Chapter 5
APPLICATIONS SCENARIOS

Every seismic rehabilitation project occurs because someone has chosen or been required to modify a building. Because "every building has its own story," actual seismic rehabilitation projects depend upon the local societal and organizational contexts in which they take place. While the purpose of Chapter 3 was to present three alternative models to help the user of the *Guidelines* documents select a path through the forest of general issues related to seismic rehabilitation, this chapter narrows the focus and offers the reader a set of relevant scenarios that illustrate specific "typical" situations and highlight key factors important to achieving seismic rehabilitation. Although many variations are possible, these three scenarios (a private initiative, a local regulatory approach, and a professional service request) represent common seismic rehabilitation motivations and processes.

The first scenario focuses on a private voluntary decision. The facilities manager of a company owning 16 buildings in various cities across the United States received the *Guidelines* documents and wishes to determine if all or any of his buildings are possibly hazardous in earthquakes. If this proves to be the case, the facilities manager will recommend whether a seismic rehabilitation process be initiated with the company's own funds.

The second scenario addresses the public policy dilemma of a city manager whose chief building official received a copy of the *Guidelines* documents. After review and conference, they jointly decide to initiate the preparation of a proposed mandatory seismic rehabilitation ordinance for the city council's consideration.

The third scenario places a private consulting structural engineer, who knows little about earthquake engineering, in the difficult situation of needing to respond to his/her client by determining if any of the client's multiple properties in the Midwest is susceptible to earthquake damage. If so, the consulting structural engineer is to recommend whether any or all of the client's buildings should be seismically rehabilitated.

SCENARIO ONE: THE PRIVATE COMPANY

Situation

As the corporate facilities manager, you are responsible for all property acquisition, leasing, construction, remodeling, operations, and maintenance of the company's buildings. Your employer owns 16 buildings of various ages, sizes, and types of construction nationwide (Los Angeles, 5; Albuquerque, 1; Seattle, 2; St. Louis, 3; Charleston, 1; Baltimore, 2; and New Haven, 2).

Because of your position as facilities manager, you recently attended a workshop on seismic rehabilitation of existing buildings and you received the Guidelines documents. As a result, you became concerned about the potential earthquake performance of your company's buildings. The chief executive officer (CEO) has authorized you to evaluate the earthquake risk and likely earthquake performance of the 16 buildings. Your task is to assess the risk and likely earthquake performance of the 16 buildings and make seismic rehabilitation recommendations (which include doing nothing) to the CEO and possibly to the company's board of directors.

Considerations

Many factors have to be taken into account in your report which will influence the decision to invest or not invest in the seismic rehabilitation of the buildings. You may have to collect some information from other company units. Some of the issues you need to consider are:

- The geographic distribution of objective earthquake risk;
- The expected loads from the most likely seismic events;
- The probability of those events likely to occur (e.g., the planning horizon);
- The expected performance of the buildings from the expected earthquake loads;
- Competing needs for the funds and the trade-offs between short-term profits and long-term asset protection, including inventory and equipment values;
- The current status of capital replacement timetables and the flexibility of those timetables;
- Current business planning that could affect short-term and long-term use of the buildings (e.g., changes in product lines and markets, rates of facility obsolescence, and the existence or nonexistence of functional redundancy in other "safer" locations); and
- The benefits and costs associated with seismic rehabilitation.

You are aware that implementation of a voluntary seismic rehabilitation program within the company will require:

- Conducting a formal comparative risk evaluation and an initial screening or rapid assessment of the buildings;
- Developing an upgrading program that addresses various levels of desired performance;
- Specifying alternative design strategies to achieve those desired performance levels;
- Determining whether there are financial incentives external to the company that might be available for seismic rehabilitation;
- Determining what penalties external to the company may be imposed for not choosing to rehabilitate.
- Assessing the extent and depth of commitment to seismic rehabilitation of the company's top management and the board of directors; and
- Judging how and where seismic rehabilitation will fit in with and help meet the company's overall business objectives and priorities.

You are also aware that operational considerations must be factored into the decision about how to deal with the earthquake risk to the company's buildings by:

- Locating design professionals and contractors capable of performing seismic risk evaluations and the rehabilitation work;
- Determining if a seismic rehabilitation project will trigger requirements to comply *with other* local building code provisions that could add significantly to the costs and increase business interruption (e.g., disabled access, plumbing, electrical, life safety, asbestos removal, and energy conservation requirements);
- Estimating the costs of permits and inspections including the timeliness and difficulty of the process; and
- Assessing the value to the company of enhanced visibility and the goodwill associated with public knowledge that the company has engaged in a program of voluntary seismic rehabilitation of its buildings.

SCENARIO TWO: LOCAL GOVERNMENT POLICY DECISION

Situation

You are a city manager and generally aware that your community might experience periodic damaging earthquakes. Your chief building official has informed you that he has received and studied the recently issued *Guidelines* documents by the Federal Emergency Management Agency. The building official informs you that your community has two classes of exceptionally vulnerable buildings -- unreinforced masonry (URM) and early (pre-1973) concrete tilt-up light industrial buildings.

As the city's chief executive officer, you agree with the building official that an appropriate action would be to prepare an ordinance for city council consideration. The proposed ordinance would require the owners of these two identified classes of building to seismically rehabilitate them and to use the *Guidelines* to meet the ordinance's requirements. In effect, this course of action means that you and the building official have to prepare the proposed ordinance; serve as the city's lead staff members for advising the council on the technical, socioeconomic, and other issues likely to arise if the ordinance is passed; and be ultimately responsible for enforcement of the "Community Earthquake Rehabilitation Ordinance."

As city manager, your experience tells you that *regardless* of the merits of a proposed ordinance to require the strengthening of URM and early tilt-up buildings, enacting and implementing it will be highly controversial. You also know that for the ordinance to both pass and then be effectively implemented, the city will need political leaders and a coalition of supporters behind the proposal.

