondents rated special seismic resistant building standards as an effective mitigation technique. Twenty-nine percent of the respondents rated retrofit of existing structures as very high in effectiveness, and another 30% rated it as high; thus almost two-thirds rated retrofitting as a highly effective mitigation technique. Location of critical facilities (hospitals, schools) ranked next in effectiveness, with 17% very high and 36% high; thus more than half (53%) rated techniques to locate critical facilities highly effective mitigation measures.

8.3.8 Sufficiency of Information

The survey also asked how sufficient respondents considered specific mitigation strategies. Table 8.10 lists responses on sufficiency of information to support mitigation strategies.

Table 8.10. Sufficiency of information to support mitigation strategies

Mitigation Strategy	Very sufficient %	sufficient %	About average %	insufficient %	Very insufficient %	No reply %
Building standards	19	46	26	6	1	3
Critical and public facilities policies	4	25	36	24	3	8
Development regulations	1	12	42	30	6	9
Information dissemination	1	15	38	35	4	7
Land use policy/land acquisition	1	4	30	41	12	12
Planning	1	7	39	36	8	9
Taxation and fiscal policies	1	6	25	40	17	11
Search and rescue	2	19	37	22	7	13
Insurance		12	34	30	12	11
Reconstruction	1	15	44	27	5	9
Retrofitting	3	27	35	28	5	7

The results show a fairly even distribution, with between 25% and 44% giving average rankings to all categories. Four categories should be noted, however. About one-third of the respondents (29%) noted technical information on mitigating policies for critical and public facilities was above average. More than three-quarters (65%) rated technical information on building standards above average—very sufficient (19%), sufficient (46%), or about average (26%). Taxation and fiscal policies received a low rating—40% felt information provided was insufficient and another 17% very insufficient. Another low ranking went to land and policy acquisition, with 30% giving it an average ranking, but 41% stating that information was insufficient and 12% very insufficient. The comparable category was insurance—receiving a 34% average ranking but 30% saying information was insufficient and another 12% considering the information very insufficient.

8.3.9 Improving Information on Earthquake Mitigation Strategies

Three issues are associated with improvement of information from existing publications or provided in NEHRP-sponsored workshops—determining what is lacking or missing, what needs upgrading, and what information is adequate as is. Respondents were asked what improvements were needed. A list of technical information sources was provided that allowed responses of no improvement, slight improvement, some improvement, moderate improvement, and major improvement. Table 8.11 presents the results of the question on improvements.

Table 8.11. Perceived need for improvement in information
(in percent)

Information Category	No improve ment	Slight improve ment	Some improve ment	Moderate improve ment	Major improve ment	No response
Probabilistic risk maps	7	19	28	22	17	7
Ground failure maps	4	15	27	28	16	11
Fault maps	6	23	24	27	10	11
Liquefaction potential maps	2	8	19	39	22	9
Damage intensity maps	2	11	28	32	19	9
Geotechnical site characterizations	2	6	27	36	19	10
Strong ground motion data	4	11	32	31	14	9
Seismic data (seismographs)	6	19	28	28	10	10
Building codes/standards	3	21	30	31	10	4
Design practice manuals	3	11	26	36	20	4
Public information brochures	2	10	26	29	26	8
Seismic safety seminars	3	9	27	35	18	7
NEHRP workshops	4	11	33	32	12	8

8.3.10 Experiences with Retrofitting

The results of the survey indicated that roughly two-thirds (65%) of the sample had actually retrofitted buildings. The numbers of buildings ranged from 1 to 541. The respondent involved in the retrofitting of 541 structures was responsible for installation of telecommunications networks. In an age of increasing reliance on telecommunications for business purposes and recognizing that retrofitting does not require a large outlay of resources, the number was not unusual. For those 132 people who had been involved with retrofitting, the mean number was 21.5 buildings, although the mode was much lower, at two structures. The total number of buildings retrofitted was 2905.

8.3.11 Respondents' Attitudes Toward FEMA

The responses on attitudes toward FEMA are contained in Table 8.12. The table provides the percent responding for each category.

Table 8.12. Attitudes toward FEMA
(percent responding)

Statement	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	No response
FEMA has the information I need to perform my job	6	37	34	7	2	15
FEMA is easy to contact	10	29	39	6	2	15
The information FEMA provides always meets my needs	3	19	45	14	3	16
The information FEMA provides is easy to understand	7	49	22	7	1	15
The information FEMA provides is inexpensive	32	38	14	1	2	14

The results show a general overall level of satisfaction with FEMA, particularly with the cost of information, the ease of obtaining the information, and the ease of understanding the information. The results indicate the major way in which FEMA can improve is to provide additional information.

8.4 USER NEEDS AND THE SUCCESS OF FEMA IMPLEMENTATION COURSES FOR HOSPITALS AND HEALTH CARE FACILITIES

This section describes the results of the Battelle survey examining the effectiveness of courses (and material distributed) conducted by FEMA from 1989 through 1993 for managers/employees of hospitals and health-care facilities.

8.4.1 Definitions of Users

In this study users are defined as participants in FEMA's course on nonstructural earthquake hazard mitigation for hospitals and other health care facilities. Although health care facilities were the target of the survey, others outside that arena also participated. Of those returning the questionnaire, 80% represented the health industry, 20% other organizations. Table 8.13 describes percentage of respondents in the Battelle survey.

Table 8.13. Respondents in Battelle survey

Facility type of course attendee (N= 271)	%
Health/medical	80
Emergency services	13
Government agency	5
Private organization	2

Respondents were asked to identify the positions that best represented their principal responsibilities in their organizations. Table 8.14 describes position in organization by percentage of participants.

Table 8.14. Position in organization by percentage of participants

Position of health/medical attendees (N= 216)	**%**
Engineering or facilities	28
Medical	27
Others (primarily safety officer or disaster coordinator)	24
Administrators	21

The results show a fairly even distribution among the four position categories. The largest category represented the engineering or facility management community; the smallest group was facility administrators. The survey also ascertained the type of facility represented by health care. Table 8.15 lists types of facilities represented by respondents.

Table 8.15. Types of facilities represented by respondents

Facility type (N= 216)	**%**
Acute care	77
Outpatient only	2
Long-term care	10
Ambulance/paramedic	1
Other	10

The results indicated that most of the facilities involved acute care. Many respondents checked multiple categories of services. All of those checking acute care were classified as such, even though many also provided other types of health services.

In addition, it was determined whether respondents attended the course alone or with others from their facility. Most respondents (59%) attended with one or more other employees from their facility.

8.4.2 Geographical Distribution of Respondents

The locations of respondents can be classified according to the location at which they attended the course as well as the risk zone in which their facility is located. Table 8.16 represents geographical distribution of participants.

Table 8.16. Geographical distribution of participants

State in which workshop was held (N=216)	%
California	32
Washington	27
Maryland	18
Alaska	6
Hawaii	6
Oklahoma	4

Risk zone (N=212)	%
4 (highest)	50
3	26
2b	11
2a	6
1	7
0 (lowest)	1

Ninety percent of those responding took the course in a Pacific Rim state, with the remainder taking the course in the East or Midwest. Exactly one-half of the participants work in the highest risk zone. Participation declines as the risk decreases.

8.4.3 Use of Course Material

Almost all the health care facility respondents remembered receiving the student manual prepared for the course, and just slightly more than two-thirds of all health facility respondents said they had made some practical use of the student manual in order to implement some hazard reduction or preparedness planning action. Over two-thirds of the health care facility respondents also remembered receiving two other FEMA publications, FEMA 150 and FEMA 74, but fewer than half had made some practical use of them. Use rates were very low for the other instructional materials listed in the questionnaire. (See Table 8.17.) Much smaller percentages of the respondents, however, remembered even receiving them. This fact may be to some extent an indication of variations in what was provided in different courses. Without any specific knowledge about what instructional materials were used, only a fairly general list could be made for respondents to think about. Findings on this item would be more valid if the list of instructional materials were developed based on what was actually provided to participants at a particular course. If it is found across several courses that certain materials are generally useful, or seldom useful, this information could be used to help recommend to local organizers what might be best to provide. It also must be remembered that many of the respondents to our evaluation questionnaire had taken the class more than 2 years ago; with so much time elapsed, they may well have simply forgotten which materials had been made available to them, or even which materials they had used for guidance in the months after attending the course.

Table 8.17. Use of course material

Material (N=216)	% Received	% Used
Student manual	95	65
FEMA 150	69	32
FEMA 74	75	41
Slide set	26	10
Videotape: Non Structural	34	15
Videotape: 1985 Earthquake	29	13
Videotape: Buildings	25	12

Just because students remember receiving a publication, and state that they used it, does not necessarily indicate that its use is warranted. Even inaccurate or outdated material can be seen as useful to naive users. It is still necessary to get expert review and opinion on instructional materials in order to be able to make high-quality, state-of-the art information accessible to course participants.

8.4.4 Relevance of Course Material

Respondents were asked to assess the relevancy of the course materials to their facility in the reduction of nonstructural hazards. Table 8.18 describes how respondents rated relevancy of course material to their needs.

Table 8.18. Relevance of course material

Relevance of course materials (N=209)	%
Very relevant	68
Moderately relevant	31
Slightly relevant	1
Other comments	3

The results indicate a very high degree of relevancy to the course participants. Only one participant indicated the course was only slightly relevant to his organization's needs.

8.4.5 Motivation

The 188 respondents who had taken some form of action to reduce or prepare for earthquake hazards were asked about their chief motivations for doing so. Table 8.19 presents reasons for taking actions.

Table 8.19. Motivations for taking actions

Motivator (N=188)	Most important (%)	Among 3 most important (%)
Facility able to function after EQ	31	81
Concern over injuries	26	64
Awareness gained from course	8	39
Concern over losses to facility in EQ	1	29
Concern about liability for injuries	6	22
Accreditation requirements	6	20
Recent earthquakes	6	19
Local or state regulations	3	14
Other	1	3

The question about the most important motivation for taking some hazard reduction or preparedness planning action revealed that concern over the facility's ability to function after an earthquake is the most important driver. This fact suggests that people taking the course find most relevant to them the information that helps them to more clearly understand what is vulnerable within health care facilities and how to address these vulnerabilities directly. Recent events and legal mandates do not provide a great level of motivation.

8.4.6 Constraints

All health facility respondents were asked what prevents them or their organization from beginning or continuing to expand on nonstructural and preparedness activities. Their answers are tabulated in Tables 8.20 and 8.21.

Table 8.20. Constraints to nonstructural mitigation

Constraints to nonstructural mitigation (N=216)	Most important (%)	Among 3 most important (%)
Money	44	68
Threat not important	16	44
Other	12	23
Facility has done all it could	10	24
No mandates	5	31
Lack of in-house expertise	5	23
Lack of information	3	20

Table 8.21. Constraints to emergency planning

Constraints to emergency planning/training (N=216)	Most important (%)	Among 3 most important (%)
Money	35	58
Threat not important	19	47
Other	15	23
Facility has done all it could	14	31
Lack of information	7	17
No mandates	6	31
Lack of in-house expertise	5	23

The most important barrier to addressing nonstructural hazards is lack of money; least important among the factors that prevent a greater degree of action are lack of expertise and lack of information. Of second greatest import is the perception that the threat is not significant enough to warrant action. This perception suggests that even the best-designed and best-taught course in the nation cannot overcome the major in-house barriers to earthquake hazard reduction actions. Thus, the teaching of such courses provides necessary information to enable hospital personnel to take actions when resources are available, but the proffering of information only will never be sufficient to solve the entire problem of lack of action.

8.4.7 Actions Taken After Course

The postcourse actions listed in Table 8.22 regarding earthquake hazard mitigation were reported by the health facility respondents.

Fig. 8.22. General actions taken

Action	%
Training for staff	69
Nonstructural protection	66
Emergency planning	63
Exercise	46
Coordinating/communications	35
Use higher seismic standards	18
Structural improvements	14
Other	7
No actions taken	10

With respect to the postcourse actions, 82% of the health facility respondents reported that one or more enhancements had been made to the facility's emergency preparedness and planning, and two-thirds reported actions to reduce nonstructural hazards. These are impressive percentages. This figure is likely to be biased toward the high end because those who returned the questionnaire are probably those with the greatest interest or the most to report. In contrast, those who did **not** respond are likely to be those with the least interest or with little or nothing to report.

Although the principal objective of the course was to promote the reduction of nonstructural hazards, and this subject was probably given great emphasis in most or all of the classes, it is not surprising that actions to enhance a facility's emergency preparedness and planning were reported more often than nonstructural or structural measures. Emergency preparedness actions are generally easier actions to implement, cost less, and require less administrative commitment than nonstructural hazard reduction or structural reinforcements. The findings suggest, however, that, even for planning and preparedness, larger facilities and those in the higher risk zones are more likely to report taking actions following the course.

The percentage that reported taking actions to reduce nonstructural hazards is likewise impressive. The question did not ask for further detail or clarification on the extent of the action taken, however; therefore, a reported action could range from some fairly insignificant action in one department to a major assessment and hazard reduction campaign throughout the entire health care facility.

As expected, only a relatively small number took any structural actions or planned to increase the level of safety in planned or future construction.

8.4.8 Dissemination of Course Information

All respondents were asked about what they did to disseminate course information to other people. Table 8.22 describes the actions taken.

Table 8.23. Specific actions taken

Action (N=263)	%
Gave a talk at meeting	65
Distributed course materials to others	43
Used videos in presentation	13
Was instructor in course	14
Used slide set in presentation	13
Other	29
None	11

Almost 90% of the respondents reported having passed information from the course to someone else by at least one means (e.g., gave a course, gave a talk, photocopied material), and just over half reported having passed information along in two or more ways. The major means in which information was disseminated were through giving a talk or by photocopying some of the course material for others.

8.5 DISCUSSION OF FINDINGS

8.5.1. General Findings

The two studies suggest that:

- The two NEHRP activities assessed are going a long way in meeting the user needs for which they are targeted. Overall, users expressed a relatively high degree of satisfaction with the courses and related materials and the publications on the built environment. On the other hand, the extent to which they serve the entire universe of potential users and the size of that universe cannot be assessed.

- People are using the materials and publications in their respective professions and disseminating the work to others with a need or desire to learn more about earthquake hazard mitigation.

- NEHRP activities can be associated with efforts to adopt earthquake mitigation activities. Although a simple cause and effect relationship has not been established, those attending the course or who have received FEMA publications are engaging in earthquake mitigation activities.

- A further unmet demand exists for additional technical information that would support a range of mitigation efforts. Those areas include better technical assistance manuals, additional workshops and courses, better geotechnical information for mitigation applications, and better information for use in planning and public education efforts.

8.5.2 Significant Relationships

Either contingency tables using Chi-square tests of association or T-tests were used to examine relationships among the variables measured in the studies. The documentation of the results of these tests is not presented but is summarized in this section.

8.5.2.1 Relationships to Mitigation Activities

The Battelle study examined relationships between mitigative actions and a number of different factors. The study examined actions classified as nonstructural-, structural-, and preparedness-related, as well as the total number of actions taken. The analysis showed that nonstructural actions are more likely to be taken in higher risk zones than in lower risk zones. In addition, nonstructural actions more likely in long-term care facilities and less likely in outpatient facilities. The respondents' position in the organization had little to do with taking such actions. Planning and preparedness activities were also more likely in higher risk zones. Structural actions were not related to risk zone position or organizational type. The number of actions taken was higher in higher risk zones and weakly related to organizational size. Multiple participation by members of an organization in a course was not related to number of actions taken by the organization.

The Lead Team study examined differences between those respondents who had performed retrofit and those who had not. Those with experience consistently used the FEMA documents on mitigation techniques more frequently than those who had not, although those who had did not have different perceptions of the usefulness of the documents nor different attitudes towards FEMA. Retrofitters came from smaller organizations, which spent a larger portion of their time and budget on earthquake mitigation activities than those organizations who had not retrofitted. Respondents involved with retrofitting perceived a greater vulnerability from earthquakes, perceived higher odds for a damaging earthquake, and had more direct earthquake experience. They were also professionally active in organizations related to earthquake hazard mitigation.

8.5.2.2 Relationships to Information Use and Dissemination

The Battelle study examined use of course materials and dissemination of information acquired in the course. Use of materials was significantly related to the respondents' perception of the relevance of the course. Position was not related to use of the materials except that medical staff were less likely to use the materials than other attendees.

The findings also indicated a strong relationship between a person reporting that his/her facility had taken some action and in reporting that he/she had disseminated information in multiple ways. The perceived relevance of the course to the attendee's type of facility seems to be a key factor in participants' use and sharing of the information provided to them. This perception suggests that the better the match of participants to the content of a particular class, the more effective the class will be in meeting the objective of enabling participants to lessen the vulnerability of their facility to earthquakes. Dissemination was also related to risk zone, with those health care participants in higher risk area being more likely to actively disseminate information.

The Lead Team study had similar findings. Respondents who found the publications useful were also likely to use them frequently. Again, use also increased among those retrofitting, suggesting that dissemination of information will have variable effectiveness regardless of mechanism, with those active in the mitigation process viewing the information as useful and relevant and putting it to use in their activities.

8.5.3 Implications for User Evaluation

Evaluative research generally uses scientific procedures to acquire data to determine if a program is producing the desired results—the stated goals or objectives. NEHRP is an umbrella program covering many aspects of earthquake reduction and hazard mitigation techniques. Some programs are directed to large municipalities; others, such as those activities related to the built environment, are designed to reduce hazards on a much smaller scale. The problem with NEHRP is that the specified goal—reducing earthquake hazard through mitigation—has not had wide empirical testing because earthquakes are events of low probability with wide variations in time occurrences, even though high in consequences in terms of potential damages. The specific goal of transmitting information may be more easily evaluated than other aspects of the NEHRP, such as interagency plans to protect lifelines or maintain networks after an event.

Clearly the evaluation of current strategies to disseminate information to user groups influential in protecting targeted populations is appropriate for NEHRP. That both the Lead Team and Battelle surveys used scientific procedures to examine the effectiveness of two aspects of NEHRP is an important distinguishing feature of the results, equal to and of no less importance than examining how key informants or experts view the progress of the program. Both evaluative strategies were designed to assist decision-makers in their efforts to refine the program and to initiate policies to reduce earthquake hazards.

A dilemma is the extent to which questions reflect the types of questions decision-makers want answered, and whether those questions should reflect the broader conceptual base of the program itself. Another problem is how specific questions should be in relationship to the information provided.

8.5.3.1 Choice and Delineation of Populations

The NEHRP program serves a variety of audiences and participants. It is often difficult to segment these participants into different populations with the intent of robustly measuring their experiences with the program. In the two surveys conducted, fairly well-defined populations were developed. Despite careful delineation, methodological problems still are found.

For example, studies used the same questionnaire for all respondents. In the case of the health care course, the approach assumes that all the course offerings were the same. Because of variations, however, in local experts available to teach the course, time constraints, or other reasons, it is probably the case that not all courses cover all topics in the same amount of detail. Thus further segmentation of the population might produce more meaningful results.

In the Lead Team study, the population was limited to building design professionals requesting publications. There is no doubt overlap between this group and other groups requesting publications. In this case, limiting the group may have also limited the insight gained from the general approach used in the survey.

8.5.3.2 Focus of Dependent Variable

Ensuring validity and reliability among measures used to determine effectiveness is essential in any evaluation program, particularly if the assessment covers various aspects or functions of an extensive program like NEHRP. Consider the Battelle study. Measures will be most valid when the questionnaire asks specifically about things that were addressed in some detail in the course. When designing the list of actions used to prompt the respondent, it would be better to have this list of postcourse mitigation activities matched to the way in which the course is offered at a particular site. If it is necessary to use a generic instrument such as was used for this evaluation, the alternative is for the evaluator to be aware of which of the items in the list would be expected to have low answers because they weren't covered in that particular course.

8.5.3.3 Timing of Evaluation

The responses received may have been affected by the time various respondents had to work with or apply information from reading publications or from course attendance. The Battelle survey used as a population all persons who had attended FEMA courses since 1989. Thus, some respondents may have attended a class in April 1989 while others attended classes in July 1993. The Lead Team survey used as a population persons that received FEMA publications on retrofitting between the beginning of 1991 and July of 1993. Thus the time frame is probably similar between the two groups sampled, but the decay rate of recollection for specific course activities may be greater for respondents to the Battelle survey. The Battelle researchers postulated that the longer the time since the course taken, the less likely respondents were to remember much about the course or what they did following their attendance. Battelle researchers recommended a follow-up be conducted between 6 months and a year to balance the need for time to accomplish something, yet still have the respondents remember enough about the course and their intentions and actions in relation to the facility.

The population sampled by the Lead Team likely used the documents requested on a more regular basis, and thus respondents were more familiar with (and knowledgeable about) the information available, making recall easier. That such documents were used on an ongoing basis was indicated by several respondents. Those respondents noted that they used specific FEMA documents in initial consultations to assist clients in understanding the problems associated with retrofitting structures. It is clearly in the design professional's best interest to be informed, but it is unclear whether such objectives would be a factor important to those sampled in the Battelle survey. If the goal is to examine dissemination of information generated by FEMA, those surveyed by the Lead Team achieved that goal, but the time frame is uncertain because of the randomness of dissemination.

One purpose of an evaluation after dissemination of information is to determine if the material was organized and received in a timely manner to enhance use. The following points arose from the study of survey results.

Causation. In both studies it was difficult to establish a notion of causality. Did people take the course because they were engaged in mitigation, or did the course prompt mitigative actions to be taken? Likewise, did the publications on retrofitting cause an increase in retrofitting activities, or were they requested to carry out planned activities?

Survey vs Other Techniques. It is difficult to evaluate intentions prior to actual implementation of mitigation strategies. Methods such as survey research cannot always capture intent or the dynamics of human behavior. Surveys should be complemented by other evaluation methods designed to lend context and meaning to the survey results.

Institutionalizing Evaluation. The first step in institutionalizing an evaluative program for NEHRP is to acknowledge that a program needs continuous monitoring to refine the objectives and initiate mitigation strategies. Targeting specific groups as well as gaining feedback from a large cross section of program participants are desired activities. Such activities will be most effective if they are institutionalized as part of the NEHRP.