Considerations

You and the building official have to be prepared to explain to the city council, media, and the public several important items:

- The earthquake threat to the community;
- What other communities facing a comparable threat are doing about the problem;
- The community-wide benefits of avoiding future losses, the costs of doing nothing, and the costs of rehabilitation;
- Plans to address the unique problem of historic buildings;
- The capabilities of local design professionals and contractors to meet the provisions of the ordinance;
- Ways to ameliorate the dislocations and economic effects caused by rehabilitation; and
- The need for rapid improvement of your staff's technical abilities.

From a program implementation perspective, you will have to address several other points including:

- The minimum level of compliance;
- The square foot costs and how costs will be shared, if at all, by building owners and the city;
- What other upgrade requirements will be triggered;
- The capabilities of city staff and whether staff will need to be increased and how;
- The appeal and arbitration procedures;
- The length of time for compliance;
- For what period of time owners will be exempt from additional retroactive measures; and
- The process and cost for handling noncomplying buildings (e.g., through condemnation and demolition).

Interestingly, this scenario demonstrates why jurisdictions often use "nonmandatory" alternatives to achieve the goal of seismic rehabilitation. For instance, an ordinance might only require that owners of buildings in the two suspect classes have licensed architects or structural engineers evaluate the buildings and file with the city reports that then become a matter of public record. This strategy could result in the quasivoluntary strengthening of buildings because the owners possess "guilty knowledge" of the susceptibility of their buildings, knowledge that could raise questions of liability associated with an existing hazard should a damaging earthquake occur.

SCENARIO THREE: THE CONSULTING ENGINEER'S DILEMMA

Situation

You are a consulting engineer in a small midwestern town located in a low seismic zone. Because of your professional interests, however, you are aware of specialist peers in the field of "earthquake engineering." Moreover, you are aware that the New Madrid fault zone, which has received a lot of publicity of late, is about 200 miles away.

While a particular concern for earthquakes has not been part of your lengthy practice, one of your best long-term clients has raised the earthquake issue with you. Following the client's attendance at a seminar on New Madrid area earthquakes at the University of Memphis' Center for Earthquake Research and Information where she obtained a copy of the newly released *Guidelines* documents, your client is concerned about the earthquake resistance of her apartment and commercial buildings located in Memphis, St. Louis, Kansas City, and several other smaller cities in the same general area. The client is concerned about the area's earthquake risk and her responsibilities and liabilities as a property owner.

Considerations

This situation is a real dilemma for both you as the consulting engineer and your client. Some of your key considerations include:

1. Getting more exact risk information;
2. Defining other skills needed to augment your own and their availability;
3. Determining if the cities where the buildings are located require seismic rehabilitation and if so, to what level;
4. Determining whether other code requirements will be triggered by work undertaken to seismically strengthen the buildings; and
5. Determining, now that you are a "knowing person," what, if any, liabilities are associated with the earthquake performance of your client's buildings.

Further considerations relate to evaluating client's properties; establishing priorities based on risk, occupancy, function, and other factors; determining acceptable levels of performance under expected events; designing effective rehabilitation schemes; accurately estimating costs; determining whether seismic rehabilitation can somehow be linked to the owner's general long-term property improvement plans; and deciding whether advising your client to sell the properties is a viable solution. Clients seldom understand that there are no guarantees in earthquake engineering and especially in the seismic rehabilitation of existing buildings. The consulting engineer who oversees a seismic rehabilitation project always has lingering concern about what will happen when an earthquake does occur and a rehabilitated building does not perform to the client's expectations. For example, a California Seismic Safety Commission report (p. 49) noted that "many engineers view the performance of retrofitted buildings in the Northridge earthquake positively" but "many owners were unaware that a retrofitted (rehabilitated) building could still be damaged to the point of not being economically repairable." One way to lessen this concern is for the design professional and the client to understand that, just as with the performance of new buildings, the effectiveness of seismic rehabilitation will vary with the severity of the earthquake. To illustrate this point, FEMA's benefit-cost volumes note that the anticipated effectiveness of an investment in seismic rehabilitation varies with the intensity of an earthquake. The greatest economic benefit derives from rehabilitation measures that perform best in lower magnitude but more frequent events. For example, rehabilitating a common low-rise tilt-up building is expected to reduce damages by 50 percent at modified Mercalli intensity (MMI) VI but only 30 percent at MMI XII.

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Chapter 6
SELECTED ANNOTATED BIBLIOGRAPHY AND ADDITIONAL REFERENCES

The various "societal" (political, socioeconomic, administrative, and policy) problems inherent in the seismic rehabilitation of buildings and discussed in this publication are treated in literature that can be considered a subset of the literature on earthquake hazard mitigation which, in turn, is a subset of the literature on natural hazard mitigation. Thus, in discussing seismic rehabilitation or "hazardous structure abatement," there are three distinct but partially overlapping sets of reference literature that, taken together, are quite extensive.

The purpose of this publication has been to alert and orient the reader and potential user of the *Guidelines* documents with the array of societal problems often encountered in the seismic rehabilitation of buildings. A full treatment of each component of the array, however, simply is not feasible in a single document.

Once an individual begins to address seismic rehabilitation, he/she will face many of the problems and issues discussed earlier in this volume. The first section of this chapter presents a selected annotated bibliography designed to help those individuals identify appropriate additional reading, most of which also contain reference lists. It focuses on a core group of 10 books, 4 chapters from another book, 13 journal articles, and 4 reports. The second section of this chapter presents a list of other excellent works that may be of use to readers in specific situations.

CORE READINGS

A place to start exploring the policy and socioeconomic issues involved in the seismic rehabilitation of buildings is a January 1996 Earthquake Engineering Research Institute publication, *Public Policy and Building Safety*, an excellent and very readable report that succinctly surveys all of the major technical (i.e., nonengineering) issues and suggests practical strategies for understanding and dealing with many of them. It includes a case study of the development of the Los Angeles ordinance requiring the inspection of steel-frame buildings; an overview of the typical policy-making process; and a reminder-style checklist of social, economic, and political factors to be considered in building safety.