8.5.4 Implications for NEHRP Strategic Planning

The surveys conducted in this assessment provide solid evidence of the value of a scientific approach to assessing user needs. Such efforts do not necessarily cost more or consume more time than less rigorous approaches to assessing user needs. Often surveys such as these produce results that defy conventional logic or prevailing wisdom. It is easier to document such cases when the techniques used can be understood and replicated. Both surveys illustrated the need to do further targeting of information to particular subgroups of the populations investigated. For instance, having medical personnel attend earthquake mitigation course is not a particularly good investment of resources.

Given the time constraints and resources at hand, the surveys provide a demonstration of the role systematic evaluation can play in program assessment. As such they cannot lead to a comprehensive set of recommendations on how to improve NEHRP. Nevertheless they provide an initial starting point for a more rigorous and comprehensive approach to planning.

9. NEHRP STRENGTHS AND SUCCESSES

9.1 GENERAL

During the teams' assessments and during the workshop, many of the users identified strengths and successes. Although it was not the purpose of this Assessment to seek strengths and successes of NEHRP, it was decided that they needed to be considered in this Assessment to put this report in proper perspective. NEHRP has been extremely successful since Congress created the 1977 Act, especially in the area of increasing the knowledge base. In Sections 3 through 7, crosscutting and single-area strengths and successes have been identified for each of the four areas. In addition, because of the Project Team's experience with NEHRP, other strengths and successes can be easily identified. As a result, the Project Team chose to summarize and generalize some of the major accomplishments of NEHRP, as described below. The summaries reflect Assessment Team and user input and the Project Team's knowledge. For more detailed identification of strengths and successes, the reader is referred to Sections 3 through 7.

9.2 NEHRP ACCOMPLISHMENTS

The Project Team has selected 15 broad areas to cite as major NEHRP accomplishments since 1977:

1. In 1977, engineers and scientists were the primary champions of earthquake knowledge and mitigation. Today, professionals such as social scientists, planners, emergency preparedness personnel, doctors, and school teachers are also champions.

2. In 1977, there were four model building codes—and only one required seismic design—though they were woefully lacking compared to today's standards. As a result of NEHRP, seismic design provisions have evolved since the formation of the Building Seismic Safety Council and the support it has received from the Applied Technology Council. Today, three model building codes exist with consistent seismic design provisions that basically represent a national consensus.

3. In 1977, federal and federally backed building construction in the United States was not consistently required to be designed for seismic loads. Today, Executive Order 12699, executed with the collaboration of federal agencies through the ICSSC, requires for agencies that own, build, or assist in building any new buildings, that all such new construction be designed for seismic loads.

4. In 1977, basically only one recognized center (EERC) existed for earthquake research. Today, four centers exist (EERC, CERI, NCEER, and SCEC).

5. In 1977, no consortia existed for earthquake preparedness. To date, four organizations (CUSEC, BAREPP, NESEC, and SCEPP) have provided direct technical assistance to their respective regions.

6. In 1977, no work had been done on the Wasatah Fault, but during the 1980s, a comprehensive program funded by NEHRP through USGS resulted in a significantly improved understanding of the hazards and risk for Salt Lake City.

7. In 1977, very little was understood about seismicity in the central and eastern United States. Today, a wealth of information exists, including a better definition of the New Madrid fault, the development of a New York City proposed seismic code, the adoption of seismic provisions in the model building codes, and the adoption by many states and municipalities of those codes.

8. In 1977, very little was known about earthquake predictions, although, at the time, many thought the profession's ability to predict earthquakes was near. While advances have been made, the profession still has a long way to go. NEHRP has brought about a major earthquake prediction experiment, the Palmdale Experiment, and the formation of the National Earthquake Prediction Council (NEPC) that assesses the credibility of scientists' predictions to keep the public properly informed.

9. Since 1977, FEMA has been the lead agency for coordinating NEHRP activities among the four responsible agencies. In 1987, the agencies conducted what might be called a self-audit by bringing in an expert review committee to assess NEHRP. That committee's report recommended that a leadership role be established to make NEHRP more effective, and this action was taken by Congress when the Act was amended in 1990.

10. From 1977 through the 1980s, NEHRP was primarily a knowledge-based program. Today NEHRP's activities have a large element of implementation of mitigation which has, for example, led to the formation of the consortia mentioned above.

11. In 1977, the professions had little knowledge about the cost of seismic design or the cost of damage, both direct and indirect, as a result of earthquakes. Today, the cost for seismic design is well-understood, and we are on the threshold of understanding well the cost of damage as a result of earthquakes.

12. In 1977, no nationally accepted earthquake loss estimation methodology existed, and the understanding of the seismic vulnerability of major metropolitan areas was lacking. During the 1980s, NEHRP moved toward developing a nationally accepted loss estimation methodology, an activity, which is now under way, and conducted several vulnerability studies using existing loss estimation methodologies to try to better understand the risk to major metropolitan areas such as Los Angeles, Memphis, and Charleston, South Carolina.

13. Since 1977, NEHRP has been responsible for the production and distribution of numerous special publications and educational materials, including a program for grades K-12. This body of information has contributed substantially to the knowledge for all users.

14. NEHRP has been a prime sponsor of workshops, seminars, and conferences. Many of these activities would not have been carried out without the funding and support from NEHRP.

15. NEHRP has continued to support a lessons-learned program through postearthquake investigations around the world. That in itself has contributed greatly to the understanding by all professionals of all facets of earthquake risk, from building damage to human suffering.

9.3 SUMMARY

Many accomplishments have occurred through NEHRP. While improvements can still be made to the program, it has been successful, and the accomplishments described above are only a representative sampling of the program's strengths and successes.

9.4

10. MAJOR ISSUES AND RECOMMENDATIONS

10.1 GENERAL

This chapter presents the results of an analysis of the findings and recommendations identified in Sections 3 through 6 for the four generic assessment areas: (1) Seismic Hazard, (2) Built Environment, (3) Societal and Policy, and (4) Implementation. This analysis searched for common themes among the findings and recommendations to identify the major issues for NEHRP in meeting user needs. As a result, six major issues were identified from the four assessment areas: (1) Funding, (2) Management, (3) Consensus, (4) Linkages—Researcher to User, (5) Codes and Standards, and (6) Education and Information Flow. They are further defined in Section 10.3.

When analyzing findings and recommendations of assessments of this type, there can be a number of ways to approach their summarization. The approach used for this Assessment is described in Section 10.2.

The six major issues and their corresponding recommendations are the essential areas where NEHRP must place its future emphasis in order to make significant improvements in NEHRP and to achieve improved seismic risk reduction for the public.

10.2 THE ANALYSIS OF FINDINGS AND RECOMMENDATIONS

When reviewing the findings and recommendations of this Assessment, the original concept for this chapter was to identify the top 10 findings that would include common themes and individual findings throughout the four assessment areas. As the Project Team began the analysis of the findings and recommendations, however, the process evolved into what can be described as an approach that would result in developing major issues from the Assessment Teams' findings and the key recommendations associated with each.

This approach involved reviewing each finding with the goal of categorizing similar findings. As an example, finding 3.6 states, "NEHRP addresses the major seismic hazard issues, but, because of funding limitations, not all issues are being pursued." Because the root cause of this finding appeared to be funding, it was placed into a category called "Funding." During the initial phase of the analysis, approximately 12 potential categories were identified. After several analysis iterations, however, six categories were retained, categories that the Project Team felt encompassed all findings of the four assessment areas. These six categories then became the six major issues.

To further analyze the appropriateness of each category and the respective category placement of each finding, each individual issue was evaluated against the other issues and associated findings for (1) clarity of definition (i.e., did the definition of the issue reasonably represent the findings and corresponding recommendations?), (2) mutual exclusivity (i.e., can the issue be considered generally independent of the other issues?), (3) internal consistency (i.e., was the sorting of findings into a category consistent throughout all six categories and 37 findings?), and (4) comprehensiveness (i.e., did the six categories reasonably encompass all findings and recommendations?).

To further evaluate the classification process, the six issues were evaluated as to how fully they represented the NEHRP process. The NEHRP process was defined using a standard model of knowledge dissemination. The process begins with (1) "the development of basic engineering and scientific knowledge" which results in (2) "the development of mitigation technology" for which (3) "knowledge transfer mechanisms must be developed," followed by (4) "the use and adoption of mitigation methods" that result in (5) "risk reduction." The five elements defining this flow of the NEHRP process are shown in Fig. 10.1.

The six major issue categories were also placed onto Fig. 10.1 to determine how well they represented or compared with the five components of the NEHRP process. Funding and Management obviously cover or have an impact on all five components. Consensus primarily represents the first two elements, Linkages—Researcher to User link the first four elements, Codes and Standards address the first two, and Education and Information Flow relate the third and fourth elements.

As discussed in Section 10.1, there can be a number of ways to analyze the findings and recommendations of this Assessment. This analysis represents one appropriate method. Table 10.1 summarizes the results of the classification of the 37 findings and recommendations into the six major issue categories of this Assessment.

Table 10.1. Categorization of findings and recommendations in major issue categories

Funding	Management	Consensus	Linkage - Research to User	Codes and Standards	Education and Information Flow
Finding	Finding	Finding	Finding	Finding	Finding
3.6	3.10	3.3	3.5	4.2	3.1
3.8	5.10	3.4	3.8	4.3	3.2
6.4	5.12	3.7	4.1	4.4	3.9
	5.13		5.15	5.9	4.5
	5.14		5.3		5.1
	5.2		6.5		5.4
	5.7				5.5
	5.8				5.6
	6.6				5.11
					6.1
					6.2
					6.3
					6.7

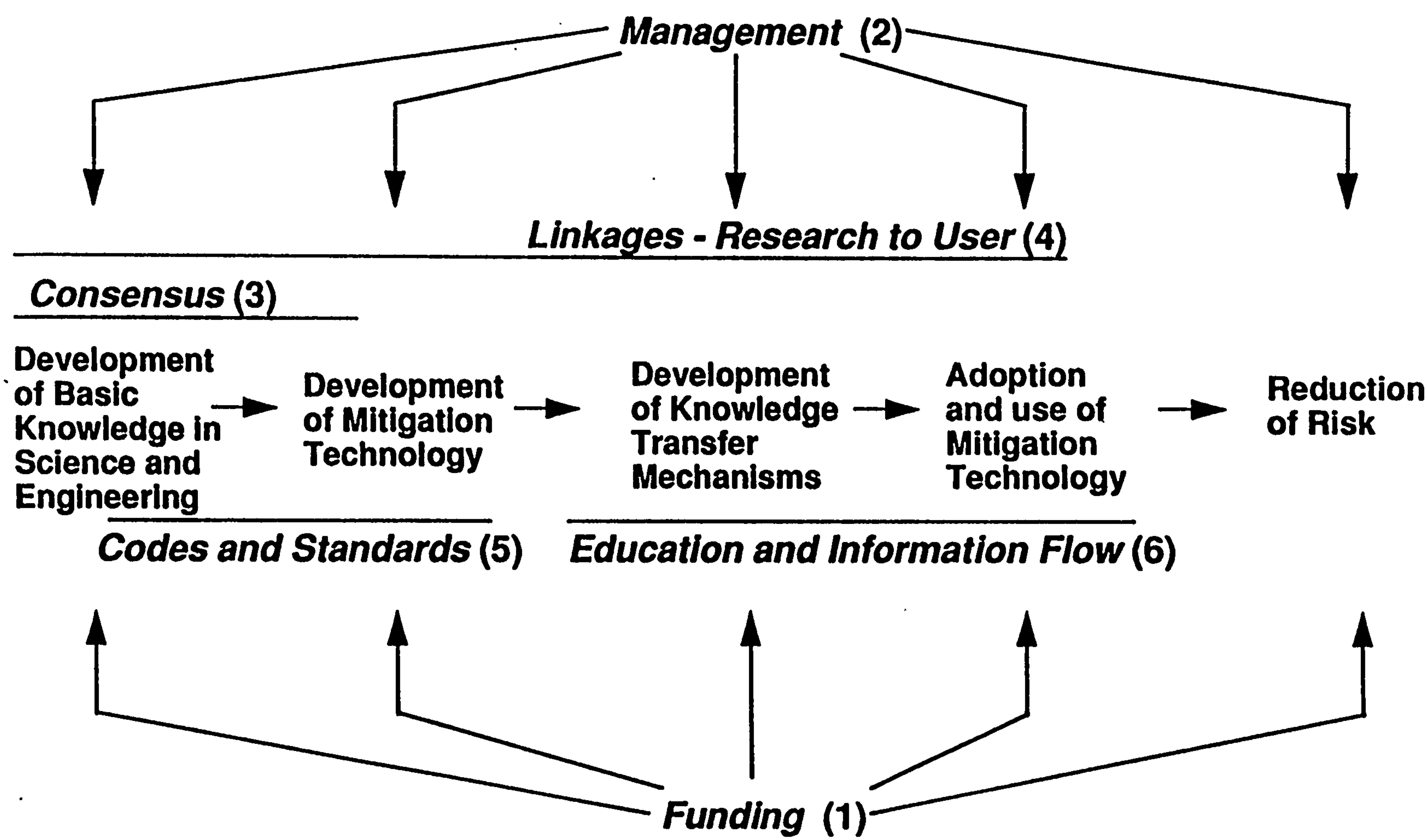

Fig. 10.1. Analysis of user needs in the implementation of mitigation in NEHRP.

10.3 MAJOR ISSUES AND RECOMMENDATIONS

10.3.1 Funding

Issue. The availability of funding has prevented NEHRP from being a truly national program and is limiting the pace of mitigation.

Discussion. Assessment findings 3.6, 3.8, and 6.4 specifically identify funding as an issue related to NEHRP's not being a truly national program, point out gaps in seismic mapping of high-risk areas, and rank funding as the number one barrier to implementing risk reduction measures. The level of funding for NEHRP and its apportionment has been identified in reauthorization hearings (1990, for example) over the years, and most recently in the NEHRP FY 1994 budget. Since authorization of NEHRP in 1978, in real dollars the funding level decreased from $53 million to $35 million in 1990 ($66 million in 1990 dollars). After the Loma Prieta earthquake of October 17, 1989, Congress added supplemental funds of $20 million. Since 1990, NEHRP's funding has basically remained at that level—increasing to $99 million for FY 94. Considering real dollars, the FY 94 budget is comparable to the 1978 budget level, however. Following the Northridge earthquake of January 17, 1994, Congress added supplemental funds of $15 million to NEHRP, and the President has added some funds to NIST and the USGS from his discretionary budget. Even so, the NEHRP budget has not grown as many expected. In 1987, the Expert Review Committee recommended an annual budget for 1989–1993 of $199 million. Thus the total funding available, its apportionment, and the requirements associated with its use are all topics of concern. For NEHRP to better meet user needs and for risk reduction to proceed at a generally expected pace, NEHRP needs to examine its prioritization of activities and develop a better means of leveraging limited funds.

Recommendations. NEHRP needs to develop a strategic plan that addresses program priorities in the short and long term. NEHRP needs to leverage the funding for its own programs through greater cooperation with other federal agencies, state and local governments, and private industry. Such cooperation could reduce some of the barriers to implementation and mitigation fueled by state and local officials.

10.3.2 Management

Issue. Improvements need to be made in the overall management of NEHRP and in NEHRP's coordination, support, and cooperation with other federal agencies, state and local governments, private industry, and regional consortia to make significant gains in seismic risk reduction.

Discussion. Assessment findings 3.10, 5.2, 5.7, 5.8, 5.10, 5.12, 5.13, 5.14, and 6.6 are considered to be issues related to the management of NEHRP, including the associated need for improved teamwork. It was pointed out that NEHRP needed to work with and utilize the seismic products of other federal agencies, that NEHRP needed to tailor its programs to specific regions, and that flexibility with state and local government requirements was needed (less bureaucracy) to maintain state involvement and to encourage state support. It was noted that programs were highly diffused, and a stronger involvement of the private sector and regional consortia is required. A consistent and organized method for developing strategies and evaluating effectiveness of NEHRP programs and activities was lacking. The lack of understanding of the lead agencies' (FEMA) total responsibility was shown as a symptom of this issue.

Recommendations. A management structure should be set up to ensure better coordination, cooperation, and support of all federal agencies, state and local governments, and nongovernmental organizations that are working in seismic risk reduction. NEHRP educational, training, and implementation programs should be tailored to users' needs. NEHRP needs to include improved incentives or other alternative mechanisms to increase user support of seismic risk reduction.

10.3.3 Consensus

Issue. The lack of consensus for a number of NEHRP products is limiting the pace of risk reduction.

Discussion. Assessment findings 3.3, 3.4, and 3.7 were identified with the ability to maintain, or the need for, consensus. Although finding 3.3 did not specify consensus as the issue, the corresponding recommendation cited "verification of models" and "proof tests by users," which are methods for achieving consensus. In today's world, the development of new research products is occurring at a rapid pace. To get these products into user's hands, however, a consensus that such products are useful is required. The recommendation of finding 3.4 states, "NEHRP should place greater emphasis on consensus building and consensus documents...."

Recommendations. NEHRP needs to place greater emphasis on the process of establishing consensus to ensure that consensus is achieved in the various products it develops before such products are distributed or introduced for broad use in seismic risk reduction activities. Some levels of consensus must be achieved even for products distributed for trial use; however, one must be careful when selecting products that require consensus, since obtaining consensus can be a significant impediment to timely transfer of a product to a user.

10.3.4 Linkages—Research to User

Issue. The linkage between research products and user needs must be improved, including having the research products transferred to the users in a user-friendly form.

Discussion. Assessment findings 3.5, 3.8, 4.1, 5.3, 5.15, and 6.5 identified a number of NEHRP activities in which the relationship between the researcher and the user must be improved. This relationship involves researchers' understanding of what user needs are and doing research to meet those needs. It also involves NEHRP issues related to Issue 10.3.6, Education and Information Flow. As stated in finding 4.1, "Translation requires...improved channels of communication between the practice/research community and NEHRP agencies...." Users need to be involved in setting NEHRP research priorities. In addition, finding 5.15 and associated discussion point out that today there are a number of social science user needs but a lack of social science research to meet those needs.

Recommendations. In parallel with recommendation 10.3.2, NEHRP must establish mechanisms to obtain user input in research agendas and priorities, and communication links should be set up through advisory committees and/or research/user-need summit meetings. In addition, NEHRP should conduct future self-assessments (such as this one) to continually determine whether research products fulfill user needs.

10.3.5 Codes and Standards

Issue. The lack of (and the need for improvement of) existing codes, standards, guidelines, and methodologies is slowing the pace of seismic risk reduction.

Discussion. Assessment findings 4.2, 4.3, 4.4, and 5.9 can be considered as having identified this issue as a root cause. In addition, other Assessment findings can be found to support this issue, such as finding 3.4, "Standards, guidelines, and professionally accepted methodologies are needed for many hazard mitigation products." Many users expressed the concern that current codes and standards need improvement, that performance codes should be developed for designs of buildings, and that methodologies need to be adopted to assess infrastructure vulnerability. It was pointed out that for lifelines—a major portion of the nation's infrastructure—no codes, standards, or guidelines exist for design or evaluation.

Recommendations. NEHRP should address this issue in its strategic planning process. Specifically it should evaluate the current status and user needs for codes, standards, guidelines, and methodologies; establish a plan for addressing the issue; and implement the plan as soon as possible.

10.3.6 Education and Information Flow

Issue. A significant need exists for more education and for improvements to information flow from researcher to user to enhance NEHRP and seismic risk reduction.

Discussion. This issue resulted in the biggest category in the analysis, 13 of 37 assessment findings (3.1, 3.2, 3.9, 4.5, 5.1, 5.4, 5.5, 5.6, 5.11, 6.1, 6.2, 6.3, and 6.7). Obviously a number of these 13 findings also relate to the other issues, but they were deemed by the Project Team analysis to fit better in this issue. Like Issue 10.3.4, Linkages—Research to User, findings across all four Assessment areas involve this issue. When interviewing users, it became apparent that many were not aware of NEHRP. Those who were had difficulty obtaining the information they requested. Cases were cited in which the information was never received. As in Issue 10.3.4, Linkages—Research to User, the flow of information with respect to knowledge transfer is weak. In addition, as in Issue 10.3.2, Management, users cited the need to improve the flow of information through such channels as regional consortia and target groups.

With respect to education, finding 3.9 states, "Education of hazard-product users (e.g., owners, regulators) must occur for the hazard information to be useful and implemented." Finding 4.5 states, "Improvements are needed in basic education...to improve the technology base of designers and constructors for seismic safety." Finding recommendation 6.7 states, "NEHRP...should place greater emphasis on training and education programs that address implementation of risk reduction programs...."

Recommendations. NEHRP needs to reevaluate its educational and information service activities, to become more proactive rather than reactive, and, in its strategic planning process, to develop new educational and information requirements that, when evaluated against the 13 Assessment findings, will be considered as addressing those findings.

11. CONCLUDING REMARKS

The primary objective of the 1993 National Earthquake Hazards Reduction Program Assessment was to take a "snapshot" assessment of the needs of selected users throughout all major program areas of NEHRP, with secondary objectives being to assess the knowledge that exists (or is being developed by NEHRP) to support earthquake risk reduction and to begin a process of evaluating how NEHRP is meeting user needs to reduce seismic risk.

As noted in Section 1, while the results of this Assessment do not totally represent a comprehensive, scientifically based survey approach, the Project Team believes the findings identified are representative of user needs, and the recommendations made, when implemented, will significantly improve NEHRP and meet many user needs identified in this Assessment.

During the planning stages of this Assessment, the NEHRP Advisory Committee provided four fundamental comments and recommendations for the Assessment, as follow.

1. Caution should be exercised in the identification of users and the collection of information from them, so that the most effective and useful input to the program is gathered.

2. The schedule may be unrealistic, but could be accommodated if preliminary information is acceptable for commencement of the program planning process.

3. The project is feasible if depth is not a preoccupation and if it is viewed as an ongoing effort.

4. The NEHRP Assessment as stated in the presented approach is actually seeking participation in the decision process of the user groups. That is a good goal to have.

With respect to the first comment/recommendation, the Project Lead Team believes the Assessment Teams did an outstanding job in identifying users that could provide effective input. The collection of information from the users is difficult to challenge when the 188 personal interviews, which lasted from 30 minutes to 3 hours, are considered. In addition, more than 1700 professionals had the opportunity to provide direct input into the Assessment, and, as noted in Section 2, the Assessment Teams have evidence of approximately 900 direct participants.

The Project Lead Team and the NEHRP Advisory Committee shared a like concern about the schedule. The Project Lead Team, however, is of the view that the data collected from the users extend beyond preliminary information and that the results of this Assessment (Sections 3 through 10) provide a strong foundation for NEHRP agencies to begin their strategic planning process.

Concerning the NEHRP Advisory Committee's third principal comment/recommendation, the Lead Team or the Assessment Teams did not become preoccupied with investigating user issues of great depth. It should be noted by the reader throughout Sections 3 through 10, however, that enough common themes emerged from interview results, backed up by various workshops and mail surveys (in particular the Assessment's User Workshop), to show that the findings and recommendations contained in Sections 3, 4, 5, 6, and 10 are well founded.

With respect to the NEHRP Advisory Committee's fourth comment/recommendation, the number of collaborative and end-users who participated in this Assessment is strong evidence of the opportunity for user participation in the planning process. For this user input to be part of the process, however, the results of this Assessment must be used by the NEHRP agencies.

In conclusion, this Assessment has provided the NEHRP Agencies with six major issues and associated recommendations for improvement in meeting user needs as discussed in Section 10. In addition, the 47 findings and recommendations defined at the subprogram level are discussed throughout Sections 3 through 6.

The results of this Assessment have focused on user needs for the improvement of NEHRP; however, NEHRP has had significant successes, as was briefly discussed in Sections 3 through 6 and more broadly discussed in Section 9. The NEHRP Provisions for seismic design of new buildings are a perfect example of success in meeting user needs. That which was done right, with the development of the Provisions and the transfer of technology to the end-users, repeated in the future for other areas of user needs will accomplish many of the recommendations that resulted from this Assessment.

APPENDIX A

NEHRP ASSESSMENT PROJECT
PROJECT TEAMS AND STEERING COMMITTEE

APPENDIX A.1

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APPENDIX B

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Maps 5-6: Preliminary map of the maximum 0.3 second spectral response acceleration, $S_{A(0.3)}$, with a 90 percent probability of nonexceedance in 50 years.
Maps 7-8: Preliminary map of the maximum 1.0 second spectral response acceleration, $S_{A(1.0)}$, with a 90 percent probability of nonexceedance in 50 years;
Maps 9-10: Preliminary map of the maximum 0.3 second spectral response acceleration, $S_{A(0.3)}$, with a 90 percent probability of nonexceedance in 250 years;
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APPENDIX C

GLOSSARY OF TERMS

A/E firm	is an architect and engineering firm.
Agencies	are the NEHRP agencies.
Anonymity	is at three levels in this document: (1) anonymity in which the user is known only to the interviewer in a face-to-face interview; (2) anonymity for mail survey respondents who may not be known even by the surveyor, and (3) anonymity in which the user participation is not identified with any findings or quotes but his/her name is listed in Appendix D as participant of the overall Assessment.
Assessment	is the NEHRP Assessment Project.
Assessment finding	is a brief (one- to two-sentence) statement of common user needs identified in the Assessment and deemed by an Assessment Team or the Project Lead Team as needing attention in the planning process of NEHRP in order to meet user needs, as defined in Sections 3 through 6.
Assessment Project	was requested by the Steering Committee.
Assessment recommendation	is a recommendation resulting from an Assessment finding.
Assessment Team	is any one of the four teams: Seismic Hazard, Built Environmenbt, Societal and Policy, or Implementation.
Base isolation	is a system used to decouple the superstructure of a building from ground shaking.
Collaborative user	is a knowledgeable user characterized as a professional very familiar with NEHRP activities; may be a champion of such activities.
Common themes	are information concerning user needs obtained from individual users that was similar or constant with user needs defined by other users.
Consensus	in the broadest sense, is a process of getting agreement between professionals on a particular subject that a majority of other professionals would also support.
Consistent themes	See Common Themes.
Crosscutting priorities	are priority needs, findings, or recommendations that cut across the four fundamental areas of NEHRP that will require two or more NEHRP agencies to satisfy those needs, findings, and recommendations.
Data base	is a collection of data organized especially for rapid search and retrieval by computer.

Data Generators/Researchers	are those individuals who collect basic data and conduct basic research; their research findings are used by hazard analysts.
Delivery systems	are mechanisms for knowledge transfer (see Methodologies).
Eccentrically braced frames	are the framing system of a multistory building braced by eccentrically placed diagonal braces.
Emergency facilities	are buildings and facilities that provide critical emergency services during earthquake disasters (e.g., hospitals, police and fire stations, utility systems such as electric power and water supply, emergency communication systems).
End-user	is a least knowledgeable user characterized as a professional who may not be knowledgeable of NEHRP but needs NEHRP products to carry out his/her professional responsibility.
Federal assessment	is the Implementation Teams' assessment of user needs of federal agency members of the Interagency Committee for Seismic Safety in Construction (ICSSC).
Final Report	is the NEHRP Assessment Project Report provided to the agencies.
Finding	See Assessment finding.
Generic area	is one of the four program subareas of NEHRP defined as seismic hazard, built environment, societal and policy, and implementation.
Generic Assessment area	See Generic area.
Geographic information	is a computer-based digital system for archiving and Systems displaying geographic data sets.
Geotechnical	is the application of scientific methods and engineering principles to the acquisition, interpretation, and analysis of engineering problems involving earth materials.
Goals	is a term interchangeable with Purpose (which see).
Hazard	is an area or areas where potential for earthquakes exists and can threaten life and property and cause corresponding ground effects, liquefaction, lateral spread, and fault rupture.
Hazard analysts	are those individuals who compile and analyze basic data to arrive at a representation of seismic hazard (e.g., ground motions, liquefaction).
Hazard-product user	is a professional who use hazards information to make design and hazard mitigation decisions.

Implementation	is to give practical effect to and ensure actual fulfillment by concrete measures.
Implementation strategies	are the development of increased knowledge and improved knowledge of transfer delivery systems (same as Methodologies).
Issue	is the result of analyzing findings from Chapters 3 through 6 for commonality that could be combined into one major issue.
Knowledgeable user	See Collaborative User.
Least knowledgeable user	See End-User.
Liquifaction	is a general class of deleterious ground behavior caused by softening or loss of strength of granular sediments as a consequence of increased pore water pressure generated by earthquake shaking.
Local assessment	is the Implementation Team's assessment of local government and regional users in 12 cities of seven states.
Long-term goals	are defined as long-term goals of NEHRP.
Methodologies	are procedures for development of increased knowledge and improved knowledge of transfer delivery systems (same as Implementation Strategies).
Mitigation	constitutes activities that lessen impacts (of earthquakes) through controlling the quality and location of buildings and other structures; activities that reduce the expected losses from earthquakes; specifically, for the **Societal and Policy Team**: any action that reduces risk from an earthquake; for the **Implementation Team:** actions taken to directly limit damage to the built environment through seismic resistant design and land use practices.
NEHRP agencies	are the four agencies—FEMA, NIST, NSF, and USGS.
Networks	are groups or arrays of seismographs within particular regions that record earthquakes.
Nonstructural components	are building components other than those comprising the basic structural system (e.g., exterior cladding, interior nonbearing partitions, mechanical, electrical, and plumbing systems).
Nontechnical user community	See End-User.
Objectives	is a term interchangeable with Purpose (which see).
Operational capacity	is the performance capacity of a facility or system to remain functional and operational after an earthquake.

Paleoseismic refers to the study of ancient earthquakes, e.g., using carbon dating to determine when offsets in sedimentary layers of soils occurred.

Policy is a definite course or method of action selected from among alternatives and in light of given conditions to guide and determine present and future decisions; a high-level overall plan embracing general goals and acceptable procedures; for example, if NEHRP were to adopt a risk reduction policy to mitigate earthquake risks through the implementation of mitigation measures for new construction throughout the United States and for existing construction in selected high risk areas.

Preparedness is the quality or state of being prepared in the event of an earthquake.

Prioritization is interchangeable with Ranking.

Problem-focused research is a user need that can be defined into a specific problem that requires research in order to fill the need; in most cases, such problem-focused research would have defined goals and milestones with a specific schedule and status report process.

Program is NEHRP.

Program area See Generic Area.

Project is interchangeable with Assessment (which see).

Project Team is FEMA Project Staff, CNPE Project Staff, and Assessment Teams.

Purpose is the purpose of the NEHRP Assessment Project and is the same as Objectives or Goals.

Questionnaire is a questionnaire used in one of the Assessment's mail-out surveys.

Questionnaire guide is a protocol used by an Assessment Team member as a guide in order that interviews be consistent.

Ranking is interchangeable with Prioritization.

Reccurring theme See Common Theme.

Recommendation is a recommendation for the improvement of NEHRP that resulted from analysis of an issue.

Rehabilitation is the action or process of restoring a structure (building) for useful or safe activity.

Respondent is a professional who responded to a mail survey.

Retrofit	is to refurbish a structure (building) with new parts, which were not included in the existing construction, to resist forces of earthquake.
Risk	is the quantification of loss resulting from seismic hazard-related vulnerability.
Scope	refers to scope description in the BOS report delineating the workplan of the NEHRP Assessment Project.
Seismic hazard assessment	is an analysis and depiction of the earthquake threat.
Seismic hazard products	are analyses and maps that represent the seismic hazard.
Seismic retrofit	is the strengthening, repair, and/or rehabilitation of older, hazardous buildings to improve their earthquake-resistant design and performance.
Seismic risk	is the people, property, or functions exposed to potential harm, damage, or disruption from an earthquake; seismic risk reduction involves lessening the impact of the occurrence of an earthquake when a seismic hazard exists for people, property, and functions; greater risk exists when more people and property are exposed to a hazard or when critical functions are likely to be disrupted.
Seismic Safety Coordinator	a member of a federal agency who has been assigned by that agency to be the seismic safety coordinator for all divisions/elements of that agency.
Single-area user need	a need identified by one user as being significant but not identified as a need by very few users, or no other users.
Site response	is ground shaking felt or predicted at a particular locality or site. It generally refers to the response of sites underlain by unconsolidated soils or sediments that may greatly amplify or attenuate ground motions relative to motions transmitted through underlying bedrock.
Strategy	is the science and art of employing the political, economic, psychological, and military forces of a nation or group of nations to afford the maximum support for adopted policies in peace or war; a careful plan or method; the art of devising or employing plans or strategies toward a goal, e.g., an implementation strategy that could be the dissemination of hazards information.
Strong motion data	are the recordings of vibratory ground motions that have been processed for data analysis.
Target audience	is the individual or group for whom information, products, or programs are developed.

Team is one of the four teams, which consist of three members each, who conducted the surveys.

User is an individual or group that utilizes information, products, or programs.

User need a NEHRP service or product needed by users so that they can more effectively carry out their responsibilities of seismic risk reduction.

Workplan is a detail of the scope of the NEHRP Assessment Project, including cost and schedules presented to the Steering Committee at the June 5-6, 1993 kickoff meeting.

APPENDIX D

USERS SURVEYED AND WORKSHOP PARTICIPANTS

APPENDIX D.1

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APPENDIX D.2

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APPENDIX E

ASSESSMENT SUPPORT DATA

APPENDIX E.1
SEISMIC HAZARD: SAMPLE INTERVIEWS

NEHRP ASSESSMENT PROJECT INTERVIEW

Bill Cotton, William Cotton & Associates
Los Gatos, California

Hazard Analyst
Interviewed by Bruce Clark

Q.1. *What kinds of seismic hazard analysis do you, and your organization, carry out?*

Two types: analysis of slip rates from fault deformation and ground deformation measurements in exposures and trenches, and analysis of earthquake-triggered landslide hazards.

Q.2. *What percentage of your time do you spend on seismic hazard analysis efforts? What are your sources of funding? (1)**

About 40 percent on hazard assessment and another 5–10 percent on generating data and basic research. Sources are NEHRP and private clients who need consulting advice on seismic hazards. Cotton & Associates also contributes time to some State and local agencies for various analysis purposes.

Q3. *Which of your efforts are funded directly by NEHRP? What percentage of your time is spent on NEHRP-funded efforts? (2)*[1]

5 to 10 percent of efforts are funded by NEHRP.

Q4. *What specific types of data that you use are provided directly from NEHRP-funded work (e.g., recurrence intervals provided by trenching studies; seismicity catalogs provided by seismic networks)? (3)**

Final reports and USGS publications, e.g., PP1360 (Earthquake Hazards of Southern California), also State publications for planning purposes.

Q5. *How easily available and retrievable are these NEHRP databases? Could they be made more easily available? If so, how? (4)**

They are fairly available to us, but not generally available to non-technical people, where they could be much more instrumental in influencing public decisions.

Q6. *What additional information do you need that is not being produced by NEHRP or other researchers? (5)**

[1]Number in parentheses indicates number order of questions in Table 3.1.

NEHRP has generally targeted the right issues, especially the ground deformation effort. New intense ground amplification maps (related to site conditions) would be very helpful, as would accurate and detailed bedrock ground acceleration maps. However, there is a bias against research on secondary ground effects, in favor of details about surface faulting itself. As a result, researchers have missed some important data from recent earthquakes about the nature of the earthquake hazard.

The major problem is that the goal of scientific research, and getting the publications out first is not very relevant to the objective of reducing the earthquake hazard or responding to the needs of the community. This showed up in major ways after Loma Prieta, when much of the NEHRP money was used to study basic research topics, while the affected people were dependent on another segment of the technical community. There has generally been little focus on what's needed after the earthquake, or on how the decision-making process actually works after the earthquake.

Q7. *Do you believe that there are important data or information that have been generated by NEHRP researchers that are not available to you? Are there data available in a form that is unusable to you? (6)**

The answer to both of these is "no" as best I am aware. But there are certainly data unusable to the decision-makers, and I have to spend a lot of my time translating information for them. While this is part of my job as a hazard analyst, there are a lot of data being generated that are not very usable in the final decisions being made by my clients.

Q8. *What percentage of your organization's seismic hazard analysis work is performed in-house? What percentage is contracted out to others? (7)*

100 percent is done in-house.

Q9. *How are the results of your hazard analyses used, either within the NEHRP or for other purposes?*

We provide information directly to end users, who use it for land use decisions, especially siting locations and design criteria.

Q10. *Who makes decisions or recommendations regarding hazard mitigation from your analyses (this may include yourself and/or other groups)? What kinds of decisions are made? Do you serve as a consultant or expert witness for these decision makers?*

They are made by clients, including (a) land developers and public agencies for siting buildings, (b) city councils and planning commissions to resolve land use issues, (c) school boards for siting and design of schools, (d) elected officials for planning decisions and to raise awareness of public.

Q11. *Do you see knowledge gaps between data collection/research findings and hazard analysis? Between hazard analysis and its application by decision-makers? (8)**

We really need good bedrock ground acceleration maps for regional areas. We also need good liquefaction and intense ground-shaking maps, which take into account the presence of soft or sensitive soils.

There is still not enough transfer of the information obtained by NEHRP to the public decision-making process. We need a bigger effort to get the research results out on the street to the public, where it could have a big impact. We need to identify "champions" who are in the decision-making loop: the city engineer, planning commissioner, city councilperson, and building officials. Even a private citizen can have a large influence in the community, such as the earthquake preparedness coordinator. NEHRP needs a more meaningful outreach program.

NEHRP ASSESSMENT PROJECT INTERVIEW

J. Carl Stepp, Electric Power Research Institute
Palo Alto, California
August 9, 1993

End User
Interviewed by Kevin Coppersmith

Q.1. *What are the earthquake-related data or seismic hazard analyses that you use in your organization? How much of these data and analyses would you estimate are supported by the NEHRP?*

Data include: earthquake locations and parameters (magnitude, coordinates, depth), focal mechanisms, stress orientations, strong and weak ground motion recordings, geodetic information, regional and local site response recordings and analyses, dense array data, fault slip rates, fault segment interpretations, paleoseismic data, geophysical data (gravity, magnetic, seismic reflection and refraction, etc.), and geotechnical parameters.

Analyses include: probabilistic seismic hazard results (site-specific and generalized), attenuation relationships, liquefaction maps, and landslide maps.

Approximately 85% of these data and analyses are supported by NEHRP; remaining 15% are supported by EPRI.

Q.2. *What is your opinion of the quality and reliability of NEHRP-sponsored data and hazard analyses?*

In general, quality of both gathered data and hazard analyses is moderate to high. Concerns: lack of quality control during data gathering; strong motion data set is very fragmented and baseline corrections may not be high quality. Attenuation modeling is of high quality for research purposes, but not for integrated product mode (i.e., origin of uncertainties is not well understood). Hazard maps typically lack a good assessment of uncertainty.

Q.3. *How easily available and retrievable are the NEHRP databases and hazard analyses? Could they be made more easily available? If so, how?*

Availability and retrievability are variable: earthquake data set is up-to-date and easily accessible; strong motion data sets are very fragmented and some data are unavailable. USGS data sets should be available in a more timely manner, and baseline corrections need to be consistent and appropriate. USGS should work with NOAA to be the repository for strong motion data and take a proactive role in obtaining important records and making uniform corrections. Databases should be developed for all important seismic parameters (there is significant wasted effort when multiple researchers must compile original data to begin a study).

Q.4. *What additional information do you need that has not been produced by NEHRP or other researchers?*

Dense array strong motion data (more than provided by SMART 1). NEHRP has placed a low priority on soil dynamics to date; site response issues in particular should be given a higher priority: well-planned soil-structure interaction experiments should be conducted, and vertical array data should be acquired (Japanese have large down-hole array programs); the objective of these efforts should be to obtain guidelines for evaluating site response.

Q.5. *Do you believe there are important data or information that have been generated by NEHRP researchers that are not available to you? Are there data available in a form that is unusable to you?*

In general, geophysical data sets are not readily available and are difficult to obtain; generally must go to the original source (researcher, institution, etc.) to obtain the data. Geophysical data sets may be difficult for even experienced researchers to use. Some specific data sets (e.g., strong motion data) are not available/cannot be obtained, but these constitute a very limited part of the program.

Q.6. *What percentage of your earthquake-related data or analyses needs are met with in-house capabilities. What percentage are contracted out to others?*

Nearly all studies are contracted out, but all are managed in-house. About 15% of the studies are performed in-house (e.g., data from various contractors are integrated, etc.).

Q.7. *Do you make decisions or recommendations regarding hazard mitigation? If so, what kinds? If not, where are these decisions made?*

Yes—roughly 40–50% of EPRI efforts are devoted to developing codes, guidelines to implement codes, hazard maps, and other products that contain hazard mitigation decisions.

Q.8. *Do you see knowledge gaps between NEHRP-sponsored data collection and hazard analyses to those products that you use?*

Major gaps are inherent in the NEHRP hazard products—EPRI/utilities industry must develop their own products because they are interested in very low probability events. It is not appropriate for NEHRP to focus on these products, however, data sets (e.g., dynamic response of soils) and analysis tools could be improved.

Q.9. *What has NEHRP done well? What research, products or accomplishments have led to significant earthquake hazard reduction?*

NEHRP does best providing information in data generation/basic research efforts, and in getting hazard maps into codes and guidelines (engineering products) that are available to the community. NEHRP is weak in the intermediate stage of integrating data sets and developing hazard products.

NEHRP ASSESSMENT PROJECT INTERVIEW

Walter J. Arabasz, University of Utah
Salt Lake City, Utah
July 27, 1993

Data Generator
Interviewed by Kevin J. Coppersmith

Q1. *What is the technical focus of your earthquake-related data-collection or research activities?*

My technical focus is on the operation of a regional seismic network in the Utah region and in neighboring parts of the Intermountain Seismic Belt—for earthquake science, engineering, and emergency management. The University of Utah's regional seismic network, as other such networks, is a fundamental multipurpose tool of observational seismology that provides data and information for a host of users—as outlined and described in U.S. Geological Circular 1031 (1989: *National Seismic System Science Plan*, pp. 3ff) and in the National Research Council's publication, *Assessing the Nation's Earthquakes, The Health and Future of Regional Seismograph Networks* (1990: National Academy Press, Washington, D.C., pp. 7ff).

The current research efforts of our earthquake seismology group are focused on addressing three outstanding scientific problems regarding earthquake hazards in Utah's Wasatch Front region and neighboring parts of the Intermountain Seismic Belt: (1) the enigmatic relationship of ongoing seismicity to active faulting (both expressed at the surface and buried); (2) uncertainties regarding attenuation and site amplification of strong ground motion along Utah's urbanized Wasatch Front; and (3) the nature of contemporary deformation and the stage of the seismic cycle along active segments of the Wasatch fault and nearby faults.

Q2. *What percentage of your time do you spend on these earthquake-related activities? What are your sources of funding?*

About 90 percent of time—both individual and organizational—is spent on these earthquake-related activities. Remaining time spent on diverse public-service and professional activities.

Current sources of (organizational) funding: U.S. Geological Survey/NEHRP (60 percent), State of Utah (30 percent), National Science Foundation/NEHRP (5 percent), U.S. Bureau of Reclamation (5 percent).

Q3. *Which of your earthquake-related activities are supported by the NEHRP? What percentage of your time is spent on NEHRP-supported efforts?*

NEHRP-supported activities of our organization currently include: (1) "Seismic Network Operations Along the Wasatch Front Urban Corridor and Adjacent Intermountain Seismic Belt" [USGS]; (2) "Seismicity, Ground Motion, and Crustal Deformation—Wasatch Front, Utah, and Adjacent Intermountain Seismic Belt" [supported by research funding from USGS as a companion to the network-operations support of (1)]; (3) "Operation and Upgrade of the Yellowstone Seismograph Network" [USGS]; and (4) "Observation and Three-Dimensional Simulation of Site Amplification in the Salt Lake Valley, Utah" [NSF].