An unusual and intentionally thought-provoking 1989 essay by Timothy Beatley, "Towards a Moral Philosophy of Natural Disaster Mitigation," appears in the *International Journal of Mass Emergencies and Disasters* (7 March 1989: 5-32). It is a clear and well written exploration of a rarely asked but fundamental question: What is the extent of government's moral obligation to protect people and property from natural disasters such as hurricanes and earthquakes? While many of the examples are drawn from the hurricane milieu (Beatley's specialty), mitigating the earthquake risk is addressed as well. Beatley argues that mitigation as public policy may be built on four ethical bases: utilitarian and market failure rationales (maximizing net social benefits); the concept of basic rights (providing primary physical security and subsistence); culpability and the prevention of harm (highlighting responsibility and costs); and paternalism (legitimating government interventions).

A more conventional starting place is with a book by William J. Petak and Arthur A. Atkisson, *Natural Hazard Risk Assessment and Public Policy: Anticipating the Unexpected* (New York, New York: Springer-Verlag, 1982), which describes and explains mitigation policies and programs within the larger context of disasters and/or disaster management.

A "handbook" spelling out a four-step mitigation process (community analysis, emergency analysis, mitigation needs assessment, and mitigation strategy development) is, *Practical Mitigation: Strategies for Managing Disaster Prevention and Reduction* (Rockville, Maryland: Research Alternatives Inc.,

1982) by James W. Morentz, Hugh C. Russell, and Judith A. Kelly. The orientation of this work is much more practical than conceptual. Of special interest are 81 mitigation case histories from across the United States involving all types of natural and technological hazards.

A special kind of "cookbook" (meant in the best possible sense) cosponsored by FEMA and the International City Management Association is *Emergency Management: Principles and Practice for Local Government* (Washington, D.C.: International City Management Association, 1991) edited by Thomas E. Drabek and Gerald J. Hoetmer. This comprehensive textbook is intended for "front line" emergency managers and local government officials. The "Introduction" and Part I, "History and Foundations of Emergency Management," provide the reader with basic concepts and terminology setting the stage for the remaining parts. Two chapters are of specific relevance to mitigation -- Chapter 5, "Perspectives and Roles of the State and Federal Governments," which explains in detail the relationship between local emergency management and other levels of government, and emphasizes the intergovernmental process and system interdependence, and Chapter 6, "Disaster Mitigation and Hazard Management," which covers the evolution of federal mitigation policy, the relationship between mitigation and comprehensive emergency management, hazard identification and analysis, and mitigation strategies, tools and techniques.

In *Natural Hazards and Public Choice: The State and Local Politics of Hazard Mitigation* (New York, New York: Academic Press, 1982), Peter H. Rossi, James D. Wright, and Eleanor Weber-Burdin explore attitudes of "political influentials" toward hazard mitigation across 20 states using 100 community samples and 2,000 respondents. Their findings that community elites across the United States did not find hazards to be very important compared to other problems and that these elites preferred "quick fixes" to politically painful long-term measures were subsequently challenged by Elliott Mittler in *Natural Hazard Policy Setting: Identifying Supporters and Opponents of Nonstructural Hazard Mitigation* (Boulder, Colorado: University of Colorado Institute of Behavioral Science, 1989). Using the same data but a more sophisticated statistical treatment, Mittler came to different, more positive conclusions about elite hazard perceptions and about who tends to be a supporter, nonsupporter, or neutral with respect to hazard policy.

A special edition (Volume 45, January 1985) of a leading scholarly journal, *Public Administration Review*, is entitled "Emergency Management: A Challenge for Public Administration," with William J. Petak serving as editor. This issue is an excellent overview/primer devoted to FEMA and to disaster response and recovery (including technological disasters). Of the 21 articles, all relatively short, those dealing at least in part with mitigation are: "Emergency Management: A Challenge for Public Administration" by William J. Petak; "Emergency Management and the Intergovernmental System" by Alvin H. Mushkatel and Louis F. Weschler; "Disaster Recovery and Hazard Mitigation: Bridging the Intergovernmental Gap" by Claire R. Rubin and Daniel G. Barbee; "Mitigation Strategies and Integrated Emergency Management" by David R. Godschalk and David J. Brower; and "Financing Disaster Mitigation, Preparedness, Response, and Recovery" by Allen K. Settle.

Continuing a focus on intergovernmental issues and problems is a thoughtful 1984 article by William J. Petak, "Natural Hazard Mitigation: Professionalization of the Policy Making Process," in *International Journal of Mass Emergencies and Disasters* (2, August: 285-302). In this article Petak examines the constraints/barriers to adopting and implementing hazard mitigation policies. Petak notes that while FEMA historically has pushed state and local governments to improve mitigation and enhance response and recovery capabilities in order to better handle hazards on their own, those very same state and local governments are constrained by geophysical, ecological, and sociopolitical factors. With this in mind, Petak addresses two important questions: How can current and projected natural hazard losses be reduced through improvements in building and land use practices in designated hazard areas? How can the adoption and use of specific hazard mitigation approaches by state and local governments be accomplished?

Also treating the intergovernmental problems generated by disaster is *Disaster Policy Implementation:*

Managing Programs Under Shared Governance (New York, New York: Plenum Press, 1986) by Peter J. May and Walter Williams. Adopting a "two worlds of disaster politics" approach (the world of normal politics/low saliency and the world of active policy making in the aftermath of a disaster), this study was driven by two fundamental questions: How are good ideas turned (or not) into concrete actions? How might FEMA stimulate greater mitigation and preparedness efforts? Taking an "implementation perspective," May and Williams explore the "politically less visible aspects of disaster policy" under situations of "shared governance" (local, state, and federal).