About two-thirds of time—both individual and organizational—spent on NEHRP-supported efforts.

Q4. *How are the data or information that you generate used in their final form—either within the NEHRP or for other purposes?*

As one of the co-authors of U.S.Geological Survey Circular 1031 (*National Seismic System Science Plan*) in 1989, I had to answer this same question and wrote a section on the "Uses of Current Regional Networks." The following excerpt reflects directly the uses of data and information from the University of Utah's regional seismic network:

"Regional seismic networks are a fundamental multipurpose tool of observational seismology. Although commonly perceived as simply a tool for earthquake 'surveillance' of 'monitoring,' existing seismic networks provide data and information for a host of uses:

— Public safety and emergency management
— Quantification of hazards and risk associated with both natural and human-triggered earthquakes
— Surveillance of underground nuclear explosions
— Investigation of earthquake mechanics and dynamics
— Investigation of seismic wave propagation
— Investigation of seismotectonic processes
— Earthquake forecasting and prediction research
— Probing the internal structure of the Earth

"Importantly, seismic networks are also key facilities for the graduate education and training of this country's professional seismologists, and they provide direct outlets for public information and for expert assistance to public policy makers, planners, designers, and safety officials."

Q5. *In your area of expertise, who makes decisions or recommendations regarding hazard mitigation (this may include yourself and/or other groups)? Do you serve as a consultant or expert witness for other decision makers?*

Within the state of Utah, binding decisions are basically made by the governor, the state legislature, and by local public officials.

As a member of the Utah Earthquake Advisory Board, an advisory group to the Governor's Disaster Emergency Advisory Council, I am directly involved in making recommendations regarding hazard mitigation to the governor and the state legislature. Further, as director of the University of Utah Seismograph Stations, I have a leadership role—together with the directors of the Utah Geological Survey and the Utah Division of Comprehensive Emergency Management—in guiding Utah's state earthquake program.

I also routinely serve as either a consultant or expert witness for other decision makers. For example, during the past 18 months, I've been involved in consulting of significant import for seismic hazard mitigation relating to: (1) the design and construction of the Jordanelle Dam, a large high-hazard dam just completed in Utah by the U.S. Bureau of Reclamation; (2) the Department of Energy's potential waste repository site at Yucca Mountain, Nevada; and (3) the Department of Energy's Rocky Flats Plant in Denver, Colorado. In connection with these activities, I was invited to make special presentations to the Utah congressional delegation (regarding the Jordanelle Dam) and to the president's Nuclear Waste Technical Review Board (regarding the Yucca Mountain repository).

Q6. *Do you feel that your research findings are being adequately utilized in hazard mitigation? Please explain.*

Yes—in terms of hazard evaluations and design considerations for critical facilities and large construction projects. No—in terms of public policy making in the state of Utah.

The "no" goes to the heart of the fundamental question motivating this exercise: "How well has the NEHRP used the available incentives and reduced the barriers to earthquake hazard reduction in the United States?" In the case of Utah, NEHRP participants have not yet been able to persuade state policy makers to take many first-order steps towards hazard mitigation—at least not steps that cost any money. By historical accident, the people of Utah have not suffered a catastrophic earthquake since modern settlement of the region in 1847, and the majority of moderate-sized earthquakes in recent decades have struck relatively unpopulated parts of the state. Despite firm scientific evidence indicating the vulnerability of many of Utah's urban centers to large devastating earthquakes, state policy makers do not rank hazard mitigation as a high-priority urgency vis-a-vis other competing needs for state resources.

The above-described failure is not a failure of the NEHRP participants. (The political process is clearly unwieldy, and most NEHRP participants who have worked in Utah have been unschooled in "the street smarts" of influencing local and state politics.) In my opinion, the failure is the federal government's for not emplacing sufficient incentives for state and local public officials to make necessary budget and policy decisions.

Q7. *In your opinion, are there any relevant technical issues that the NEHRP has not targeted?*

In my opinion, NEHRP's best and brightest have been intelligent and creative enough to identify and "target" a sufficient scope of relevant technical issues. The issue isn't the technical agenda, it's the lack of reasonable resources consistent with the scope of that agenda. My repeated experience and observations (for example, on numerous NEHRP proposal-review panels) tells me that NEHRP has never been funded at a level that would make it a truly credible national program, given the scope of technical issues under its mandate.

[additional comments from interview] Data collection and support for basic infrastructure (e.g., regional networks, etc.) outside California is very inadequate. California is often used as a standard for evaluating NEHRP, however, the program should be evaluated based on the national situation.

Q8. *Are there data or information of potential importance to the NEHRP that are not being developed or, if available, are not being utilized?*

Let me first answer the latter part of the question about non-utilization of available information and data: I repeat my belief that there has been a distinct lack of progress towards hazard mitigation in Utah in terms of state and local legislation required to affect mitigation measures that cost money.

Regarding the first part of the question, I give an emphatic YES! Utah, and the intermountain region in general, continue to suffer from two problems endemic to NEHRP funding: (1) lower-priority allocation of NEHRP funding to the Utah region, because Utah's congressional delegation hasn't tried to earmark funds, as has notably been done for some other parts of the country outside of California; and (2) the persistent focus on densely populated areas.

As a result of the above, the gathering of basic earthquake information is being neglected in rural parts of the Intermountain region that are inherently seismically dangerous and where there are threats to regional lifelines and infrastructure. I presently am involved in shutting down parts of Utah's regional seismic network, outside the populated Wasatch Front area, throughout seismically hazardous parts of southwestern, central, and eastern Utah.

In analogous ways, adequate resources are not available to develop a true national seismic network, and efforts to develop a truly national strong-motion program have been consistently handicapped by inadequate funding. There are critical needs for strong-motion instrumentation, outside of California, in many parts of the Nation, and the Intermountain region desperately needs high-quality seismological information to deal with what may be unique aspects of large normal-faulting earthquakes.

[additional comments from interview] For NEHRP to be a more balanced national program, USGS should broaden the geographic areas of focus from the four areas currently designated (So. Calif., No. Calif., Pacific Northwest, and central US). Political pressure and population density are major factors that have been used to identify geographic areas of focus. Early plans to study earthquakes in more active areas (i.e., California) and then transfer information to other parts of the country have not proven to be effective. On the State and National levels there are evolving tensions/antagonism (fueled by scarce funding) between planners/emergency management people and geoscientists; it is critical that this divisiveness be controlled.

NEHRP ASSESSMENT PROJECT INTERVIEW

Arch Johnston, Director, Center for Earthquake Research and Information (CERI)
Memphis, Tennessee
July 13, 1993

Data Generator
Interviewed by Kevin J. Coppersmith

Q.1. *What is the technical focus of your earthquake-related data-collection or research activities?*

The principal areas of focus at CERI are: 1) regional monitoring of central and southeastern U.S. earthquakes, which includes operating an instrument network; 2) neotectonic studies in the New Madrid seismic zone (including trenching and paleoliquefaction studies, and interpretation of shallow seismic reflection data); 3) developing a site response data base for the New Madrid seismic zone (utilizing soils information from well logs, etc.); and 4) Global Plate Interior seismicity study, which includes review of existing earthquake catalogs.

Q.2. *What percentage of your time do you spend on these earthquake-related activities? What are your sources of funding?*

100% of time is spent on these earthquake-related activities. Funding for CERI is approximately: 17% University; 31% State; and 52% external funding, including NEHRP (composing about ⅔ of external funds; studies in the New Madrid seismic zone, identified as a NEHRP priority area since 1991, have significantly increased the level of funding in recent years), NRC (present funding level is low; in previous years it was much higher), NSF, NCEER, EPRI, and other public and private agencies for specific hazard studies (e.g., TVA, USCOE, etc.).

Q.3. *Which of your earthquake-related activities are supported by the NEHRP? What percentage of your time is spent on NEHRP-supported efforts?*

NEHRP supports operation of the regional seismic network and focused studies in the New Madrid seismic zone. Roughly ¼ to ⅓ percent of total time, and 5/7 of technical (as opposed to administrative) time, is spent on NEHRP-supported efforts.

Q.4. *How are the data or information that you generate used in their final form -either within the NEHRP or for other purposes?*

Data are published in technical reports and earth science journals such as JGR and BSSA, and in seismicity bulletins; PANDA seismic network data is on magnetic tape, and will soon be on CD ROM. Published literature, particularly peer reviewed journals, are most easily accessed by other researchers, who are the primary users of the information. Data may also be provided directly to hazard analysts for specific studies.

Q.5. *In your area of expertise, who makes decisions or recommendations regarding hazard mitigation (this may include yourself and/or other groups)? Do you serve as a consultant or expert witness for other decision makers?*

Program managers of funding agencies (e.g., USGS for NEHRP funds) make hazard mitigation decisions by selecting funding priorities. Researchers make these decisions when they submit proposals for funding; successful proposals, however, generally must address the funding priorities. Better understanding of seismic hazards can be used to obtain better hazard mitigation results. Participation in committee work, providing testimony to congressional committees, etc., helps to make data and interpretations known and provides vehicle to ultimately shape policy (e.g., testimony on central U.S. earthquakes helped to make New Madrid seismic zone a NEHRP priority area).

Q.6. *Do you feel that your research findings are being adequately utilized in hazard mitigation practice? Please explain.*

Yes; research findings are published and available to hazard analysts. Research on maximum magnitudes has been utilized nationally and internationally. Availability of earthquake data has had an impact on building codes for central U.S. cities, and has been directly applied to local and regional construction projects.

Q.7. *In your opinion, are there any relevant technical issues that the NEHRP has not targeted?*

1) Short-term prediction of earthquakes -- useful data could be obtained from studying precursors (since prospects for funding appear slim, proposals for such research are not submitted). 2) NEHRP is not a truly national program -- the level of funding for the national seismic network is far too low, and seismic hazards in low activity areas (e.g., New England) are not being assessed; this is partly a result of the absence of a recent destructive eastern earthquake. It is a low probability but high consequences problem, and the technical issues are difficult to define.

Q.8. *Are there data or information of potential importance to the NEHRP that are not being developed or, if available, are not being utilized?*

1) Seismicity patterns could help to identify the location of active faults in the central and eastern U.S., however, location resolution from existing seismic networks is inadequate to define these patterns. 2) Strain rates should be monitored throughout the country. If GPS was used, areas with the highest potential for future large earthquakes could probably be recognized. Information on strain rates would also be useful for constraining fault slip rates. 3) In the central and eastern U.S., virtually no data outside the New Madrid seismic zone are being collected. 4) International work is not encouraged, yet research on earthquakes in other parts of the world could provide valuable insights on seismic hazards in the U.S.

NEHRP ASSESSMENT PROJECT INTERVIEW

James Davis, California Division of Mines and Geology
Sacramento, California

Hazard Analyst
Interviewed by Bruce Clark

Q1. *What kinds of seismic hazard analysis do you, and your organization, carry out?*

We carry out a broad range of seismic hazard analyses, including seismic hazard mapping, reviews of EIRs, hospital design ground motions for OSHPD, school design ground motions for OSA, CEQA reviews, scenario earthquakes, Alquist Priolo Special Studies Zones mapping, and retrofit controls for URMs, tilt-ups, etc. We will be doing at least three more scenario earthquakes, for San Bernardino, Rogers Creek, and North Coast.

Q2. *What percentage of your time do you spend on seismic hazard analysis efforts? What are your sources of funding? (1)*[**]

About 65 percent is spent on seismic hazards. Sources of funds include building fees, the State General Fund for Alquist-Priolo maps, NEHRP (FEMA-OES) and general funds for the scenario earthquakes, contracts with OSA and OSHPD. NEHRP funds make up about 20-25 percent of the seismic hazard analysis budget.

Q3. *Which of your seismic hazard analysis efforts are funded directly by the NEHRP? What percentage of your time is spent on NEHRP-funded efforts? (2)**

Scenario earthquake studies, as well as some specific External Contract Program proposals that vary from year to year. Staff spends about 25 percent of time on NEHRP funded efforts.

Q4. *What specific types of <u>data</u> that you use in your hazard analyses are provided directly from NEHRP-funded work (e.g., recurrence intervals provided by trenching studies; seismicity catalogs provided by seismic networks)? (3)**

The types of data depend on what projects we are working on. The seismic hazard ground motion maps use the Evernden algorithm for calculations, and seismicity catalogs and geologic maps, created in part by NEHRP and part in-house by CDMG. The OES work on scenario earthquakes uses raw seismicity data, but also building population and lifeline information from other sources. The CEPEC working group reports depend almost entirely on input such as short term prediction data from USGS-NEHRP sources.

Q5. *How easily available and retrievable are these NEHRP databases? Could they be made more easily available? If so, how? (4)**

[**]Number in parentheses indicates number order of questions in Table 3.1

The situation needs to be improved, but we are making the necessary changes. This is not such a problem for the CDMG work, but we are going to a new GIS database. It is clear that we need to computerize the information more, so it can be handled and transmitted more easily.

Q6. *What additional information do you need that is not being produced by NEHRP or other researchers? (5)**

The biggest need right now is for good ground motion maps. We are in the process of creating them at several different periods for the State.

Q7. *Do you believe there are important data or information that have been generated by NEHRP researchers that are not available to you? Are there data available in a form that is unusable to you? (6)**

I think we know about almost all of the important data available. We do need to do a better job of communicating with the engineers, before they start using our data, and so we know what they are doing. There seems to be a lack of any institutional linkage with the practicing engineering community. Organizations like the USGS and SCEC are trying to help solve that problem, so at least it is recognized.

Q8. *What percentage of your organization's seismic hazard analysis work is performed in-house? What percentage is contracted out to others? (7)**

Very little is contracted out. We receive contracts funded by Federal money, less frequently by State money (OES, OSHPD, OSA). But we generally do the work in-house. We do contract out some structural engineering work on the Scenario Earthquake program.

Q9. *How are the results of your hazard analyses used, either within the NEHRP or for other purposes? (9)**

Our situation is a bit unique, because many of our products are mandated by State law. The Alquist-Priolo studies are used for siting buildings in areas of active faults. They are applied directly by OSA and OSHPD for schools and hospitals, and used by local jurisdictions for private buildings, per State laws and regulations. Informally, there is a wide distribution of our products for advisory purposes to the private sector and to local government emergency planners.

Q10. *Who makes decisions or recommendations regarding hazard mitigation from your analyses (this may include yourself and/or other groups)? What kinds of decisions are made? Do you serve as a consultant or expert witness for these decision makers? (10)**

Local governments take the lead in local hazard zoning, special studies requirements, and acceptable mitigation measures. OSA and OSHPD make the decisions directly for schools and hospitals throughout the State. We serve as consultants in most situations, occasionally as expert witnesses, particularly in State hearings.

Q11. *Do you see knowledge gaps between data collection/research findings and hazard analysis? Between hazard analysis and its application by decision-makers? (8)**

In the technical area, we could use better analytical methods for generating probabilistic ground motion hazard maps, and instructions for their use in the building codes. We also need to better understand amplified ground motions and earthquake-triggered landslides. It would be good to have a well-validated model for simulating ground motions from wave propagation and soil condition information. We also need to incorporate the latest data into attenuation formulas.

In the area of applying the hazard analysis information, we need more local governments to be staffed with earthquake professionals to help interpret the level of risk at local levels. This would be a big help to the consistency and uniformity of technical reviews.

NEHRP ASSESSMENT PROJECT INTERVIEW

Paul Heigold, Illinois Geological Survey
Urbana, Illinois

Data Generator
Interviewed by Bruce Clark

Q1. *What is the technical focus of your earthquake-related data collection or research activities?*

The study of neotectonic features (including sand blows and other evidence of liquefaction) as indicators of recent earthquake activity. The NEIC and Central Mississippi Valley database is used as a source of seismic data.

Q2. *What percentage of your time do you spend on these earthquake-related activities? What are your sources of funding?*

25 percent or more. He is the only person at IGS with rigorous academic training in seismology. Primary source of funds for the program is State General Revenue funds, a secondary source is from NEHRP external grants.

Q3. *Which of your earthquake-related activities are funded directly by the NEHRP? What percentage of your time is spent on NEHRP-funded efforts?*

About half of the neotectonic studies are funded by NEHRP.

Q4. *How are the data or information that you generate used in their final form -either within the NEHRP or to reduce earthquake hazards directly?*

Data are available in final form in NEHRP reports and National Meeting presentations; also in in-house publications, such as Seismicity of Illinois. They have a direct working relationship with the Illinois Emergency Management Agency (IEMA), state counterpart to FEMA. Primary use by IEMA is for public information.

Q5. *Who makes decisions or recommendations regarding hazard mitigation based on the data you generate (this may include yourself and/or other groups)? Do you serve as a consultant or expert witness for these decision makers?*

IEMA, city and county planners, general public (whom he reaches through general interest talks, etc.). Building codes are not used often because there are no relevant risk maps, i.e., no intensity maps that take into account loose glacial soils.

Q6. *Do you feel that your research findings are being adequately utilized in hazard mitigation practice? Please explain.*

Not entirely. They know what they want to do, but haven't been able to execute it yet. They still need to put risk levels in perspective around the state. They need to approach the issue with integrity rather that scaring people to death, as the recent Mississippi Valley prediction did. He was involved in damage control in that prediction effort, although the State Geologist (Leighton) took on a large part of that effort.

Q7. *In your opinion, are there any relevant technical issues that the NEHRP has not targeted?*

For the central Mississippi Valley, they need to fine-tune intensity maps, considering the influence of surficial sediments (liquefaction-prone units, character of sediments). IGS has the well data, and the stratigraphic detail to accomplish this, but there is no money. Methodologies are already developed. The local agencies could and would apply the information.

Q8. *Are there data or information of potential importance to the NEHRP that are not being developed or, if available, are not being utilized?*

Again, the most important information is the data for creating good intensity maps. The biggest impact would be to take the data we already have and apply it to these maps.

NEHRP ASSESSMENT PROJECT INTERVIEW

Mary Ellen Hynes, U.S. Army Corps of Engineers
Vicksburg, Mississippi
July 27, 1993

Data Generator, Hazard Analyst, and End User
Interviewed by Les Youd

Do you classify yourself as (1) a researcher or data generator, (2) a hazard analyst, or (3) a designer, planner, or other end user of earthquake information.

In formulating my answers to this questionnaire, I talked to several of my colleagues including, research program managers, seismologists, geotechnical engineers, etc. We fit into all three categories. That diversity is typical, however, for the range of work we do here the Waterways Experiment Station (WES). Our primary focus is research, but it is very definitely applied research. We provide guidance to our clients, Corps districts and other government agencies, to assist them with specialized problems that usually involves testing, analyses and design guidance. For earthquake problems, the state of the art is so poor, that almost any problem that comes to us is a research problem. So we perform work in all three categories, but our primary focus is research.

Questions for Researchers and Data Generators

Q1. *What is the technical focus of your earthquake related research or data-collection activities?*

In my group, the primary research focus is dam safety. We also consider a variety of appurtenant hydraulic structures and have a secondary focus on navigational structures for both riverine and marine navigation. An important part of our research focus is the Corps of Engineers strong motion instrumentation program, which comprises the largest federally funded network of strong motion instruments in the nation. Most of these instruments are installed at major projects such as dams and water control structures. We have a cooperative agreement with USGS for operation of our network. We maintain the Corps and USGS instruments east of the Rocky Mountains, and they maintain the instruments west of the Rockies. In the past, they have also digitized and processed our analog records.

Q2. *What percentage of your time do you spend on these earthquake-related activities? What are your sources of funding?*

Because the focus of my group is earthquake engineering and seismology, virtually 100 percent of our effort is spent on earthquake activities.

We are contributors to the NEHRP report, but we do not receive any NEHRP money. Our research funds come convincing other people that we can solve their problems. Our funds come primarily from federal agencies, but occasionally we may get some money from state agencies. Only in very rare circumstances would funding come from the private sector. Typically more than 60 percent of our funds come from DOD with other major sources being DOE, EPA.

Q3. *Which of your earthquake-related activities are supported by NEHRP? What percentage of your time is spent on NEHRP-supported efforts?*

As noted above, we receive no money from NEHRP and thus spend no time on NEHRP efforts.

Q4. *How are the data or information that you develop used in their final form--either within NEHRP or for other purposes?*

With respect to our research work, we publish reports and make presentations at conferences, etc. Basically we follow the same routes that university professors use to transfer their results. For example, when we are funded to analyze data from our strong motion instrumentation program, we will prepare and publish a WES report which is publicly available from either WES or NTIS. In addition, we write manuals to provide design guidance and teach courses.

Q5. *In your area of expertise, who makes decisions or recommendations regarding hazard mitigation (this may include yourself and/or other groups)? Do you serve as a consultant or expert adviser for other decision makers?*

We are part expert advisor; we are part decision maker; and we make recommendations. For example, for a seismic safety evaluation for a particular embankment dam safety project, we would act as research consultants to a district office. The study would include all the phases involved in a seismic stability evaluation for the dam, including determination of ground motions that should be used at the site, performance of field investigations to characterize materials at the site, performance of laboratory tests to develop dynamic soil properties, performance of various analyses to determine whether there is a liquefaction problem and what the possible embankment deformations might be and, finally, determine if catastrophic failure is possible and what would be the consequences.

We would discuss and evaluate the results of the studies from ground motions through testing and analyses to conclusions about dam safety cooperatively with the district engineers and Corps of Engineers technical monitors from Washington, D.C. As the dam owner, the district then makes the decision, but we provide technical recommendations and the technical monitors provide additional technical recommendations and policy guidance. Commonly, the districts will also provide one or two outside expert consultants to provide peer review. The district personnel are usually very well informed and I find that our technical monitors are also well informed and have excellent technical perspective. Thus, the decisions are made in a very balanced manner with an effective amount of internal and external review.