Perhaps the core book of the 1980s is Thomas E. Drabek's *Human System Responses to Disaster: An Inventory of Sociological Findings* (New York, New York: Springer-Verlag, 1986). This work is a self-conscious attempt to survey the disaster literature extant at the time and create an "encyclopedia" of findings. It remains a fundamental resource in the field, and significant attention is focused on to mitigation.

Next is a book edited by Louise K. Comfort, *Managing Disaster: Strategies and Policy Perspectives* (Durham, North Carolina: Duke University Press, 1988). This collection of original essays by 21 scholars in the field of public policy is organized around two basic questions: What are the primary issues confronting public managers in a disaster? What actions/measures can they take to save lives and protect property? Case studies are woven into the articles, and significant attention is paid to mitigation.

W. Henry Lambright began a research project in the early 1980s on the rapidly evolving role of states (including California) in disaster management, and he subsequently published *The Role of States in Earthquake and Natural Hazard Innovation at the Local Level: A Decision-Making Study* (Syracuse, New York: Syracuse Research Corporation, 1984, also available from the U. S. Department of Commerce, National Technical Information Service). Lambright's logic of comparison is actually based on three different "policy settings": Emergent (South Carolina and Nevada); intermediate (California); and advanced (Japan). The core of the study is the application of a six-stage process of innovation model emphasizing "entrepreneurs," "triggers," "the search for options," "adoption," "implementation," and "incorporation."

Focusing solely on one California policy innovation, Lambright followed his larger study with a 1985 journal article, "The Southern California Earthquake Preparedness Project: Evolution of an 'Earthquake Entrepreneur'" in the *International Journal of Mass Emergencies and Disasters* (3, November: 75-94). Lambright depicts the Southern California Earthquake Preparedness Project as a novel mechanism created to accelerate the pace and intensity of preparedness.

Kathleen J. Tierney reviews much of the mitigation literature through 1989 in "Improving Theory and Research on Hazard Mitigation: Political Economy and Organizational Perspectives "in the *International Journal of Mass Emergencies and Disasters* (7, November 1989: 367-396). In this article, Tierney notes that mitigation is the least studied and therefore the least understood of the four key disaster phases. The literature on mitigation, according to Tierney, can be divided into three major areas: studies on public perceptions of mitigation measures; research on agenda setting, adoption, and the implementation of hazard mitigation measures; and studies assessing the impact of hazard mitigation measures. Moreover, three themes pervade the literature on disaster mitigation: the only slightly coupled relationship between perceived risk and level of mitigation; the difficulty in promoting mitigation programs because the problems they attempt to address are complex and highly technical; and the positive role played by critical events in the adoption and implementation of hazard mitigation programs.

Questioning the role of critical events is Elliott Mittler in *The Public Policy Response To Hurricane Hugo In South Carolina* (Boulder, Colorado: University of Colorado Institute of Behavioral Science, Natural Hazards Research and Applications Information Center, Working Paper 84, April 1993). This study contradicts the popular assumption that in the honeymoon period following a major disaster, political windows open easily for mitigation improvements. He maintains that those windows do not always open and, even if they do open, they slam shut very quickly.

Another antidote (but from earthquakes and from California no less) to the facile assumption that disasters lead easily to mitigation improvements is *Standing Rubble: The 1975-1976 Oroville, California Experience with Earthquake-Damaged Buildings* (Sacramento, California: Robert Olson Associates, Inc., 1988) by Robert A. Olson and Richard Stuart Olson. An article-length version appeared as "The Rubble's Standing Up in Oroville, California: The Politics of Building Safety" by Richard Stuart Olson and Robert A. Olson in the *International Journal of Mass Emergencies and Disasters* (11, August 1993: 163-188).

Another book high on any "must read" list for earthquake mitigation is *Earthquake Mitigation Policy: The Experience of Two States* (Boulder, Colorado: University of Colorado Institute of Behavioral Science, 1983) by Thomas E. Drabek, Alvin H. Mushkatel, and Thomas J. Kilijanek. This book is important not only because it pays explicit attention to definitions and policy issues, but also because its selection of state cases does not include California. In fact, hitting head-on the tendency to think of earthquake mitigation and California as synonyms, the authors subtitled their Missouri chapter, "This Isn't California," and their Washington chapter, "North from California." Rich in detail, the authors discuss three case histories of conflicts over earthquake mitigation policy that reveals the perceptual barriers and resource constraints typical at the state and local levels. Of particular interest is Chapter V, "Resistance from Below: St. Louis vs. HUD," which chronicles an intergovernmental political battle over lateral force requirements for building rehabilitations.

Almost a decade later, Philip R. Berke and Timothy Beatley published *Planning for Earthquakes: Risk, Politics, and Policy* (Baltimore, Maryland: Johns Hopkins University Press, 1992). Combining micro and macro approaches, Berke and Beatley present three earthquake mitigation case studies (Salt Lake County, Utah; Palo Alto, California; and Charleston, South Carolina) with statistical analysis of the responses to a questionnaire on mitigation practices from 202 communities in 20 states.

Arnold J. Meltsner's, "The Communication of Scientific Information to the Wider Public: The Case of Seismology in California," in *Minerva* (3, Autumn 1979: 331-354) follows the early 20th century history of seismology studies in California and the tremendous political obstacles faced by earth scientists and engineers who attempted to convince California's leaders to publicly recognize and come effectively to grips with the earthquake threat. The article chronicles the truly heroic efforts to establish that most basic of earthquake mitigation policies -- a seismic building code -- and is an excellent antidote to the myth that California's road to seismic safety prominence was easy.

The issue of what to do about "bad buildings" constitutes a small but important literature of its own. Still the only book-length study of the policy dilemmas inherent in trying to reduce the life-safety threat posed by unreinforced masonry buildings is *The Politics and Economics of Earthquake Hazard Mitigation: Unreinforced Masonry Buildings in Southern California* (Boulder, Colorado: University of Colorado Institute of Behavioral Sciences, Monograph 43, 1986) by Daniel J. Alesch and William J. Petak. In this book, Alesch and Petak analyze three California cases: Long Beach, Los Angeles, and Santa Ana. The emphasis is on the interplay between technical solutions, the economics and financing of building rehabilitation, and the political maneuvering (especially the role and importance of the "window opening" San Fernando earthquake of 1971) that yielded different ordinance outcomes in each of the cities.