This procedure is typical for all major projects, particularly safety evaluations, for which we serve as research consultants.

Q6. *Do you feel that your research findings are being adequately utilized in hazard mitigation practice? Please explain.*

We are an applied research organization. Since we work so closely with our clients, we basically haven't done our job unless our work is applied.

Q7. *In you opinion, are there any relevant technical issues that NEHRP has not targeted?*

Since I do not have a comprehensive picture of the entire NEHRP program, and specifically the area of seismic hazard assessment, I can't fully address this topic.

Q8. *Are there data or information of potential importance to NEHRP that are not being developed, or, if available, are not being utilized?*

We rely heavily on at past performance information. Since a large part of our work is empirical, performance information is critical to us. However, that information is difficult to get. First, we have to wait for an earthquake; then someone has to go out and get the data before conditions change or the effects are obliterated; then we have to put it together in a meaningful form so that it can be used in an empirical fashion. We need much more site-specific information at such case history site, which is generally very expensive information to retrieve. Collecting of pertinent site specific information usually requires drilling, sampling and testing. Time and expense to conduct such investigations usually exceed post-earthquake reconnaissance budgets, so that type of information is often neglected. Investigations following the 1971 San Fernando and 1989 Loma Prieta earthquakes are perhaps happy exceptions to this criticism.

Question for Hazard Analysts

Q1. *What percentage of your time do you spend on seismic hazard analysis efforts? What are you sources of funding?*

As noted above, because the focus of my group is earthquake engineering and seismology, virtually 100 percent of our effort is on earthquake activities.

Q2. *Which of your seismic hazard analysis efforts are supported by NEHRP? What percentage of your time is spent on NEHRP supported efforts?*

As noted above, we receive no funds from NEHRP.

Q3. *What are the specific types of data that you use in your hazard analyses that are provided directly by NEHRP?*

Very little of our seismic hazard data comes from NEHRP. Corps of Engineers policy requires that our high hazard structures, which are primarily dams, are designed using deterministic seismic hazard evaluation procedures. Thus, much of the recurrence or probabilistic data and hazard maps developed by NEHRP is not directly useful to us. For our seismic hazard evaluations, we use seismicity catalogs (very valuable to us) and strong-motion records. We obtain strong-motion records from a wide variety of sources. We use some of our own records, records from USGS, CSMIP and other U.S. sources, and we are rather well connected to a number of foreign countries. We'll search for and use any records that we think are applicable to our specific problems. Generally, we collect a number of pieces of information and then do our own syntheses and analyses to meet our design needs.

In addition to reports from our strong-motion instrumentation program, we document our hazard analyses and make this information available to the public in the form of reports.

Q4. *How easily available and retrievable are these information sources and databases? Could they be made more accessible or available? If so, how?*

We do have trouble getting information. Let's break information into categories of strong-motion records and field performance data.

For strong-motion records, we would like to have a more accessible database that we can contact or call up and retrieve information electronically without the glitches that currently exist. At present, we work from floppy disks or magnetic tapes and we find severe compatibility problems, particularly when we are accessing records from different databases. So we'd like to have a database that is more easily retrievable, more uniform, and more user friendly. If you recall, that was one of the major recommendations of the "Nuttli" report prepared several years ago by the National Research Council Committee on Earthquake Engineering. Rapid release of records is not a burning issue to us. We usually look at a wide variety of records from many different sources, so one record may not be critical.

We would like much more data on field performance. As I mentioned previously, there is a sparse amount of field performance data; greater efforts should be made to acquire this type of information.

Q5. *What additional information do you need that has not been produced by NEHRP or other researchers?*

I think NEHRP should not try to be all things to all people. Much of the information that I need is unlikely to be produced by NEHRP. I think that the current distribution of mission assignments helps keep us as federal agencies from duplicating each others work. NEHRP's primary focus seems to be on basic studies about earthquake processes and generated ground motions and, with respect to infrastructure, buildings and lifelines. The Federal Highway Administration has responsibility for bridges and roads. The Corps of Engineers and the Bureau of Reclamation have responsibility for dams, with the Corps having additional responsibility for flood control structures, navigational structures, etc. EPA has responsibility for waste disposal sites.

Other than issues directly related to buildings and lifelines, NEHRP does not appear to devote sufficient funds to significantly improve geotechnical earthquake engineering. (The lifeline part of NEHRP, however, appears to be a small effort compared to the rest of the program.) That lack of attention may result from budget restraints, and the fact that there is plenty of work that needs to be done with respect to buildings and lifelines. If NEHRP continues to do the basic work on hazard studies, as they are now doing, I think we will all benefit. The Corps of Engineers certainly isn't funded to do that kind of work. Since our main interest is dams, and dams are beyond the primary focus of NEHRP (at least at this time), we don't see NEHRP directly solving our problems.

Q6. *Do you believe there are important data or information that have been generated by NEHRP researchers that are not available to you? Are there available data that are ineffectual because they are in a form that is unusable to you?*

We have already discussed strong-motions records and field performance data, so I will not repeat myself on these topics. Beyond that, I think that the communities of engineers, geologists, and seismologists are sufficiently tightly-knit and inter-connected that our scientists and engineers could probably find any pertinent existing information.

Q7. *What percentage of seismic hazard analyses do you perform internally? What percentage are contracted to others?*

Our clients come to us for seismic hazard analyses. Typically we do most of the work, but some specialized efforts might be contracted to others in universities or private practice. I estimate that on average we would contract about 30%, and do the remaining 70% within the Corps.

Q8. *Do you see knowledge and implementation gaps between data collection/research findings and hazard analysis? Between hazard analysis and its application?*

Certainly knowledge and implementation gaps exist between data collection and research findings and their application. However, it is a long road from basic research to solving practical problems and it takes time and many types of players to develop tested and true design concepts. So, as long as we are doing research, I expect that there will always be a gap. Although it would be beneficial to narrow the gap more quickly, there may be detriments to pushing too hard in this direction. One detriment would be to get the players in the wrong positions. The goals and skills of researchers and end-users are very different. Those doing basic research or basic data collection usually have goals of improving the knowledge base or developing some improved model. Whereas, the users are usually people who are trying to fix some specific problem, such as an inadequate foundation, and their goals are to correct the problem as quickly as possible. These engineers may use design criteria that were developed from research, but he or she really doesn't care about advancing some mega-model or improving science. To narrow the implementation gap, I don't believe that the people who are good at doing the basic research should be asked to switch to applied research and implementation--is not what they are good at. We need the right people in the right positions all along the chain and then allow sufficient effort, time and experience for conversion of research findings into proven design criteria.

Q9. *How are the results of your hazard analyses used, either within NEHRP or for other purposes?*

I addressed this question previously. I don't have any additional comments.

Q10. *In your area of expertise, who makes decisions or recommendations regarding hazard mitigation (this may include yourself and/or other groups)? What kinds of decisions are made? Do you serve as a consultant or expert advisor for other decision makers?*

I noted before that our decisions are group efforts between the owner (one of the Corps districts for a dam), ourselves as research or analytical specialists, and our technical monitors from Corps headquarters. We strive for a decision that is in the best interest of our stockholders, the taxpayers.

In answer to the second part of the question, yes, I and my colleagues often serve as expert advisor/consultants to other decision makers.

Questions for End Users

Q1. *What earthquake related data and seismic hazard analyses do you use in your organization? How much of these data and analyses would you estimate come from studies supported by NEHRP?*

The comments given for Question 3 for Hazard Analysts apply to this question as well.

Q2. *What is your opinion of the quality and reliability of NEHRP-sponsored data and hazard analyses?*

Although my use of NEHRP data or analyses is limited, I generally feel that they are quite good. I do have concerns about various aspects of earthquake research, however, including some supported by NEHRP:

1) I think that the emphasis on "expert opinion," statistics and risk analysis is getting out of hand. Something should be done in that arena to add more reality to ground-motion inferences coming from these studies.

2) I would like to see a showdown of all the models to predict ground deformation. I look forward to seeing what comes out of the VELACS project, which is a step in that direction, but I feel that there will likely be need for many additional comparisons and verification tests for the many numerical models. Certainly we need such a showdown in the arena of dam safety. Because we are applying the results of numerical models to help us devise remediation designs for dams, verification of models is very important to us. A lot of taxpayers' money has gone into the development of these models and a lot more taxpayers's money will be spent by various agencies to buy, apply and maintain these models. We are having success by working closely with Professor Liam Finn in running his TARA model, and we feel that this work has led to substantial savings on remediation of our dams. But that is only because we have invested about 15 year's worth of time on centrifuge testing and working extremely closely with Professor Finn to verify and in some instances, revise the model. That experience is very different than just buying a model off the shelf with little experience or verification record. One of the difficulties in having a showdown is that many of the models are proprietary and most owners of models have no intention of giving me or someone else the code to conduct independent tests. What I would really like to find out is what each model is good at? What it is poor at? What makes it easy to use? And how can I interpret the results?"

Q3. *How easily available, retrievable and useful are the NEHRP databases and hazard analyses? Could they be made more easily available?*

Again, I have already answered this question.

Q4. *What additional information do you need that has not been produced by NEHRP or other researchers?*

Our wish list here is long:

1) We want a better way of predicting earthquakes: We want to know, within a few days, when one will occur. We want to know where, within a few tens of kilometers, one will occur. We need to know how big, within a half an order of magnitude. If we could get to the point where we can predict earthquakes, based on physical processes, that would be a valuable contribution. That ability is the single-most important achievement that could come out of NEHRP in the long run. Our biggest uncertainty in any earthquake engineering problem is the earthquake.

2) We want better methodology for determining the residual strength of liquefiable silts, sands and gravels. NEHRP apparently hasn't targeted residual strength as a high-priority need. Residual strength is one of our biggest information black holes right now. We can't reliably predict the

residual strength, nor the stress strain behavior of the material as it approaches or leaves a residual strength condition.

3) We need better criteria for predicting load capacities for foundations, both shallow and deep. Another big black hole for the profession is the load capacity and behavior of pile foundations subject to dynamic loading, particularly foundations that will experience liquefaction and lateral deformation. There are some beautiful pictures from Japan that show what happens to a pile foundation when the material around it liquefies and deforms, but there is not much data for developing criteria to prevent that type of damage to a pile foundation. We don't have adequate dynamic design procedures. In fact, our profession doesn't even have adequately accurate procedures for static loading of pile foundations, let alone dynamic loading.

4) One of our biggest problems in performing seismic stability evaluations within budget constraints is allocating enough money to conduct adequate site investigations. The message here is that we need to develop procedures to get site-characterization information more quickly, more accurately, more inexpensively, and in three dimensions. We need to define the site-stratigraphy; we need to define the dynamic properties of the materials within those strata; we need to know the pore pressure generation characteristics; we need to know the stress-strain characteristics; we need to know the residual strength characteristics and how the ground is going to deform. That is a big gap for the Corps, NEHRP or others to try to fill.

5) At present, there is not a single dam that has been remediated that has been fully proof tested. We haven't done nearly enough work to look at the behavior of remediated sections. We haven't done enough numerical work to understand interactions in remediated areas. We don't have enough data to proof test our remediation techniques. When we are not sure of our effectiveness, to assure safety, we err on the side of conservatism and that costs money, perhaps a lot of money (maybe millions of dollars) that we probably don't really need to spend. But since we're working with public safety issues, we have no choice.

Q5. *Do you believe there are important data or other information that have been generated by NEHRP researchers that would be useful to you, but are not available to you? Are there data available in a form that is unusable to you?*

I have adequately commented on this issue in previous answers.

Q6. *What percentage of your earthquake-related data or analyses needs are met with in-house capabilities? What percentage is contracted out to others?*

I have also adequately commented on this question in previous discussions.

Q7. *Do you make decisions or recommendations regarding hazard mitigation? If so, what kinds? If not, where are these decisions made?*

This issue has also been adequately discussed in previous answers.

Q8. *Do you see knowledge and implementation gaps between NEHRP-sponsored data collection and hazard analyses and those products that you use?*

I also believe that this issue has been adequately discussed in previous answers.

Final comments: as a summary, give your opinion on the following questions.

1. *What has NEHRP done well? What research, products or accomplishments have led to significant earthquake hazard reduction?*

I do not have a comprehensive or detailed picture of the NEHRP program, but I will offer a few comments from my perspective. It seems to me that NEHRP has made a valuable contribution to the development of seismic provisions for building codes. The work on seismic hazard maps is probably very useful for the more conventional forms of construction across the country. The basic research in seismology seems to have paid off in terms of better understanding of tectonic processes, earthquake sources and related seismic issues. Funding the best and brightest ideas, as done by NSF and USGS, is essential. In terms of criticism, I don't see how someone like Iben Browning could predict an earthquake in the midwest, and NEHRP not defuse the prediction. It seems that many emergency response folks may have prematurely jumped on the band wagon in that instance. As a consequence, you get people in Vicksburg, MS panicked into buying earthquake insurance for their houses. Is this really the informed response by the public that we are seeking?

2. *What NEHRP data, research, or other information have been compiled that could be more effectively applied to reduce hazards? What should be done to improve the utilization of products that have already been developed?*

I will just reiterate that you can't ask the people who are really good at basic research to also be really good at applied research, development, demonstration, and implementation. You need to pay them to do what they do best.

3. *What are the major data, information, or implementation gaps that need to be filled to achieve greater earthquake hazard reduction? List some high-priority gaps or needs that you feel should be pursued or emphasized to meet the objectives of the program.*

I summarized my thoughts on this issue for Question 2 for Designers, Planners and other End Users, as listed above.

4. *Additional comments.*

I think that there could be some beneficial changes in NEHRP. I heard the report given at the National Earthquake Conference in Memphis by the chairman of the NEHRP Advisory Committee, George Bernstein. His comments in general made a lot of sense. I agree with the need to re-evaluate the priorities of NEHRP. However, I would not like to see NEHRP sacrifice the basic research component, which seems to be its current focus, in order to put all of its efforts into applied research and implementation.

We at the Corps of Engineers do not do a lot of basic research. Thus, we rely on other programs such as NEHRP to fund the bright ideas. Not all of those ideas will produce important new information or methodologies, but some do, and we need these new ideas. Not all bright ideas can be applied the next year; in fact there is danger in doing so. We need to give these new developments time for maturation, trial and testing, and then use demonstration projects, etc., to develop the new ideas into practical methods for implementation. For some design criteria, these processes have taken decades to reach fulfillment. So, again, we shouldn't put all of the money into implementation.

Since the Corps and several other non-NEHRP agencies have a history of success in conducting focused research programs, NEHRP might consider working more closely with others to improve implementation of basic research. We do have to be careful in our research efforts that we achieve synergism without duplicating mission areas. Once congress perceives that we have duplicated missions, they will likely pull the funding from one or both of our programs. None of us wants that to happen. Thus, we need to do more to develop coordination.

As manager of a new Corps research program for earthquake engineering, I devote considerable effort to achieving coordination. Relative to water control structures, there is an interagency federal research coordination conference held every other year. All of the interested federal program managers go to that conference. A report from that conference goes to congress to show our research needs and also show how we cooperate to avoid duplication. Each year, NSF provides me with a list of projects they are funding in the earthquake area. The USGS annually provides a document describing their expenditures for earthquake studies. I have also attended NCEER program planning meetings so that I can coordinate our efforts with NCEER. I am a member of the Highway Seismic Safety Research Council, so that keeps me abreast of federal highways research. We also participate in UJNR activities which includes many federal agencies such as the Corps of Engineers, NIST, USGS, DOE, FHWA, NSF and others. We use UJNR as another forum to compare and coordinate programs. We do not currently sit in on NEHRP meetings, so we do need a better path to coordinate our applied research program with overall research in NEHRP (beyond that in the other meetings).

Finally, let me list some of my colleagues' comments, whom I shall leave anonymous.

One colleague says he finds it hard to assess the benefits of NEHRP research because it is not always clear which products he uses or reads come from NEHRP; in this instance, maybe publicity is part of the problem.

Another colleague comments that in the past 5 years he hasn't seen any difference in geotechnical practice in the Corps of Engineers or in any of the major geotechnical consulting firms as a result of NEHRP research. He just doesn't see anything that NEHRP has done in the past 5 years that directly affects our areas of geotechnical engineering practice.

All of my colleagues felt that NEHRP should continue working in the political process with codes. But because the Corps doesn't use these codes, that part of NEHRP's research doesn't affect our projects. We do not use NEHRP codes because we have our own policies and manuals that guide our applications. Codes are a useful tool for more conventional facilities, but most of our work pertains to critical facilities.

It would be nice to see more focused research projects like VELACS. Another good example of focused research was the re-evaluation of the Lower San Fernando Dam. These types of focused efforts, however, are applicable only to areas of research that are sufficiently mature that promising joint verification efforts can be identified.

Another colleague said, "don't expect too much from basic research." We just have to fund bright ideas and enthusiasm; some will give good results while others may need to go back on the shelf.

Another respondent noted that to develop a rational earthquake research and mitigation program, NEHRP might start by examining important consequences of earthquakes on constructed works, and then working back to determine what investments are needed to reduce that damage and loss of lives. One could also measure the effectiveness of the program by similarly determining the marginal returns of the program in terms of loss reduction per unit of investment.

For example, one of the very damaging consequences of earthquakes has been fire ignitions. Has NEHRP given adequate attention to development of aggressive and effective fire fighting procedures and preparedness?

Another example is communications. The first need after a disaster strikes is communications; what research is NEHRP doing in communications? The next most important need is water supply. Other needs are shelter, security, etc. It is not clear what improvements NEHRP is making in these areas.

NEHRP ASSESSMENT PROJECT INTERVIEW

Robert A. Page, U.S. Geological Survey
Menlo Park, California
July 27, 1993

Data Generator
Interviewed by Les Youd

Do you classify yourself as (1) a researcher or data generator, (2) a hazard analyst, or (3) a designer, planner, or other end user of earthquake information.

I fit into the category of a researcher.

Questions for Researchers and Data Generators

Q.1. *What is the technical focus of your earthquake related research or data-collection activities?*

There are two thrusts to my technical work: The first thrust focuses on the earthquake framework of southern Alaska. The second thrust relates to my general involvement in earthquake hazard assessment strategies and methodologies.

Q.2. *What percentage of your time do you spend on these earthquake-related activities? What are your sources of funding?*

Currently, about half. Over the past several years, my time has been split among NEHRP, the USGS Volcano Hazards Program, and the USGS Deep Continental Studies Program.

In the past couple of years, I have not spent much time on administrative tasks.

Q.3. *Which of your earthquake-related activities are supported by NEHRP? What percentage of your time is spent on NEHRP-supported efforts?*

For tectonic-related earthquake studies, I am supported entirely by NEHRP. However, for volcano-related earthquake studies, I am supported by the Volcano Hazard Program.

Q.4. *How are the data or information that you develop used in their final form--either within NEHRP or for other purposes?*

There are several paths through which results of my studies get used: 1) Some results have been directly applied in engineering studies for major projects, such as the Alaska Pipeline. 2) Results from my studies also are used in preparation of earthquake risk maps. Specifically, results from my studies have been used to aid definition of earthquake source zones and levels of seismic activity within those zones. 3) Some information from my studies makes its way into public education. 4) Other information is used to advise government officials at various levels about potential earthquake and volcanic activity during volcanic and seismic crises.

Q.5. *In your area of expertise, who makes decisions or recommendations regarding hazard mitigation (this may include yourself and/or other groups)? Do you serve as a consultant or expert adviser for other decision makers?*

I do not directly make decisions or recommendations for hazard mitigation. Information I develop, however, is used by regulatory bodies at different levels, from federal regulatory agencies to local boards, in their decision-making processes. Information that I have produced is also used by engineers, geologists, engineering seismologists, etc., in making recommendations for specific projects.

I sometimes serve as a consultant or expert advisor to regulatory bodies as noted above. I may also give advice to state and local governmental agencies. Investigating Alaska, but living in California, I am more removed from users of our data than, are USGS researchers in California. The latter scientists seem to have more opportunities and more direct involvement with users than I do. We have taken specific steps in the past year to increase the involvement of our project personnel in Alaska. One of those steps was the transfer of John Lahr from California to Fairbanks, where we have a cooperative seismic monitoring effort with seismologists at the University of Alaska. His presence in Alaska will facilitate involvement with local users. As a second step, we moved our seismic recording facilities from Palmer to Fairbanks, where we can work more closely with the seismologists at the University of Alaska. Both groups operate seismic instruments around the state and cooperation will be beneficial to both programs.

We have co-located strong motion accelerometers with high gain instruments at several stations in Alaska, primarily in areas where large earthquakes are expected, such as the Yakataga seismic gap. The acquisition of strong motion records, particularly for large subduction-zone earthquakes, would fill an important research need as well as provide more opportunities for interaction with local users, such as the engineering community.

Q.6. *Do you feel that your research findings are being adequately utilized in hazard mitigation practice? Please explain.*

Because of my remoteness from Alaska, I'm not sure that I am completely cognizant of how our information is or is not being used. I suspect, however, that the information is not being used as much as would be ideal. That lack of use may be in part because we have not adequately summarized results from our earthquake research and made them as readily available and usable as we could. Another impediment to researchers taking time to target results to specific users is that present culture provides more incentives and rewards for new research than for synthesizing and developing existing information to make it more available and useful to end-users.

Q.7. *In you opinion, are there any relevant technical issues that NEHRP has not targeted?*

In the are of earth sciences, the NEHRP addresses practically all the technical issues. One particular technical issue, however, that has not been targeted because of cost considerations is deep fault zone drilling and placement of instruments to directly monitor faulting processes. This monitoring is needed to develop physical knowledge of seismogenic process in the source zone of an earthquake--what happens to the pore fluid, what stress changes occur, etc. Much progress has been made with data collected from surface instruments, but at some time we are going to have to drill and make measurements in the source zone to completely define the processes involved in fault rupture.

Q.8. *Are there data or information of potential importance to NEHRP that are not being developed, or, if available, are not being utilized?*

I think there are. In Alaska, for example, we are sorely lacking information on recurrence rates for moderate to great earthquakes. George Plafker and others continue to study the Prince William Sound area and we are gaining some data there, but there are other important faults, like the Castle Mountain fault near Anchorage, where we have little information. We also don't have near-source strong motion records from major subduction zone earthquakes. In the past few years, we have made significant progress by recording near-field motions from moderate to large events, but there is still a major gap in our dataset for great subduction zone events. Also, we need to expand hazards assessments in terms of integrated studies of all the various types of earthquake hazards on a regional basis. In this respect, we haven't made much progress in some important urban areas, such as the Anchorage region. But because of limited resources, the priorities of the program so far have not emphasized these areas.

Final Comments: In summary, give your opinion on the following questions.

1. *What has NEHRP done well? What research, products or accomplishments have led to significant earthquake hazard reduction?*

I believe that NEHRP has done well in the following areas. 1) In terms of risk maps, the NEHRP efforts have led to development of better capabilities for estimating ground motions for various sized earthquakes, liquefaction hazards, etc. 2) I believe NEHRP research has lead to important new understanding of, and ability to predict, amplification of ground shaking by local geologic conditions at a site. This important advancement is having major impact on building codes, etc. 3) In California, we have developed an emerging capability to make meaningful statements about earthquake probabilities for intervals of a few decades. These statements are focusing public attention on the earthquake problem in a way that allows more direct use of the data in decision making, such as in financial decisions. I feel very good about this progress and its results in California. 4) Progress is incremental; we always seem to move forward. For example, ten years ago most big companies were not incorporating earthquake hazards into corporate decisions. That situation has changed--now many companies are taking steps to reduce earthquake hazards to their facilities. 5) There are other accomplishments, like defining the possibility of major subduction zone earthquakes in the Pacific Northwest. That accomplishment has certainly caused engineers and other users or NEHRP data to re-evaluate their whole approach to earthquake hazards in that region. 6) The recognition of buried thrusts as an earthquake source in California has led to a major improvement in the definition of the earthquake sources zones. 7) The whole area of advancement of seismic zonation techniques and strategies has provided a means for better defining earthquake hazards for a multitude of users. This advancement positions us to move into the question of earthquake insurance with rates structured to reflect different degrees of risk.

2. *What NEHRP data, research, or other information have been compiled that could be more effectively applied to reduce hazards? What should be done to improve the utilization of products that have already been developed?*

It takes time to verify and distill earthquake information and to educate people to properly use it. In this regard, I don't think that the Bernstein report was looking at application of information on a sufficiently long time scale. For example, consider site amplification effects. Look how long it has taken to develop and verify concepts and then effectively integrate that knowledge into improved building codes, etc. Although data or information may be available, it takes time to distill that information into practical mitigative measures.

In order to expedite transfer and use of data, the USGS is encouraging researchers to become involved in communicating results directly to users. For example, in evaluating performance, USGS scientists now receive recognition for their personal involvement in outreach to users in addition to writing journal articles. Also, the USGS has directed more of its NEHRP efforts to urban regions where the exposure to potential earthquake losses are greatest.

The NEHRP agencies should stimulate the creation of earthquake information resource centers and easily accessible databases in high-risk metropolitan regions throughout the nation. The compiled information would include earthquake occurrence and potential, earthquake hazard maps and associated background data, and information on reducing earthquake risk.

3. *What are the major data, information, or implementation gaps that need to be filled to achieve greater earthquake hazard reduction? List some high-priority gaps or needs that you feel should be pursued or emphasized to meet the objectives of the program.*

1) A base of earthquake recurrence information has been developed for most of the major fault structures in California; however, such information of this type is needed in regions other than California, as well as for many secondary faults in California.

2) More attention needs to be directed toward evaluating and predicting earthquake-related ground failure and deformation.

3) The origin of earthquakes east of the Rocky Mountains, outside the New Madrid seismic zone, needs additional research to define and understand earthquake sources and processes that part of the nation.

4) Earthquake prediction remains elusive, but the subject should continue to be pursued at a moderate level.

5) Nationwide, there is still much that needs to be done to understand the earthquake framework. In California, we understand the framework pretty well. But in places like Alaska and the central and eastern United States, we don't have reliable models for quantification of earthquake processes.

6) We need to modernize seismic instrumentation. Many of our instruments are more than 20 years old and are of low fidelity and reliability. These devices should be upgraded to modern digital units. Currently, there isn't enough money in the program to make much progress in this area, but the need must be acknowledged.

7) Integrated instrumental studies of site and building response are needed. Such studies require enough instruments to discover what is happening to both the site and to the building.

8) Real-time earthquake warning systems should be pursued. In places like California, active faults could be instrumented in such a way that we could give a few seconds warning before major strong shaking strikes a community or critical facility. That brief warning would allow quick emergency actions to be taken.

9) Public education should developed to a level where people feel comfortable in making responsible decisions with respect to hazard mitigation and acceptance of risk.

4. Additional comments.

None.

NEHRP ASSESSMENT PROJECT INTERVIEW

Maurice S. Power, Geomatrix Consultants, Inc.
San Francisco, California
July 27, 1993

Hazard Analyst
Interviewed by Kevin Coppersmith

Q1. *What percentage of your time do you spend on seismic hazard analysis efforts? What are your sources of funding?*

About 40% of time (100% of non-administrative time) is spent on earthquake-related activities. Funding is from: Federal government agencies (incl. COE, FHWA, USGS/NEHRP) - 50%; State and regional government agencies (incl. Caltrans and EBMUD) - 30%; private - 20%.

Q2. *Which of your seismic hazard analysis efforts are supported by the NEHRP? What percentage of your time is spent on NEHRP-supported efforts?*

Current projects with some NEHRP-funding include: Applied Technology Council studies on (1) how to transfer information from USGS into the design professions (includes geotech. engineering practice) and (2) seismic rehabilitation of existing buildings. NEHRP-funded projects in previous years included liquefaction susceptibility assessments in the San Diego and San Jose urban areas, and a regional probabilistic ground motion analysis for the Wasatch Front, Utah. On average, 10 to 15% of (non-admin.) time is NEHRP-funded.

Q3. *What are the specific types of <u>data</u> that you use in your hazard analysis that are provided directly by NEHRP? (e.g., recurrence intervals provided by trenching studies; seismicity catalogs provided by seismic networks).*

Data on fault characteristics, seismicity data, ground motion data, attenuation relationships, geologic maps (incl. Quaternary mapping), etc.

Q4. *How easily available and retrievable are these NEHRP databases? Could they be made more easily available? If so, how?*

Databases generally are available to those who know what they are looking for; active participation in the scientific community results in awareness of relevant studies. Data are obtained from open-file reports and publications. Several methods could be used to make data more readily available: (1) open-file all contractor reports; (2) create indexes; (3) prepare synthesis (compilation) studies that are map-based and/or summarize data available on particular subjects (e.g., slip rates). Also, a means for providing timely access to new data sets is needed, as the time lag between data collection and publication or open-filing precludes some data being used in a timely manner.

Q5. *What additional information do you need that has not been produced by NEHRP or other researchers?*

Quaternary geology mapping is essential to urban area hazard mapping. Map-based soil data and groundwater data, as well as Quaternary geology data, would be very useful for liquefaction analysis. A general repository for data would be helpful.

Q6. *Do you believe there are important data or information that have been generated by NEHRP researchers that are not available to you? Are there data available in a form that is unusable to you?*

Research reports are the most useful source of information. Since NEHRP contractor reports are not routinely open-filed, obtaining copies of these reports can be difficult. Articles published in journals and conference proceedings typically summarize only study results and do not include the raw data.

Q7. *What percentage of seismic hazard analyses do you perform internally? What percentage is contracted out to others?*

95% of analyses are performed internally; contractors provide some specific expertise.

Q8. *Do you see knowledge gaps between data collection/research findings, and hazard analysis? Between hazard analysis and its application?*

Gaps between data collection and hazard analysis: analysts may be unaware or relevant data unless they are very active in the scientific community (i.e., identifying and obtaining relevant data may be difficult). Gaps between hazard analysis and its application: applications are not strongly emphasized, and some users may not know what to do with hazard products/maps. Application may be related to the level of interest (from publicity, etc.) in a potentially affected community and to the effort to interact with the user.

Q9. *How are the results of your hazard analyses used, either within the NEHRP or for other purposes?*

Specific project examples: San Jose liquefaction study -- susceptibility maps are filed in City offices and are reviewed as part of the grading permit process; San Diego liquefaction study -- increased awareness of hazard resulted in enactment of building code provisions for requiring liquefaction studies. The probabilistic ground motion analysis for the Wasatch Front was used to provide the technical basis for a proposed upgrade to UBC Seismic Zone 4 (i.e., translation of a hazard product into a needed application) and also for proposed changes to national seismic hazard (ground motion) maps.

Q10. *In your area of expertise, who makes decisions or recommendations regarding hazard mitigation (this may include yourself and/or other groups)? What kinds of decisions are made? Do you serve as a consultant or expert witness for other decision makers?*

Serves in an advisory role to facility owners; owners are responsible for implementing mitigation measures by accepting or rejecting recommendations. Site-specific spectra may be used directly for new design decisions and for design checks.

APPENDIX E.2
BUILT ENVIRONMENT

APPENDIX E.2.1
QUESTIONNAIRE RESULTS SUMMARY
Building Owners

1. What type of facilities does your organization operate?

   __1__ lifeline: type __TVA__
   __2__ industrial structure
   __5__ commercial and/or office

2. In what geographic areas are your facilities located?

   __2__ West coast
   __1__ Central U.S.
   __5__ South east
   __1__ North east

   Please indicate seismic zones per local building codes, if known:

   __3__ UBC
   __1__ BOCA
   __1__ SBCCI
   __1__ Other: __All__

3. How much of threat do you think a major earthquake is to your facilities?

   __4__ a very real threat
   __2__ somewhat of a threat
   _____ not much of a threat
   _____ not sure

4. Do you consider the earthquake hazard to be less of an issue for your facilities than other natural or manmade hazards?

   __2__ yes   __4__ no

   If yes, what other hazards?

   __Hurricane: 2, Fire: 1__

5. What are the earthquake performance objectives for your operating facilities? Check all that apply.

   __6__ life safety
   __3__ property loss prevention
   __4__ maintain functionality

Comments?

Will earthquake performance objectives be more stringent for new construction in the future?

3 yes   2 no

If yes, please describe.

More data is needed about functionality

6. Has your organization ever had its facilities evaluated for seismic resistance by an engineer?

5 yes   1 no

If no, have such evaluations been considered?

___ yes   1 no

7. Has your organization ever performed retrofit or replacement of facilities to improve seismic resistance?

5 yes   1 no

If yes, please describe.

New office seismically designed (1); retrofit (1); upgrade (3)

8. What standards, codes, or methodology will be used as the basis for earthquake design of new facilities?

Existing code (4); NEHRP provisions (1); previous data and technical profession (1)

9. Has your organization been planning and preparing for earthquakes?

4 yes   2 no

If yes, what specific actions has your organization taken to mitigate the effects of earthquakes, and over what period of time have these actions been taken?

10. Does your organization have a written safety plan that considers earthquakes?

3 yes   3 no

11. In your professional planning and design regarding natural hazards risk reduction, do you rank earthquake resistant design as (Circle one):

__4__ very important
__2__ somewhat important
_____ not important

12. Does your organization perform earthquake safety drills?

__1__ yes __5__ no

If yes, how is the earthquake damage scenario developed and by whom?

Planner

13. Has your organization used any government publications or training programs in its earthquake mitigation efforts?

__3__ yes, specify military (1); NEHRP provisions (2)
__3__ no

14. From which federal or state government agencies, if any, has your organization received assistance for earthquake mitigation?

What type of assistance was provided?

15. On the average, how many workshops, seminars, or conferences per year have been attended by your staff for the purpose of continuing education in seismic hazard mitigation?

1, 3, 3, 4 national
1, 5 state

16. What other resources has your company used in its earthquake planning (e.g., university research, professional papers, etc.)?

Technical and professional associations (4); USGS (2); CUSEC (2); professional papers (2)

17. Does your organization have earthquake insurance?

__3__ yes __3__ no

If not, why?

____

18. Why do you believe that earthquake preparedness through earthquake-resistant design and appropriate site planning is an important objective to achieve on a national level?

    Life safety, loss, and functionality

19. From your perspective, are seismic planning and design issues adequately covered in earthquake engineering publications and other professional magazines and technical journals for you and/or your firm to be aware of the latest developments in science and technology relative to earthquake-resistant design? (Check one)

    1 very well
    3 somewhat well
    2 not at all

20. Please provide any comments concerning your needs that you feel may be useful to this study.

    Lifelines technical information is lacking

QUESTIONNAIRE RESULTS SUMMARY
Designers and Consultants

1. In what geographic areas are your designed structures located?

   __15__ West coast
   __7__ Central U.S.
   __13__ South east
   __8__ North east

   Please indicate seismic zones per local building codes, if known:

   __16__ UBC
   __8__ BOCA
   __5__ SBCCI
   __3__ Other __military, AASHTO__

2. How much of threat do you think a major earthquake is to your designed structures?

   __19__ a very real threat
   __8__ somewhat of a threat
   __2__ not much of a threat
   __—__ not sure

3. Do you consider the earthquake hazard to be less of an issue for your designed structures than other natural or manmade hazards?

   __11__ yes __14__ no

   If yes, what other hazards?

   __Wind, flood, fire__

4. What are the earthquake performance objectives for your designed structures?

   __24__ life safety
   __13__ property loss prevention
   __15__ maintain functionality

   Comments?

   __Design directed by owner__

   Will earthquake performance objectives be more stringent for new construction in the future?

   __18__ yes __8__ no

If yes, please describe.

Better performance criteria, prevent property loss

5. What standards, codes, or methodology will be used as the basis for earthquake design of new facilities?

Current building code

6. In your professional planning and design regarding natural hazards risk reduction, do you rank earthquake resistant design as (Circle one):

21 very important
4 somewhat important
– not important

7. Has your organization used any government publications or training programs in its earthquake mitigation efforts?

16 Yes, specify NEHRP provisions, military guides
9 no

8. From which federal or state government agencies, if any, has your organization received assistance for earthquake mitigation?

Most listed a few times

What type of assistance was provided?

Guides, software, funding, etc.

9. On the average, how many workshops, seminars, or conferences per year have been attended by your staff for the purpose of continuing education in seismic hazard mitigation?

19 National sponsorship   Have attended one or more per year
14 state sponsorship

10. What other resources has your company used in its earthquake planning (e.g., university research, professional papers, etc.)?

ATC, consultants, technical literature

11. Why do you believe that earthquake preparedness through earthquake-resistant design and appropriate site planning is an important objective to achieve on a national level?

Loss of life (16), threat of loss (12), functionality (5), consistent national approach (1)

12. Should earthquake hazards reduction and seismic safety planning and design issues and concerns be included as a part of State Board Professional Licensing Examinations?

25 yes   — no

13. From your perspective, are seismic planning and design issues adequately covered in earthquake engineering publications and other professional magazines and technical journals for you and/or your firm to be aware of the latest developments in science and technology relative to earthquake-resistant design? (Check one)

7 very well
14 somewhat well
4 not at all

14. Has your organization or firm completed (or been involved in any seismic repair, retrofit, or rehabilitation of existing buildings to improve their earthquake resistance?

20 yes   5 no

If yes, please give a brief description.

Strengthening, retrofit, vulnerability analysis

15. Did your college/university education include any course work in seismic design for building and/or construction?

14 yes   11 no

If yes, at what level, e.g., undergraduate or graduate?

Undergraduate (7), graduate (7)

16. Please provide any comments that represent your needs for providing improved seismic designs.

Structural response (4); Code improvements (3); Education (2);
Site specific information (4); Standards for rehabilitation (2);
Joint accommodation of wind/e.g. (3); Dynamic Analysis (2);
Guidance for achieving performance (3); Continuing education (2)

QUESTIONNAIRE RESULTS SUMMARY
Lifeline Engineers and Operators

1. What type of lifeline system(s) does your organization operate?

7 Communications	2 Electric Power	2 Natural gas
3 Oil-Pipeline	7 Highway	1 Port/Harbor
___ Airport	8 Water	4 Sewage

2. In what geographic areas are your facilities located?

15 West Coast	5 Central U.S.	7 Southeast
1 Northeast	___ States: All, 13, 6, 5, 3, 1 (7 times); 14 no response	

Please indicate local building codes, if known:

UBC: 15 BOCA: 3 SBCCI: 3 Other: AASHTO: 3; NRC: 2

3. How much of threat is a major earthquake to your facilities?

17 a very real threat	7 somewhat of a threat
2 not much of a threat	___ not sure

4. Does your organization consider the earthquake hazard to be less of an issue for your facilities than other natural or manmade hazards?

10 yes 16 no

If yes, what other hazards? Flood: 6; hurricane/tornado: 3; fire: 2; volcanism: 2; construction: 2; landslide: 1

5. What are the earthquake performance objectives for your operating facilities? (Check all that apply)

23 life safety	21 property loss prevention
26 maintain functionality	

Comments: Maintain service

Will earthquake performance requirements be increased for new construction in the future?

16 yes 10 no

If yes, please describe: Meet current requirements: 10; exceed current to maintain service dependent on cost: 3; achieve desired performance: 1

6. Has your organization ever had its facilities evaluated for seismic resistance by an engineer?

   __22__ yes __4__ no

   If no, have such evaluations been considered?

   __3__ yes __1__ no

7. Has your organization ever performed retrofit or replacement of facilities to improve seismic resistance?

   __22__ yes __4__ no

   If yes, please describe: __Retrofit: 16; improve performance: 3__

8. What standards, codes, or methodology will be used as the basis for earthquake design of new facilities in the future?

   __Building code: 10; technical associations: 12; NEHRP: 1__

9. What specific actions has your organization taken to mitigate the effects of earthquakes, and over what period of time have these actions been taken?

   __Seismic assessment: 5; retrofit: 5; brace/tie down: 3; response training: 3; replacement: 2__

10. Does your organization have a written emergency plan that considers earthquakes?

    __22__ yes __4__ no

11. In the overall safety planning of your company, how important is planning for earthquakes?

    __14__ very important __9__ somewhat important
    __3__ not important

12. Does your organization perform earthquake response drills?

    __11__ yes __15__ no

    If yes, how is the earthquake damage scenario developed?

    __Scenario event: 3; exercise: 3__

13. Has your organization made use of any government publications or training programs in its earthquake mitigation efforts?

    __17__ yes __7__ no

If yes, please specify: FEMA publication: 10; workshop/training: 6; FHWA: 6; military: 1; NEHRP: 2

14. From which government agencies, universities, or professional associations has your organization received assistance for earthquake mitigation?

FEMA; 7; ASCE/AIA: 6; technical associations: 9; USGS: 5; NCEER, EERI, COSEC; 4

What type of assistance was provided?

Review; 6; funding; 5; training: 4; information: 3

15. On the average, how many workshops, seminars, or conferences per year have been attended by your staff for the purpose of education in seismic hazard mitigation?

national sponsorship: 15 state sponsorship: 10

16. What other resources has your company used in its earthquake planning (e.g., university research, professional papers, etc.)?

Other agencies: 5; university: 5; consultants: 4; EERI, ATC, ASCE: 4

17. Does your organization have earthquake insurance?

13 yes 13 no

If no, why not? Self-insured; government agency

18. Why does your organization believe that earthquake preparedness through earthquake-resistant design and appropriate site planning is an important objective to achieve on a national level?

Functionality: 10; reduce loss: 7; life safety: 7; response/recovery: 1

19. Should earthquake hazards reduction and seismic safety planning and design issues and concerns be included as a part of State Board Professional Engineering Licensing examinations?

17 yes 4 no 5 no opinion

20. Are seismic planning and design issues adequately covered in earthquake engineering publications and other professional magazines and technical journals for your organization to be aware of the latest developments in science and technology relative to earthquake-resistant design? (check one)

8 very well 14 somewhat well 4 not at all

21. What type of technical assistance is needed to improve your practice in earthquake hazard mitigation?

__20__ workshops __19__ standards __16__ design details
_____ other: ______________________________

22. Please provide any comments that you feel may be useful to this study.

Specific design criteria (4)
Implement code and design requirements (1)
Continue work of NEHRP (1)

APPENDIX E.2.2
BUILT ENVIRONMENT
SUMMARY AND ACTION NOTES FROM USER WORKSHOP
November 18-19, 1993
Washington, D.C.

DAY ONE SESSION: THURSDAY, DECEMBER 18, 1993

M. Cassaro opened the meeting with an overview of the built environment assessment and a summary of how the information was collected and evaluated.

1. **Discussion: Assessment Process/Collecting Data and Analysis**

To place the needs survey in perspective, answers were sought to the following questions.

What do end users and collaborators expect the mitigation program to be? How long is it expected to take to complete a research program to the point at which applications are successfully implemented and in place?

H. S. Lew: The federal government anticipates 35 years to implement seismic performance standards under the provisions enacted for all existing federal buildings (own/leased and/or under HUD, DOE, GSA support programs, etc.).

Gene Corley: Seismic hazard mitigation will be a long-term process. It is not clear in the Built Environment Team (BET) report that mitigation will take time—it cannot be achieved overnight. In particular, a great misunderstanding exists about how quickly buildings can be brought up to code. This factor must recognized.

Ron Eguchi: (1) Innovative means are needed to upgrade existing lifelines. Typically, seismic upgrades are coupled with other improvements, such as replacement of aging pipe. (2) The report should show how information flows from users back to researchers. (3) Provide a statistical basis for the findings. (For lifelines, there are no statistics; most findings represent a comment or belief common to most of the experts interviewed.)