To be read as a companion piece to Alesch and Petak's book is Richard Stuart Olson's, "The Political Economy of Life Safety: The City of Los Angeles and 'Hazardous Structure Abatement,' 1973-1981" in *Policy Studies Review* (4, May 1985: 670-679). Taking a more explicitly political viewpoint than Alesch and Petak, Olson profiles the "pro" and "con" sides on the famous Los Angeles seismic rehabilitation ordinance and emphasizes the importance of a credible scenario for a future earthquake to the passage of the Los Angeles ordinance.

The last item in the core list is the February 1994 "theme issue" of *Earthquake Spectra.* Edited by Mary C. Comerio, this journal issue reflects the outcome of a U.S.-Italy workshop held in October 1992 and focuses on "Design in Retrofit and Repair." The contributions revolve around 10 problems that both U.S. and Italian experts had to confront: achieving a balance between life safety and cost, achieving a balance between life safety and building conservation, developing strategies "to preserve existing buildings (not just monuments)," finding support for pre-design investigations by an entire design team in preparation for formatting rehabilitation designs, developing performance criteria for building systems and for historic preservation as complements to structural design criteria, insufficient understanding of materials performance, insufficient understanding of the performance of composite structures resulting from multiple retrofits, resolving incongruities between finite elements analysis and building failure typologies, insufficient understanding of building performance over multiple earthquakes and how better information on that issue should be incorporated into reconstruction codes, and determining whether the building will be lost in another earthquake or by the engineer's design?

ADDITIONAL READINGS

Natural Hazards

Unique in the field and almost falling in the core list (except that it is 660 pages) is James Huffman's *Government Liability and Disaster Mitigation: A Comparative Study* (Lanham, Maryland: University Press of America, 1986). Undertaken by a professor of law, this is a fascinating study of liability laws and how they affect assignment of costs and, therefore, mitigation policy in six countries -- New Zealand, the United States, Peru, Japan, China, and what was then the Soviet Union.

In 1985, Peter J. May published *Recovering From Catastrophes: Federal Disaster Relief Policies* and Politics (Westport, Connecticut: Greenwood Press, 1985). In this work May asks who wins and who loses when it comes to bearing the costs and risks of disaster relief. Tracing the political evolution of disaster relief policy, May examines three histories -- legislative, organizational, and, most interesting, "what really happened." The legislative history focuses on policy changes, congressional politics, and the driving question of the federal government's appropriate role in disaster relief.

Another general treatment of the disaster problem in the United States is Raymond J. Burby's, *Sharing Environmental Risks: How to Control Governments' Losses in Natural Disasters* (Boulder, Colorado: Westview Press, 1991). Summarizing the results of an extensive study of the losses from over 130 natural disasters occurring in the 1980s, Burby analyzes the complex relationship between federal, state, and local policies. While the work is comprehensive, Part II, "How to Control Losses," is dedicated to mitigation and focuses on the problem of how "to ease the perennial hardships states and localities suffer." A short chapter, "The Special Case of Earthquakes," argues that earthquakes create consequences and problems different from those caused by floods, hurricanes, and landslides. The author then addresses how earthquake-prone local governments can be persuaded to insure their property at risk.

Earthquake Hazard Mitigation

Also almost falling in the core list is a recent book by Robert A. Stallings, *Promoting Risk: Constructing the Earthquake Threat* (New York, New York: Aldine de Gruyter, 1995). Starting from a different base than the other authors, Stallings explores why earthquake risk has not achieved the status of a fully developed "social problem" given the likely national consequences of a catastrophic earthquake. For Stallings, the answer is that "promoters" of the earthquake threat have followed essentially an "insider" strategy and not a "grass-roots" strategy and have therefore failed to generate widespread public support.

Another study notable for its non-California intent is Arthur A. Atkisson and William J. Petak's "The Politics of Community Seismic Safety" in *Proceedings of Conference XV: Preparing for and Responding to a Damaging Earthquake in the Eastern United States* (Reston, Virginia: U.S. Geological Survey, Open-File Report 82-220, 1982).

Other specific but non-California studies include those by Peter J. May and others in, *Earthquake Risk Reduction Profiles: Local Policies and Practices in the Puget Sound and Portland Areas* (Seattle, Washington: University of Washington, Institute for Public Policy and Management, November 1989) and *Anticipating Earthquakes: Risk Reduction Policies and Practices in the Puget Sound and Portland Areas* (Seattle, Washington: University of Washington, Institute for Public Policy and Management, November 1989).

Also worth reading is a short article by Peter J. May and Patricia Bolton, "Reassessing Earthquake Reduction Measures," in the *Journal of the American Planning Association* (52 Autumn 1986: 443-451), and May's "Addressing Public Risks: Federal Earthquake Policy Design" in the *Journal of Policy Analysis and Management* (10, Spring 1991: 263-285).

A basic resource document on federal efforts to promote seismic safety, that contains much original information is, *To Save Lives And Protect Property: A Policy Assessment of Federal Earthquake Activities, 1964-1987* (Washington, D.C.: Federal Emergency Management Agency, 1988) by Robert A. Olson, Constance Holland, H. Crane Miller, W. Henry Lambright, Henry J. Lagorio, and Carl R. Treseder.

Two U. S. Geological Survey studies that emphasize knowledge transfer and applications are *Applications of Knowledge Produced in the National Earthquake Hazards Reduction Program: 1977-1987* (Reston, Virginia: U.S. Geological Survey Open File Report 88-13-B, 1988) edited by Walter W. Hays and *Applications of Research from the U.S. Geological Survey Program, Assessment of Regional Earthquake Hazards and Risk Along the Wasatch Front, Utah* (Reston, Virginia: U.S. Geological Survey Professional Paper 1519, 1993) edited by Paula Gori. For further reading on the surprisingly partisan politics of seismic safety in Utah, see Richard Stuart Olson and Robert A. Olson's,

"Trapped in Politics: The Life, Death, and Afterlife of the Utah Seismic Safety Advisory Council" in the *International Journal of Mass Emergencies* (12, March 1994: 77-94).

A significant comparative work is *Earthquake Mitigation Programs in California, Utah, and Washington* prepared by C. E. Orians and Patricia A. Bolton for the Workshop on Issues and Options for Earthquake Loss Reduction (Seattle, Washington: Battelle Human Affairs Research Center, BHARC-800/92/041, September 1992).

In the same vein is a study by Joanne M. Nigg and others, *Evaluation of the Dissemination and Utilization of the NEHRP Recommended Provisions* (Washington, D.C.: Federal Emergency Management Agency, May 1992).

Agency reports to the U S. Congress often are given short shrift as resources, but some are of high quality. Such is the case of a 1993 FEMA report, *Improving Earthquake Mitigation, A Report to Congress* (Washington, D.C.: FEMA, Office of Earthquake and Natural Hazards, January 1993). Noteworthy within that report are "Social Science Research: Relevance for Policy and Practice" by Russell Dyness, "Local Public Capacity to Deal with a Catastrophic Earthquake" by Claire Rubin and "Education, Awareness and Information Transfer Issues" by Paula Schultz.

Of historic interest are two federal reports from the 1970s. Stimulated by unexpectedly high losses in the 1971 San Fernando earthquake, the federal government began to pay more systematic attention to the earthquake problem in the United States. *Earthquake Prediction and Public Policy* (Washington, D.C.: National Academy of Sciences, 1975) was prepared by National Research Council, Panel of the Public Policy Implications of Earthquake Prediction of the Advisory Committee on Emergency Planning and *Earthquake Hazards Reduction: Issues for an Implementation Plan* (Washington, DC: 1978) was prepared in response to the *National Earthquake Hazards Reduction Act of 1977* (PL 94-125) by the Executive Office of the President, Office of Science and Technology Policy, Working Group on Earthquake Hazards Reduction.

California Studies

Thirty-one years before the Loma Prieta earthquake captured the world's attention, Karl V. Steinbrugge published *Earthquake Hazard in the San Francisco Bay Area: A Continuing Problem in Public Policy* (Berkeley, California: Institute of Governmental Studies, University of California, 1968).

An interesting California mitigation (land use) case study is presented by Martha L. Blair and William E. Spangle in *Seismic Safety and Land-Use Planning, Selected Examples From California* (Reston, Virginia: U.S. Geological Survey Professional Paper 941-B, 1979).

In 1980, as a result of the devastation wrought by Mount St. Helens earlier that year, President Carter turned even more federal attention to the earthquake threat in California. As a result, FEMA produced a slim but important document, *An Assessment of the Consequences and Preparations for a Catastrophic California Earthquake: Findings and Actions Taken* (Washington, D.C.: FEMA, November 1980). The essence of this report is a set of earthquake scenarios with associated probabilities and with estimated casualty (dead and injured) figures.

In 1983, the small central California town of Coalinga was virtually destroyed by an earthquake. The response was unusually draconian -- level it and start over. Kathleen J. Tierney chronicles the impacts and aftermath in *Report on the Coalinga Earthquake of May 2, 1983* (Sacramento, Califorina: California Seismic Safety Commission, 1985).

Multiple jurisdiction/intrastate studies of response to risk are rare, but two were authored in the mid-1980s: "Earthquakes and Public Policy Implementation in California," by Alan J. Wyner in the *International Journal of Mass Emergencies and Disasters* (2 August 1984: 267-284) and *Preparing for California's Earthquakes: Local Government and Seismic Safety* (Berkeley, California: University of California Institute of Governmental Studies, 1986) by Alan J. Wyner and Dean E. Mann.

Although most of the world will forever associate the 1989 earthquake in northern California with the baseball World Series, coincidentally between San Francisco and Oakland, that event is technically called the Loma Prieta earthquake. In the aftermath, Patricia A. Bolton and C. E. Orians undertook a study of that disaster's mitigation lessons: *Earthquake Mitigation in the Bay Area: Lessons from the Loma Prieta Earthquake* (Seattle, Washington: Battelle Human Affairs Research Center, Summary Report BHARC-800/92/015, March 1992).

On the same disaster but with a narrower focus on housing, Mary C. Comerio published "Hazards Mitigation and Housing Recovery: Watsonville and San Francisco One Year Later," in *Disasters and the Small Dwelling* (London: James and James Science Publishers, 1992) edited by Yasemin Aysan and Ian Davis.

As Executive Director of the California Seismic Safety Commission at the time, L. Thomas Tobin also reflected on the lessons of the 1989 disaster in "Legacy of the Loma Prieta Earthquake: Challenges to Other Communities," *Symposium on Practical Lessons from the Loma Prieta Earthquake* (Oakland, Califorina: Earthquake Engineering Research Institute, March 1993).

Also stimulated by the Loma Prieta event and ensuing lessons was *Use of Earthquake Hazards Information: Assessment of Practice in the San Francisco Bay Region* (Portola Valley, California: Spangle Associates, July 1993) by Spangle Associates.

The relationship between earthquake disasters and mitigation opportunities inherent in reconstruction is the theme of two other reports by Spangle Associates: *PEPPER: Pre-Earthquake Planning for Post-Earthquake Rebuilding* (Sacramento, California: California Office of Emergency Services, for the Southern California Earthquake Preparedness Project, 1987 and *Rebuilding after Earthquakes, Lessons from Planners* (Portola Valley, California: Spangle Associates, 1991).