J. Carl Stepp: (1) It is agreed that the BET draft report should not appear to accuse NEHRP or research activities for the present state of structural vulnerability. The report should illustrate the essential extra steps/time (see Fig. E.1) needed to reach effective earthquake hazard mitigation. The draft should explain the entire process: hazard characterization research, technology transfer, implementation (currently the missing link), and design practice. (2) Suggestions and thoughts about an overriding, all-inclusive national policy need careful consideration; may not be possible. (3) Good performance of NEHRP needs to be documented. (4) The pathway leading to BET findings and recommendations in the report must be explained. Lead the reader through process; from data collection (interviews/mail survey questionnaires, etc.), through identification of problem, analysis, and basis for findings (e.g., how many responses for each finding), to the final recommendation made in the report. A link is missing in between information collected and recommendation made (need to show how many responses were received on each issue per final recommendation made on that particular finding). (5) BET draft report as written is too complex for reader to follow, as it contains too many findings and recommendations. All findings and recommendations should be pared down, and/or combined with related others, where and as appropriate.

Eric Elsesser: The positive role of NEHRP needs to be highlighted. Some good has been done. What are the strengths?

Gene Corley: The text needs some rework to give the words a more positive spin. For example, finding 4.1 starts by saying, "Too little...," which leaves a negative impression.

Chris Stoddart: The final product (i.e., our report) should reflect comments of contributors and the path to our findings and recommendations.

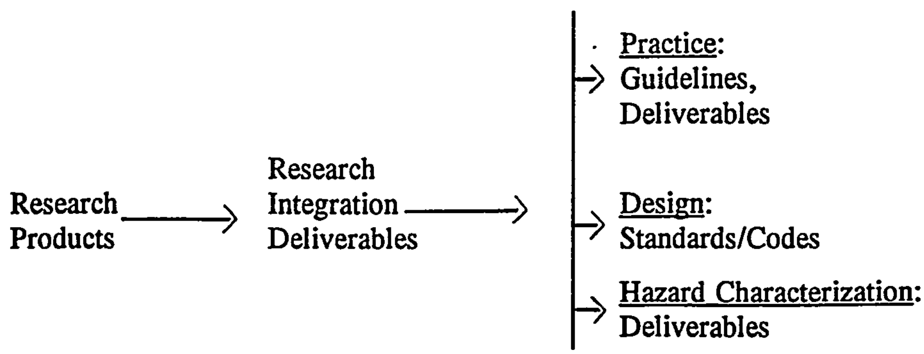

Fig. E.1. Vulnerability reduction procedure.

All: (1) Explicit differentiation of buildings vs lifeline issues/findings is needed. (2) To eliminate any confusion in text as written, workshop participants agree with BET observations made during the workshop that wording in findings and recommendations should be adjusted to make it clear that all lifelines, essential service buildings, and structures that are included refer to construction types and systems.

Action Note I: Recommend using the following paragraph in an appropriate place in the report to avoid the appearance of criticizing NEHRP for the so-called failure of the program to achieve convincing vulnerability reduction. A general statement is needed to point out the following:

> Earthquake hazard reduction is not a short-time issue, so it will not be finished in a short time. The earthquake hazard reduction program will need to continue for several decades in order to obtain the results that are needed.

Action Note II: Suggested a procedure (see Fig. E.1, drawn by Carl Stepp) to indicate phases to appropriately integrate activities from basic research to practice.

2. **Discussion: Research**

Gene Corley: The practical result of research should be funded. Research gets to practice through consensus activity.

Earle Kennett: The goal of research is to develop knowledge, and design manuals are used to achieve mitigation. The report appears to bash researchers (the bashing was unintentional; need to fix).

Thomas Anderson: Small grants are available for postearthquake research. NSF is interested in awarding grants to practitioners that also do research.

Ron Eguchi: Multidisciplinary research should be emphasized. Current efforts are too disjointed. Long-term efforts that deal with hazard, loss, and social impacts are needed.

All: BET workshop participants unanimously agree that NEHRP must not abandon basic research. Everything cannot be solved by problem-focused research; a clear balance must be maintained between the two in order to achieve stated objectives of the earthquake hazard mitigation program.

Action Note III: The report should conclude that the conduct of basic research is OK, but that improvements are needed in the process of translation. The translation process, often done on an ad hoc basis, needs to be formalized.

3. **Discussion: Technology Transfer/Education**

Ron Eguchi: (1) Emphasis should be placed on the multidisciplinary approach as the viable ways to successful technology transfer. (2) The USGS program in the Pacific Northwest is a good example of a success story (e.g., Ballantyne/AWWA/information dissemination through seminars).

Thomas Anderson: Some of the best technology transfer comes from each new generation of engineers from leading graduate schools.

Eric Elsesser and Thomas Anderson: Good examples of technology transfer occur when projects have had a combination of researchers and practitioners on research team, as has already occurred in several research activities and projects supported in the past.

Robert Whitman: (1) It may be unrealistic to expect seismic design to be included in college curriculum. As a minimum, it may be more reasonable to promote an awareness of the need for natural hazard mitigation. (2) One course is needed, sensitized to an all-hazards approach on a national base and integrated into the curriculum, not as a separate course. It is more of a state issue rather than one of universal concern. (3) Translation is one of the major problems. Each agency will claim it is doing this. The problem is that the reward system does not properly acknowledge translation activity.

Susan K. Tubbesing: Mechanisms for dissemination of information need to be identified.

4. **Discussion: Development of Tools for Design**

Gene Corley: Computer codes are not the problem (see finding 4.21). Training programs need to be emphasized (this was done in finding 4.24).

Action Note IV: The report should state that part of the problem in responding to user needs is that NEHRP currently lacks certain specific bits of technical and economic information to realistically and adequately measure building vulnerability and/or seismic performance levels.

5. **Discussion: Codes and Standards**

General Discussion: (1) All observed that performance of structures involves an important thrust, but it is necessary to understand code change and adoption process at local levels to be successful.

Does the code of the future need emphasis on performance standards? (2) Findings 4.11–4.13, and 4.4 touch on owner needs. It will not hurt to include in the BET findings and recommendations; however, in terms of priority, make owner needs last. (3) Develop appropriate design criteria that touch on many variables not now being considered. Admittedly, there is a lot of confusion on this point. There is a question as to whether this point should, or should not be, included in findings 4.12 and 4.13.

Eric Elsesser: Recommends that a seismic risk map or a user's design level map (e.g., an engineering design map as suggested by Professor G. Housner of Cal Tech, not a seismic hazard map) be developed as a guide in the design of lifeline systems, buildings, and other physical facilities. Such a map is needed as baseline information for engineering and architectural design. It could represent a good direction to take for the advancement of building code development, standards, and performance levels.

Robert Whitman: It is disappointing that finding 4.12 is necessary; ground motion definition was thought to be reasonable. Why are designers uneasy? It is recommended that this finding be toned down somewhat to avoid giving users the license to ignore the code.

Earle Kennett: (1) To meet professional user needs, as identified by practitioners, NEHRP should look at development standards when they are not found in the model building codes. (2) Focus on both standards and codes is needed. Some building codes reference standards such as SMACNA. Local jurisdictions sometimes exclude certain provisions of building codes. This problem needs to be addressed, perhaps through evaluating compliance required for federal funding. (3) It should be mentioned that all building codes will be merged into a single code.

Gene Corley and Earle Kennett: Earthquake insurance is an issue. Financial incentives are needed to promote mitigation.

H. S. Lew: Beginning on January 5, 1993, federal loan guarantees required compliance with earthquake standards and codes.

All: It was suggested that the financial incentives finding might be passed on to the Implementation Team, but **Robert Whitman** suggested leaving it in to highlight the need; it is a built environment concern.

Action Note V: As hazard characterization represents an important engineering development, the BET final report should give strong consideration to including the engineering design map concept in its findings and recommendations.

6. Discussion: BET Findings/Recommendations

Ron Eguchi: Reinforces BET findings/recommendations regarding the appropriateness for the BET draft to reflect "need for user input into research topics up front." The complete cycle of earthquake hazard mitigation process should be illustrated: USER—RESEARCH—USER.

Earle Kennett: (1) Along with findings and recommendations, emphasizes that the primary purpose of the research phase is to gain knowledge and that the researcher should not necessarily be required to perform integration activities directly and/or transfer research findings to practice. Perhaps the latter could be done better by integration/information transfer specialists (marketing experts) experienced in such activities (see Action Note II). (2) The finding relating to the policy on deliverables needs clarification.

Carl Stepp: Regarding BET findings and recommendations, agrees that BET final report should emphasize overall process and objectives of **NEHRP** and not individual organizations and/or agencies.

Thomas Anderson: Indicates that the BET recommendation on the need for follow-up long-term postearthquake investigations through special NEHRP funding programs should reference for the record the two special follow-up long-term research initiatives completed on the 1989 Loma Prieta and 1985 Mexico earthquakes.

Randy Updike: (1) How can we be sure that a finding is not just based on "ax-grinding" of a single individual? (This not happen; how do we clarify?) (2) Questions the BET finding that NEHRP information is difficult to access. How many responses (i.e., answers from interviewees and/or mail surveys) were received by BET substantiating or confirming this finding and recommendation?

Gene Corley: Believes that volunteerism should be considered with a positive attitude. We indicated how volunteer committees had been exploited, and with that clarification there seemed to be no disagreement. This finding will be clarified so that the policy of funding consensus-building and similar activities will not be affected.

All: The findings need to be prioritized.

Action Note VI: BET findings and recommendations should reflect NEHRP Program and not necessarily individual organizations and/or agencies.

Action Note VII: In the BET final report, reference for the record should be made to two special NEHRP initiatives that provided funding for long-term follow-up studies after the immediate Loma Prieta and Mexico postearthquake investigations were completed.

Action Note VIII: Reduce the number of BET findings and recommendations and/or combine them into five items (plus or minus) for less complexity and greater emphasis.

DAY TWO SESSION: FRIDAY, DECEMBER 19, 1993

7. Discussion: Reduce and combine BET Findings/Recommendations

General Discussion: Suggest combining or merging findings 4.1–4.3 and parts of findings 4.4, 4.5, 4.15, and 4.17 or 4.18 into one. Develop some type of mechanism/process to assist in translating research into practice, such as a sounding board or advisory group as part of the attempt to establish a bridge between research and practice. NEHRP is to provide funding to bring users into the research process to facilitate technology transfer.

Re: finding 4.1, the BET statement indicating "Too little research" needs to be restated in more positive terms (rather than in the dominant negative tone as now written). There is general agreement with the statement, and all agree that it should be m more supportive.

Re: finding 4.2, in general, it was assigned a low priority by the workshop participants.

Re: finding 4.3, long-term complex projects should consider having a multidisciplinary team involved.

Recommendation for Combination of Findings

4.6–4.8	technical, tools, vulnerability assessment
4.9–4.10	performance issues
4.11–4.14	codes and standards
4.16, 4.21–4.24	education and knowledge

Action Note IX: Wording in the text needs to be adjusted to make it clear that lifelines and buildings are both cited, referred to, and included in all BET findings and recommendations with equal importance.

General Comments by Tom Anderson During Steering Committee Meeting

1. The attempt to be too simple has sometimes led to misinterpretation of our findings.

2. We cannot downplay the importance of basic research. It is the seed for future development.

3. We must do a better job of reaching leaders such as CEOs and general managers because they are the ones that will influence earthquake mitigation. They will set policy and priorities for their respective organizations.

Workshop Participants

Assessment Team: M. Cassaro, H. Lagorio, D. Nyman

W. Anderson, NSF
E. Corley, PCA (Construction Technology Laboratory)
R. Eguchi, EQE
E. Elsesser, Forell/Elsesser
E. Kennett, BSSC
H. S. Lew, NIST
C. Stepp, EPRI
C. Stoddart, MMES
S. Tubbesing, EERI
R. Updike, USGS
R. Whitman, MIT

APPENDIX F

INTERVIEW QUESTIONNAIRES

APPENDIX F

INTERVIEW QUESTIONNAIRES

All four teams conducted interviews of selected users. The Seismic Hazard Team interviewed three groups: data generators/researchers, hazard analysts, and end-users. Accordingly, they prepared three questionnaires to match these users' needs.

Similarly, the Built Environment Team selected two groups of users to interview. They prepared questionnaires for designers and consultants and for lifelines and owners.

The Societal and Policy Team elected to interview people who have some responsibility for taking or influencing direct action to improve earthquake hazard mitigation or preparedness. They prepared one questionnaire for all of their interviewees.

The Implementation Team felt its most valid results would come from interviews in specific areas of the country. Accordingly, members prepared a questionnaire that they used for interviews in 13 cities in three sections of the United States: the Pacific Northwest, the Central United States, and California.

Questions asked by each of the teams follow.

F.1 INTERVIEW QUESTIONS ASKED BY THE SEISMIC HAZARD TEAM

F.1.1 Interview Questions for Data Generators/Researchers

1. What is the technical focus of your earthquake-related data-collection or research activities?

2. What percentage of your time do you spend on these earthquake-related activities? What are your sources of funding?

3. Which of your earthquake-related activities are supported by the NEHRP? What percentage of your time is spent on NEHRP-supported efforts?

4. How are the data or information that you generate used in their final form — either within the NEHRP or for other purposes?

5. In your area of expertise, who makes decisions or recommendations regarding hazard mitigation (this may include yourself and/or other groups)? Do you serve as a consultant or expert witness for other decision makers?

6. Do you feel that your research findings are being adequately utilized in hazard mitigation practice? Please explain.

7. In your opinion, are there any relevant technical issues that the NEHRP has not targeted?

8. Are there data or information of potential importance to the NEHRP that are not being developed or, if available, are not being utilized?

F.1.2 Interview Questions for Hazard Analysts

1. What percentage of your time do you spend on seismic hazard analysis efforts? What are your sources of funding?

2. Which of your seismic hazard analysis efforts are supported by the NEHRP? What percentage of your time is spent on NEHRP-supported efforts?

3. What are the specific types of data that you use in your hazard analysis that are provided directly by NEHRP? (e.g. recurrence intervals provided by trenching studies; seismicity catalogs provided by seismic networks).

4. How easily available and retrievable are these NEHRP databases? Could they be made more easily available? If so, how?

5. What additional information do you need that has not been produced by NEHRP or other researchers?

6. Do you believe there are important data or information that have been generated by NEHRP researchers that are not available to you? Are there data available in a form that is unusable to you?

7. What percentage of seismic hazard analyses do you perform internally? What percentage is contracted out to others?

8. Do you see knowledge gaps between data collection/research findings, and hazard analysis? Between hazard analysis and its application?

9. How are the results of your hazard analyses used, either within the NEHRP or for other purposes?

10. In your area of expertise, who makes decisions or recommendations regarding hazard mitigation (this may include yourself and/or other groups)? What kinds of decisions are made? Do you serve as a consultant or expert witness for other decision makers?

F.1.3 Interview Questions for End Users

1. What are the earthquake-related data or seismic hazard analyses that you use in your organization? How much of these data and analyses would you estimate are supported by the NEHRP?

2. What is your opinion of the quality and reliability of NEHRP-sponsored data and hazard analyses?

3. How easily available and retrievable are the NEHRP databases and hazard analyses? Could they be made more easily available? If so, how?

4. What additional information do you need that has not been produced by NEHRP or other researchers?

5. Do you believe there are important data or information that have been generated by NEHRP researchers that are not available to you? Are there data available in a form that is unusable to you?

6. What percentage of your earthquake-related data or analyses needs are met with in-house capabilities. What percentage is contracted out to others?

7. Do you make decisions or recommendations regarding hazard mitigation? If so, what kinds? If not, where are these decisions made?

8. Do you see knowledge gaps between NEHRP-sponsored data collection and hazard analyses to those products that you use?

F.2 INTERVIEW QUESTIONS ASKED BY THE BUILT ENVIRONMENT TEAM

F.2.1 Interview Questions for Architects and Engineers (Including Building Officials)

1. In what geographic areas are your designed structures located? West coast, Central U.S., South east, North east. Please indicate seismic zones per local building codes, if known: UBC, BOCA, SBCCI, Other.

2. How much of threat do you think a major earthquake is to your designed structures? A very real threat, somewhat of a threat, not much of a threat, not sure.

3. Do you consider the earthquake hazard to be less of an issue for your designed structures than other natural or manmade hazards? Yes, no. If yes, what other hazards?

4. What are the earthquake performance objectives for your designed structures? Life safety, property loss prevention, maintain functionality. Comments?

   Will earthquake performance objectives be more stringent for new construction in the future? Yes, no. If yes, please describe.

5. What standards, codes, or methodology will be used as the basis for earthquake design of new facilities?

6. In your professional planning and design regarding natural hazards risk reduction, do you rank earthquake resistant design as (Circle one): very important, somewhat important, not important.

7. Has your organization used any government publications or training programs in its earthquake mitigation efforts? Yes, specify; no.

8. From which federal or state government agencies, if any, has your organization received assistance for earthquake mitigation? What type of assistance was provided?

9. On the average, how many workshops, seminars, or conferences per year have been attended by your staff for the purpose of continuing education in seismic hazard mitigation? National sponsorship, state sponsorship.

10. What other resources has your company used in its earthquake planning (e.g., university research, professional papers, etc.)?

11. Why do you believe that earthquake preparedness through earthquake-resistant design and appropriate site planning is an important objective to achieve on a national level?

12. Should earthquake hazards reduction and seismic safety planning and design issues and concerns be included as a part of State Board Professional Licensing Examinations? Yes, no.

13. From your perspective, are seismic planning and design issues adequately covered in earthquake engineering publications and other professional magazines and technical journals for you and/or your firm to be aware of the latest developments in science and technology relative to earthquake-resistant design? (Check one) Very well, somewhat well, not at all.

14. Has your organization or firm completed (or been involved in any seismic repair, retrofit, or rehabilitation of existing buildings to improve their earthquake resistance? Yes, no.

15. Did your college/university education include any course work in seismic design for building and/or construction? Yes, no. If yes, at what level, e.g., undergraduate or graduate?

16. Please provide any comments that represent your needs for providing improved seismic designs.

F.2.2 Interview Questions for Lifelines and Owners

1. What type of facilities does your organization operate? Lifeline: type; industrial structure; commercial and/or office.

2. In what geographic areas are your facilities located? West coast, Central U.S., South east, North east. Please indicate seismic zones per local building codes, if known: UBC, BOCA, SBCCI, Other.

3. How much of threat do you think a major earthquake is to your facilities? A very real threat, somewhat of a threat, not much of a threat, not sure.

4. Do you consider the earthquake hazard to be less of an issue for your facilities than other natural or manmade hazards? Yes, no. If yes, what other hazards?

5. What are the earthquake performance objectives for your operating facilities? Check all that apply. Life safety, property loss prevent, maintain functionality. Comments?

   Will earthquake performance objectives be more stringent for new construction in the future? Yes, no. If yes, please describe.

6. Has your organization ever had its facilities evaluated for seismic resistance by an engineer? Yes, no. If no, have such evaluations been considered? Yes, no.

7. Has your organization ever performed retrofit or replacement of facilities to improve seismic resistance? Yes, no.

8. What standards, codes, or methodology will be used as the basis for earthquake design of new facilities?

9. Has your organization been planning and preparing for earthquakes Yes, no. If yes, what specific actions has your organization taken to mitigate the effects of earthquakes, and over what period of time have these actions been taken?

10. Does your organization have a written safety plan that considers earthquakes? Yes, no.

11. In your professional planning and design regarding natural hazards risk reduction, do you rank earthquake resistant design as (Circle one): very important, somewhat important, not important.

12. Does your organization perform earthquake safety drills? Yes, no. If yes, how is the earthquake damage scenario developed and by whom?

13. Has your organization used any government publications or training programs in its earthquake mitigation efforts? Yes, specify; no.

14. From which federal or state government agencies, if any, has your organization received assistance for earthquake mitigation? What type of assistance was provided?

15. On the average, how many workshops, seminars, or conferences per year have been attended by your staff for the purpose of continuing education in seismic hazard mitigation? National, state.

16. What other resources has your company used in its earthquake planning (e.g., university research, professional papers, etc.)?

17. Does your organization have earthquake insurance? Yes, no. If not, why?

18. Why do you believe that earthquake preparedness through earthquake-resistant design and appropriate site planning is an important objective to achieve on a national level?

19. From your perspective, are seismic planning and design issues adequately covered in earthquake engineering publications and other professional magazines and technical journals for you and/or your firm to be aware of the latest developments in science and technology relative to earthquake-resistant design? (Check one): very well, somewhat well, not at all.

20. Please provide any comments concerning your needs that you feel may be useful to this study.

F.3 INTERVIEW QUESTIONS ASKED BY THE SOCIETAL AND POLICY TEAM

F.3.1 Interview Guide — End-Users

For purposes of the NEHRP program assessment "end-users" are defined as those people who have some responsibility for either taking direct action, or influencing others to take direct action, to improve earthquake hazard mitigation or preparedness. We assume that those people are generally knowledgeable about the intent and scope of the National Earthquake Hazards Reduction Program (NEHRP) and the responsibilities assigned to the four principal agencies by the amended 1977 act.

Explain that the objectives of this assessment project are to identify factors at the user level that facilitate or impede the formulation, adoption, and implementation of work supported or done by the agencies responsible for NEHRP activities. The results will be presented in a report to FEMA, and it will be used to advise the agencies about program priorities and actions they can take to reduce barriers to application.

While it may be useful to interview more removed ("secondary") key actors, such as legislators, city council members, executive agency heads and staff members, and others this guide is not intended specifically for them. Only a few, if any, such secondary actors will be able to link their actions to the formal NEHRP program. Rather, these people tend to be the "agents" of, and depend on, the "earthquake entrepreneurs" in their areas.

F.3.2 Interview Questions for End Users

1.0 Background data about the interviewee.
Name:
Position:
How long held:
Date of interview:
Interview completed by phone: ___ In person: ____
Mailing address:
Phone:
Fax, etc.:

2.0 Summary description of interviewee's earthquake responsibilities:

3.0 Which of these activities are directly related to the NEHRP?

4.0 In general, where do your other responsibilities come from?

5.0 As you reflect on your ability to perform your earthquake program responsibilities, what things, factors, forces, and variables help you get the job done? Why are they helpful?

6.0 Which of these helpful factors can you attribute directly to the NEHRP, including any of the four principal agencies responsible for elements of the program?