As part of its own planning efforts, the California Seismic Safety Commission published and made widely available its *California at Risk, Reducing Earthquake Hazards 1992 to 1996* (Sacramento, California: California Seismic Safety Commission, Report SSC 91-091, 1992). From the same source and interesting from an historical viewpoint is *Earthquake Hazards Management: An Action Plan for California* (Sacramento, California: California Seismic Safety Commission, September 1982). Probably of the greatest historical import, however, is the California Legislature Joint Committee on Seismic Safety's *Meeting The Earthquake Challenge* (Sacramento, California: Legislature, State of California, January 1974). This study, commissioned as a result of the 1971 San Fernando earthquake, was really the blueprint for seismic safety improvements in California for more than a decade.

No list of literature on California would be complete or credible if it did not include *Waiting for Disaster: Earthquake Watch in California* (Berkeley, California: University of California Press, 1986) by Ralph H. Turner, Joanne M. Nigg, and Denise Heller Paz. This book addresses the issue of seismic preparedness in the high risk zone of Palmdale, California. Due to the alternating uplifting and subsiding of the earth's crust in the region (the so-called Palmdale Bulge), it was widely believed that Palmdale was a harbinger of earthquakes. Hypothesizing that this "near prediction" heightened the saliency of the region's earthquake threat, the authors examine the attitudes and actions of people and organizations in response to the threat.

Hazardous Buildings Studies

For more general reading on the conflict potential inherent in public policy attempts to deal with existing earthquake-vulnerable buildings, see Richard Stuart Olson and Douglas C. Nilson's "California's Hazardous Structure Problem: A Political Perspective," in *California Geology* (April 1983: 89-91), and subsequently reprinted in *Building Standards* (52, July-August 1983: 15-17).

How the federal government approached and handled the problem of its own earthquake-vulnerable buildings is the subject of Diana Todd and Ugo Morelli in "Adoption of Seismic Standards for Federal Buildings: Issues and Implications" in *Proceedings, Fifth U.S. National Conference on Earthquake Engineering, 1994* (Oakland, Califorina: Earthquake Engineering Research Institute, 1994, pp. 995-1003). In the same *Proceedings* (pp. 1005-1012) is another paper with a non-California focus -- David O. Knuttunen's, "New Code Provisions for Existing Buildings in Massachusetts."

Dealing with the problem of seismic rehabilitation of hospitals in an even more non-California (i.e., a non-United States) setting is Allan Lavell's, "Opening a Policy Window: The Costa Rican Hospital Retrofit and Seismic Insurance Program 1986-1992" in *The International Journal of Mass Emergencies and Disasters* (12, March 1994: 95-115). This article is especially interesting for its treatment of Costa Rica's ability to "learn" not only from its own earthquakes, but also from the Mexico City disaster of 1985.

Reflecting on housing lessons from the Los Angeles hazardous structure abatement ordinance is Mary C. Comerio in "Impacts of the Los Angeles Retrofit Ordinance on Residential Buildings" in *Earthquake Spectra* (8, February 1992: 79-94). In the February 1994 *Earthquake Spectra* theme issue discussed above in the core list, Comerio followed upon this earlier work with "Design Lessons in Residential Rehabilitation (pp. 43-64), which focuses on mitigation policy and housing in the aftermath of the 1989 Loma Prieta earthquake.

Example Rehabilitation Ordinances and Initiatives

To illustrate the array of subjects discussed in this publication, numerous enacted or proposed laws and ordinances and accompanying materials, bond issue descriptions, public finance materials, environmental impact reports, special studies, and federal documents and reports have been examined. While too voluminous to actually reprint in this *Societal Issues* volume, each is summarized below to make it as easy as possible for readers to understand the contents of these materials and to obtain any that might be of help.

City of Los Angeles, *Los Angeles Building Code, Chapter 88: Earthquake Hazard Reduction in Existing Buildings*, is available from the Department of Building and Safety, Building Bureau, 200 N. Spring St., Los Angeles, California 90012, (310) 485-2304. This well-known ordinance, enacted in 1981 (10 years after San Fernando earthquake), established a comprehensive program to require the seismic rehabilitation or demolition of unreinforced masonry bearing wall buildings built before 1934 (or for which a building permit was issued prior to October 6, 1933). The intent is clear: Where the analysis determines deficiencies, this chapter of the building code requires the building to be strengthened or demolished. The ordinance sets minimum standards, provides procedures and standards for identifying and classifying subject buildings according to their current use, provides analysis methods and allowable values, specifies information to be included on plans, defines priorities and time periods for compliance, and specifies penalties for noncompliance.

City of Los Angeles, Los Angeles Building Code, Division 91: *Earthquake Hazard Reduction in Existing Tilt-Up Concrete Wall Buildings* available for the Department of Building and Safety, Building Bureau, 200 N. Spring St., Los Angeles, CA 90012, (310) 485-2304. Similar in concept to Chapter 88, this ordinance focuses on another proven earthquake vulnerable building -- the tilt-up concrete wall buildings "designed under building codes in effect prior to January 1, 1976." The intent to require strengthening or demolition is the same. Like Chapter 88, Division 91 sets minimum standards for identifying and classifying subject buildings according to current use, provides analysis methods and allowable values, specifies notification procedures, prescribes information to be included on plans, defines priorities and times for compliance, and specifies penalties for noncompliance.

City of Los Angeles, Los Angeles Building Code, Proposed (June 16, 1994) *Chapter 92: Prescriptive Provisions for Seismic Strengthening of Light, Wood-Frame, Residential Buildings* available from the Department of Building and Safety, Building Bureau, 200 N. Spring St., Los Angeles, California 90012 (310) 485-2304. This ordinance, proposed following the Northridge earthquake, was adopted August 27, 1996, as a voluntary ordinance. It focuses on particularly vulnerable older light wood frame buildings that have the following structural weaknesses: "(a) sill plates or floor framing which are supported directly on the ground without an approved foundation system. (b) a perimeter foundation system which is constructed of wood posts supported on isolated pad footings. (c) perimeter foundation systems that are not continuous." Damage often is serious to structures with any of these characteristics, and the displaced occupants will result in a major demand for emergency shelter. This is a voluntary program, but like the city's other ordinances, this one also specifies analytical procedures and similar matters. Being prescriptive in nature the ordinance specifies how the corrective work should be done. Even though not officially adopted, it has been used as a handout and as a reference during plan checking.