7.0 As you reflect on your ability to perform your earthquake responsibilities, what things, factors, forces, and variables are barriers to you? Why are they barriers?

8.0 Of these barriers, which do you attribute directly to the NEHRP or any of the four agencies responsible for elements of the program?

9.0 If you could, what would you do to lessen or remove these barriers?

10.0 Focusing now on the research aspects of NEHRP:
10.1 How do you find out about and obtain the results of research of interest to you?
10.2 What makes it easiest for you [to] use research results in your present position?
10.3 What makes it difficult for you to use research results in your present position?
10.4 What are some subjects on which you need more knowledge that should start being addressed by researchers now so you have the results in the next three to five years?

11.0 In sum, as we look forward to NEHRP's next five years:
   11.1 What should be emphasized more strongly?
   11.2 What should be continued about as is?
   11.3 What should receive less emphasis or be terminated?
   11.4 Do you have any concluding thoughts about the overall organization, level of support, organizational relationships, or other general topics we should note for this report?

12.0 Other comments and notes.

F.4 INTERVIEW QUESTIONS ASKED BY THE IMPLEMENTATION TEAM

Local Assessment

1. Background data about the interviewee.
   Name:
   Position:
   How long held:
   Date of interview:
   Interview completed by phone: ___ In person: ___
   Mailing address:
   Phone:
   Fax, etc.:

2. Summary description of the interviewee's earthquake risk reduction *responsibilities*. (Check all that apply)

   Building Department:
   - Develop local building regulations
   - Plan review
   - Assist in the development of (UBC, SBCCI, BOCA, and/or local) building code
   - Assist in the development of NEHRP seismic design provisions
   - Enforcement of building retrofit policies
   - Development of building retrofit policies
   - Development of Building Department response to earthquake emergency
   - Structural inventory of the potential seismic hazards of city owned buildings
   - Structural inventory of the potential seismic hazards of commercial buildings
   - Structural inventory of the potential seismic hazards of residential buildings
   - Nonstructural inventory of the potential seismic hazards of city owned buildings (building contents, architectural elements like windows, and mechanical systems)
   - Develop City mitigation plan
   - Develop Building Department emergency preparedness and/or response plans
   - Develop Building Department emergency recovery plans
   - Provide vulnerability information to a committee tasked with preparing a Department and/or City Emergency Plan
   - Member of City seismic hazards task force, committee, or commission

   Planning Department
   - Prepare Comprehensive Plan

- Develop City earthquake risk reduction (mitigation) plan
- Develop City earthquake risk reduction (mitigation) policy
- Develop Planning Department earthquake risk reduction (mitigation) plan
- Develop Planning Department earthquake risk reduction (mitigation) policy
- Develop Planning Department emergency preparedness and/or response plans
- Develop Department emergency recovery plans
- Provide vulnerability information to a committee tasked with preparing a Department and/or City emergency plan
- Provide emergency managers with access to GIS equipment, data or other hazards related information management
- Contribute to public hazard education or citizen awareness efforts
- Serve as member if a hazard management or recovery/reconstruction task force
- Other

School Facility Manager

- Develop seismic design specifications for new buildings
- Review proposed seismic design specifications provided by consultants
- Manage structural retrofit program (set standards, etc.)
- Manage nonstructural hazard mitigation program
- Structural inventory of potential seismic hazards of buildings
- Nonstructural inventory of potential hazards of building contents, architectural elements (windows, elevators, parapets, etc.), and mechanical systems
- Prepare long term facility use, replacement, and/or building re-use plans
- Develop school facilities mitigation plans
- Development Facility Department (internal) mitigation plans
- Develop School Facilities Department emergency preparedness and/or response plans
- Develop School Facilities Department emergency recovery plans
- Provide school facility vulnerability data to a committee tasked with preparing a Department or school district emergency plan

Hospital Facility Manager

- Develop seismic design specifications for new buildings
- Review proposed seismic design specifications provided by consultants
- Manage structural retrofit program
- Manage nonstructural retrofit program
- Structural inventory of potential seismic hazards of buildings
- Nonstructural inventory of potential hazards of building contents, architectural elements (windows, elevators, parapets, etc.), and mechanical systems
- Prepare long term facility use, replacement, and/or building re-use plans
- Develop hospital facilities mitigation plan
- Develop Facilities Department mitigation plan
- Develop Department emergency preparedness and/or response plans
- Develop Department emergency recovery plans
- Provide information on facilities vulnerability to a committee tasked to prepare department and/or hospital emergency plans
- Other

3. What percentage of your total position responsibilities concerns activities related to the implementation of earthquake risk reduction measures?

What specifically is your role: Mitigation coordinator, Official liaison to emergency management, Training/awareness/outreach specialist, Information management specialist. Describe.

4. In general, where do your other responsibilities come from?

5. Which of the following would you say are among the MAJOR reasons why your planning/building/school/hospital department gives attention to the reduction of earthquake risk? (Check all that apply)

   - Executive Board or City/County Council influence
   - Past disaster or damage to your community
   - Past disaster or damage to other communities
   - Useful to manage growth
   - Influence of Professional training or information networks
   - Requests by State/Local/Department emergency manager
   - State mandates
   - State agency programs (specify)
   - State technical assistance
   - Federal agency programs (specify)
   - Federal agency technical assistance
   - Federal mandates/Executive Order
   - Special regional programs (SCEPP, BAREPP, CUSEC, NESEC, COGs/Regional Councils)
   - Citizen interest/influence
   - Interest/influence from other City Departments/School Units (teachers, PTSA, etc.)/Hospital units or other personnel
   - Other (specify)

   Is there any one reason that stands out from all the rest?

6. Which of the following *mitigation techniques* have been used by your (building department, planning department, school district, hospital, or federal agency) to reduce potential damage to your facilities and/or to improve post-event functional capabilities? (Check all that apply)

   Buildings
   - Adoption of a building code (specify)
   - Adoption of special seismic resistant building standards
   - Structural vulnerability inventory
   - Nonstructural vulnerability inventory
   - Structural retrofit of existing (city, school, hospital, or federal) buildings
   - Nonstructural earthquake hazard mitigation for (city, school, hospital, or federal) buildings

   Critical and public facilities policies
   - Capital improvement program
   - Location of critical facilities (hospitals, schools) to reduce risk
   - Location of capital facilities (streets, water) to discourage development in hazardous zones
   - Seismic safety a priority in consideration of building replacement or reuse

   Development regulations
   - Zoning or land use ordinance

- Subdivisions ordinance
- Fault setback ordinance (note if not applicable

Information dissemination
- Public earthquake hazard information program
- Personnel earthquake hazard information program
- Hazardous disclosure requirements in real estate transactions
- Hazard mitigation education for developers/builders

Land and policy acquisition
- Transfer of development potential from hazardous to nonhazardous sites (include change of use of facilities related to concern about seismic safety; e.g., in-patient to out-patient treatment, student use to storage, etc.)
- Acquisition of undeveloped lands
- Acquisition of development rights
- Building relocation
- Acquisition of damaged buildings

Planning
- Comprehensive, land use, or facility plan
- Earthquake components of comprehensive or facility plan
- Recovery/reconstruction plan
- Special geologic studies review in seismic areas
- Review of earthquake hazards risks in city environmental impact review of development actions

Taxation and fiscal policies
- Impact tax to cover additional public costs of building in hazardous areas
- Reduced or below-market taxation for open space or non intensive uses in hazardous areas
- Other

7. Of the mitigation techniques checked above, what *special problems* do you have with respect to their implementation?

8. What kind of information or activities from the NEHRP agencies (USGS, FEMA, NIST, NSF) has helped you to implement earthquake risk reduction measures? List specific sources as best you can. (Refer to the background sheet for a description of the responsibilities of each agency).

   Publications, Workshops (specify), Training/Education Classes (specify), Code development, Hazard Information, NEHRP grants/contracts, Other.

9. How did the NEHRP information or activities above specifically help you carry out earthquake risk reduction measures? (Check all that apply)

   - Provided information to define the hazard
   - Provided detailed hazard mitigation techniques
   - Supported the passage of hazard mitigation regulations
   - Supported development of hazard mitigation policies
   - Helped get mitigation on the agenda
   - Provided information to prepare mitigation plans

- Made you aware of the earthquake hazard in your community
- Made you aware of the possible impacts of an earthquake on your facility
- Increased coordination of earthquake mitigation activities among departments
- Other (specify)

10. As you reflect on your ability to perform your earthquake risk reduction/mitigation activities, what other factors and forces *help you get the job done*? Why are they helpful?

11. Which of these other *helpful factors/forces* can you attribute *directly* to the NEHRP, including any of the four principal agencies responsible for elements of the program?

12. As you reflect on your ability to perform your earthquake responsibilities, what factors and forces are *barriers* to you? Why are they barriers?

13. Of these *barriers*, which do you attribute directly to the NEHRP or any of the four agencies responsible for elements of the national earthquake hazard reduction program?

14. If you could, what would you do to lessen or remove these barriers?

15. What state agencies do you most rely on to help you develop/carry out earthquake loss reduction measures?

    - Do you interact with the State Emergency Management Agency, State Geologic Survey, or universities in order to carry out risk reduction measures? How? Why?
    - Does the State Department of Education assist you with respect to the implementation of earthquake risk reduction measures?
    - Does the Joint Commission on Accreditation of Hospitals assist you with respect to the implementation of earthquake risk reduction measures? State Hospital Association? Area Hospital Council? Dept. of Health (state department in charge of licensing)?

16. What professional associations do you most rely on to help you develop/carry out your earthquake risk reduction responsibilities? Including training and education.

17. What professional associations do you most rely on to help you develop/carry out your other (nonearthquake risk reduction) responsibilities? Including training and education.

18. Focusing now on the *research* aspects of NEHRP:

    - How do you *find out about and obtain* the results of research of interest to you?
    - What makes it *easiest for you to use* research results in your present position?
    - What makes it *difficult for you* to use research results in your present position?
    - What are some *subjects on which you need more knowledge* that should start being addressed by researchers now so you have the results in the next three to five years?

19. In sum, as we look forward to NEHRP's next five years:

    - What should the four NEHRP agencies emphasize more strongly?
    - What should they continue about as is?
    - What should receive less emphasis or be terminated?

• Do you have any concluding thoughts?

THANK YOU FOR PARTICIPATING IN THIS INTERVIEW! PLEASE BRING UP ANY ISSUES YOU FEEL SHOULD HAVE BEEN ADDRESSED WITH THE INTERVIEWER. YOUR OPINION IS IMPORTANT TO US.

Federal Assessment

Interview Questions for ICSSC Reps. and Seismic Safety Coordinators.

The following questions refer to four possible contexts, one or more of which may apply to your agency for a given question:

a. new buildings; implementation of Executive Order 12699
b. existing buildings; proposed ICSSC policy/Executive Order
c. lifelines; proposed development of federal seismic standards
d. "other"

1. What NEHRP products or services have been useful to your agency and how have you obtained them?

2. What NEHRP products would be useful in the future?

   research: data (inventories of facilities, costs of design and construction, etc.): communicating information: guidelines and standards: conferences and meetings: training: fellowships: clearinghouses, libraries: inter-agency assistance: other.

3. Are the research results and information products of NEHRP all that your agency needs to carry out earthquake hazard reduction, or are there other activities that would be necessary or useful?

   Executive Orders, agency policies: Congressional laws; budgets for architecture, engineering, and construction contracts and agency staffing to manage design and construction efforts: other.

October 22, 1993

Dear Earthquake Course Participant:

Subject: Questionnaire for past students of the course on Nonstructural Earthquake Hazard Mitigation for Hospitals and Other Health Care Facilities

We are contacting you because you have participated in the Federal Emergency Management Agency (FEMA) "hospitals and earthquakes" course. You may have taken the course at FEMA's Emmitsburg, Maryland, Emergency Management Institute or in your own region as a two-day course under the auspices of your state's office of emergency services or a regional health care organization.

We would appreciate it if you could take a moment (fifteen minutes or less) to complete and return the attached questionnaire in the enclosed self-addressed and postage paid envelope. Your opinions will be the most helpful to us if you can return the questionnaire by November 15, 1993.

Your opinions are valuable to us for an assessment of the National Earthquake Hazards Reduction Program (NEHRP) currently underway. NEHRP includes many different activities, such as earth science research, development of engineering guidelines and standards, and the dissemination of earthquake preparedness information. This initial wide-ranging study of the value of these activities to NEHRP "customers" or users is being conducted with FEMA funding to see how the NEHRP can better help users such as yourself implement earthquake hazard reduction and emergency preparedness measures.

One specific NEHRP activity is the earthquake hazard mitigation course for hospitals and other health care facilities that you participated in. The aim of the enclosed questionnaire is to find out how useful this course has been in helping you to reduce earthquake hazards or implement preparedness planning at your facility, or to help others with these activities. In addition, the questionnaire invites you to suggest other products or services that NEHRP could provide over the next five years — such as specific research, workshops and training, publications, development of standards, and other services.

Thank you for your participation.

Carlyn Orians, Survey Manager

Battelle Seattle Research Center
4000 N.E. 41st Street
P.O. Box 5395
Seattle, WA 98105

Nonstructural Earthquake Hazard Mitigation for Hospitals and Other Health Care Facilities: Follow-up Questionnaire

The following questions ask you to provide information about the course you took on "hospitals and earthquakes." The date that you took the course is indicated below. Please provide an answer for each question as indicated by the instructions with each item. It should take less than 15 minutes of your time.

A self-addressed, postage paid envelope has been provided for your convenience in returning the questionnaire. The information you provide will be the most helpful to us if the questionnaire is returned by November 15, 1993.

1. As a reminder, the location in which you attended the course, and the date, are indicated to the right:

2. The organization you represented at that time is located in the city indicated to the right. If you respond to these questions with respect to a different location, please write in the city, state, and zip code for it below:

   ____

3. When you attended the course, what type of organization did you work for? (Please check only one.)

   _____ a. Health/medical care or service organization (e.g., hospital, long-term care facility, clinic, ambulance service, laboratory, or other health care or service).

   _____ b. Emergency services organization (e.g., emergency management organization, fire or law enforcement agency, etc.)

   _____ c. Other (please specify) ________________________________

IF YOU CHECKED "b" OR "c", PLEASE SKIP OVER QUESTIONS 4 THROUGH 13, AND ANSWER ONLY QUESTIONS 14 AND 15.

4. Did other people from your health care facility attend the course at the same time as you? (Please check only one.)

   _____ a. Yes, one other.

   _____ b. Yes, two or more others.

   _____ c. No, just me.

   _____ d. Don't remember.

5. What type of position do you hold in your health care facility? (Please mark the one category that best represents your principal responsibilities.)

_____ a. Engineering or facilities

_____ b. Medical staff (e.g., physicians, nurses, technicians, etc.)

_____ d. Administration

_____ e. Other: (please specify)

____

6. Which of the following best characterizes the type of health care facility in which you work?

_____ a. Acute care hospital

_____ b. Outpatient facility, clinic

_____ c. Long-term care; nursing home

_____ d. Ambulance or paramedic service

_____ e. Other: (please specify)

____

7. What is the approximate size of your health care facility? (Please check only one.)

_____ a. Larger than 250 bed facility

_____ b. 100 to 250 bed facility

_____ c. 50 to 99 bed facility

_____ d. Smaller than 50 bed facility

_____ e. Alternative size description (if beds not applicable):

____

8. How relevant was the course material for use in your facility to reduce nonstructural earthquake hazards? Please respond even if you have not as yet actually applied anything learned in the course. (Please check the one most applicable answer.)

_____ a. Very relevant: Most of the types of hazards described and the information taught in the course could be applied to my facility in order to reduce nonstructural earthquake hazards.

_____ b. Moderately relevant: Several of the things taught could be applied to nonstructural earthquake hazards that exist in my facility; others were not relevant to my facility.

_____ c. Slightly relevant: Only a very few of the things taught were relevant for use in my facility; generally, the types of nonstructural hazards described in the course do not exist in my facility.

_____ d. Other comment on relevance of course materials: _____________________

____

9. In what specific ways has your facility taken actions to reduce its earthquake hazards, or become better prepared to respond to an earthquake, since the time you took the course? Check only those activities that resulted to some degree from information brought back by you or others attending the course. (Check as many as apply.)

_____ a. Nonstructural protection (for example, anchoring equipment, restraining supplies, ensuring that new items are properly installed, etc.)

_____ b. Structural improvements of the facility (for example, retrofit or renovation projects that strengthened walls and columns).

_____ c. Higher seismic standards used, or planned, for new construction.

_____ d. Training for staff on earthquake preparedness and response (e.g., training sessions, distribution of instructional material, etc.)

_____ e. Exercise(s) using an earthquake as the theme of the exercise.

_____ f. Emergency planning (for example, re-writing or revising the disaster plan incorporating improvements designed to be effective for earthquakes, etc.).

_____ g. Coordination and communication with other organizations (for example, hospitals observing each other's earthquake exercises, meetings that bring hospital personnel together with local building inspection departments or offices of emergency services).

_____ h. Other: (please specify) ______________________________

_____ i. My facility hasn't implemented any such measures since I attended the course.

IF YOU CHECKED "i" PLEASE SKIP QUESTION 10 AND START AGAIN WITH QUESTION 11.

10. In your opinion, what were the most important motivations for your organization to implement the measures you indicated in Question 9? Please select only three from the following list and rank them. That is, put a "1" by the most important motivation, a "2" by the second most important, and a "3" by the third most important. (Please leave the rest blank.)

_____ a. Local or state regulation.

_____ b. Accreditation requirements.

_____ c. Concern over ability of the facility to function after an earthquake.

_____ d. Concern over property loss the facility would suffer in an earthquake.

_____ e. Concern over injuries people in the facility would suffer in an earthquake.

_____ f. Concern about liability for injuries to patients, staff, or the public if an earthquake damages the facility.

_____ g. Direct experience with, or awareness created by, a recent earthquake.

_____ h. Earthquake hazard awareness gained from the information presented in the course.

_____ i. Other: (please specify) ______________________________

11. Thinking about the reduction of nonstructural hazards, in your opinion, what prevents you or your organization from beginning or continuing to expand on such measures? Please select no more than three from the following list and rank them.

Put a "1" by the most important motivation, a "2" by the second most important, and a "3" by the third most important. (Please leave the rest blank.)

_____ a. Lack of money.

_____ b. Lack of adequate information on earthquake engineering subjects.

_____ c. Lack of in-house engineering expertise.

_____ d. Belief that the earthquake threat is not as important as other problems faced by the facility.

_____ e. Such measures are not mandated by federal, state, or local laws or facility accreditation requirements.

_____ f. Belief that the facility has reached a practical limit with respect to earthquake hazard reduction measures and no further measures are warranted.

_____ g. Other: (please specify) ________________________________

12. Thinking about earthquake emergency planning and training, in your opinion, what prevents you or your organization from beginning or expanding such activities? Please select no more than three from the following list and rank them.

Put a "1" by the most important motivation, a "2" by the second most important, and a "3" by the third most important. (Please leave the rest blank.)

_____ a. Lack of money.

_____ b. Lack of adequate information on emergency planning subjects.

_____ c. Lack of in-house emergency planning expertise.

_____ d. Belief that the earthquake threat is not as important as other problems faced by the facility.

_____ e. Such activities are mandated by federal, state, or local laws or facility accreditation requirements.

_____ f. Belief that the facility has reached a practical limit with respect to earthquake hazard planning and preparedness activities and no additional activities are warranted.

_____ g. Other: (please specify) ________________________________

13. Depending on when and where you took the course, some or all of the following student materials were available to you. (Some were handed out; some could be ordered.) Which ones have been of practical use—that is, which ones have been used to guide you or others in your facility to implement a hazard reduction or preparedness measure? (Check as many as apply.)

For each type of instructional material listed below, please indicate if you remember receiving the material AND indicate if you have made use of it.

Type or name of the instructional material	**Remember receiving the material? (Circle Yes or No)**	**Have made practical use of it? (Circle Yes or No)**
Student manual (textbook): *Nonstructural Earthquake Hazard Mitigation for Hospitals and Other Health Care Facilities* (FEMA SM370)	a. Yes No	b. Yes No
FEMA Publication 150: *Seismic Considerations: Health Care Facilities*	c. Yes No	d. Yes No
FEMA Publication 74: *Reducing the Risks of Nonstructural Earthquake Damage: A Practical Guide*	e. Yes No	f. Yes No
A set of slides used in the course	g. Yes No	h. Yes No
Videotape Program: *Nonstructural Earthquake Damage*	i. Yes No	j. Yes No
Videotape Program: *The 1985 Earthquake in Mexico*	k. Yes No	l. Yes No
Videotape Program: *How Earthquakes Affect Buildings*	m. Yes No	n. Yes No
Other: (please specify)	o. Yes No	p. Yes No
Other: (please specify)	q. Yes No	r. Yes No

14. Which of the following means, if any, have you used to pass on information from the course to other people? (Please check as many as apply.)

_____ a. Was an instructor of a subsequent offering of the course.

_____ b. Gave a talk at a meeting, using information learned in the course.

_____ c. Used a slide set from the course in a presentation.

_____ d: Used one or more of the videotape programs from the course in a presentation.

_____ e. Made photocopies of material from the Student Manual or other written material from the course to provide information to others.

_____ f. Other: (please specify) ____

_____ g. None of the above.

15. Do you have any suggestions for how the National Earthquake Hazards Reduction Program (NEHRP) could help you reduce earthquake risks at your medical facility, including both physical hazard reduction measures and emergency preparedness? For example, what specific information, technical services, research, standards, training courses, etc., would be helpful to you? Please write your comments in the space below.)

(NOTE: If you are not affiliated with a health care facility, reply in terms of what would be useful to you in your capacity to assist health care facilities with earthquake hazard reduction.)

THANK YOU FOR TAKING YOUR TIME TO PROVIDE US THIS INFORMATION!

Return the questionnaire in the self-addressed, postage paid envelope provided, or mail to:
Carlyn Orians, Survey Manager
Battelle Seattle Research Center
P.O. Box 5395
Seattle, WA 98105