City of Palo Alto, California *Ordinance Number 3666 adding Chapter 16.42 to the Palo Alto Municipal Code Setting Forth a Seismic Hazards Identification Program*, is available from the Building Inspection Division, 250 Hamilton, Palo Alto, California 94303, (415) 329-2550. While not able to enact a mandatory seismic rehabilitation program, Palo Alto succeeded in requiring that engineering reports be done and publicly filed by owners of the following three types of buildings: all URM buildings, all pre-1935 buildings with 300 occupants or more other than URM buildings with 100 occupants or more, and all buildings constructed between January 1, 1935, and August 1976. The 1986 ordinance, anchored in the intent of the safety element of the city's comprehensive plan, defines responsibilities, scope, building categories, reporting requirements, review processes, and other matters.

City of Oakland, California *Ordinance Number 11274, Adopting Interim Standards for the Voluntary Seismic Upgrade of Existing Structures*, is available from the City Clerk, One City Hall Plaza, Oakland, California 94612(510) 238-3611. Ordinance 11274 was enacted in 1990 after the 1989 Loma Prieta earthquake. It was part of a series of policy efforts to deal with damaged buildings and to initiate a comprehensive program to abate the hazards posed by URM structures. This ordinance provides standards and force levels for upgrading, defines historic buildings to be exempted, establishes a design review and appeals process, and contains an exemption from future seismic upgrades for 15 years. It was seen as an interim measure until a permanent program could be established. One of the ordinance's goals was to "promote public health, safety and welfare," but this was to be done "within the constraint of reasonable economic effects."

City of Oakland, California Ordinance 11613, Adding Article 6 to Chapter 18 of the Oakland *Municipal Code Adopting a Seismic Hazards Mitigation Program for Unreinforced Masonry Structures* available from the City Clerk, One City Hall Plaza, Oakland, California 94612 (510) 238-3611. Ordinance 11613 is the city's URM building ordinance. It applies to all such buildings built before November 26, 1948 (the date of the city's first code containing seismic provisions), interestingly addresses both voluntary (limited scope) and mandatory (broader scope) rehabilitation standards, assigns interpretive responsibility to the building official, specifies right of entry, establishes notification and reporting requirements, establishes a public list of subject buildings and criteria for deletion of the building, establishes procedures for reviewing historic buildings, and provides for a variety of appeals and other processes.

State of California, *Health and Safety Code, Chapter 12.2 - Building Earthquake Safety* ("The URM

Law"), in available from legal research services or the California Seismic Safety Commission, 1900 K Street, Suite 100, Sacramento, California 95814, (916) 322-4917. Added to California's statutes in 1986, this law requires the building departments in all cities and counties located wholly or partially in the *Uniform Building Code Seismic* Zone 4 to "(a) identify all potentially hazardous buildings within their respective jurisdiction on or before January 1, 1990, (b) establish a mitigation program for potentially hazardous buildings to include notification to the legal owner, . . . and (c) by January 1, 1990, all information regarding potentially hazardous buildings and all hazardous building mitigation programs shall be reported to the appropriate legislative body of a city or county and filed with the Seismic Safety Commission." It requires the commission to monitor the program by annually publishing a report and was amended in 1993 to require that, upon transfer of ownership of any URM built before January 1, 1975, the purchaser must be given a copy of the *Commercial Property Owner's Guide to Earthquake Safety.* The law also refers to the following one, which excuses locals from associated liabilities.

State of California, *Health and Safety Code, Article 4 (Sections 19160 through 19168) - Earthquake Hazardous Building Reconstruction*, is available from legal research services or the Seismic Safety Commission, 1900 K Street, Suite 100, Sacramento, California 95814, (916) 322-4917. This law was passed in 1979 and was one of the earliest attempts to remove barriers to seismic rehabilitation. It was permissive in that the statute authorizes (not mandates) local jurisdictions to assess their hazards, allows for adoption of rehabilitation standards less than those required for new buildings, and among other subjects provides immunity from liability for local jurisdictions arising from damages to rehabilitated buildings or casualties caused by earthquakes. While well intended, the law also became an excuse for many local jurisdictions to do nothing until stronger legislation was passed in 1986.

U.S. Government, Office of the President, Executive Order 12941, *Seismic Safety of Existing Federally Owned or Leased Buildings*, is available from the Mitigation Directorate, Federal Emergency Management Agency, 500 C Street, S.W., Washington, D.C. 20472, (202) 642-3231. Based on earlier legislation, this Presidential Executive Order is an example of the exercise of authority that could be provided to any chief executive, administrative officer, city manager, or other appropriate official. Executive Order 12941 sets minimum standards for use by federal departments and agencies "in assessing the seismic safety of their owned or leased buildings and mitigating unacceptable risks. . . " In addition, the order assigns implementation responsibilities, provides for periodically revising the standards, and requires the preparation of cost estimates consistent with the standards.

State of California, *Health and Safety Code, amending Section 18938 and adding Articles 8 and 9 to Chapter 1 of Division 12.5 Relating to the Rehabilitation, Changed Use, or Closure of Acute Care General Hospitals by January* 1, *2030*, is available from legislative reference services or the Office of Statewide Health Planning and Development, 1600 Ninth Street, Sacramento, California 95814, (916) 654-3362. Following the 1971 San Fernando earthquake, state legislation was passed effective January 1, 1973, requiring new hospitals to be designed, reviewed, and constructed to higher standards. Later known as the "Alfred E. Alquist Hospital Seismic Safety Act," these amendments were passed in 1994 following the Northridge earthquake. By far, the most significant feature is the law's retroactivity: ". . . after January 1, 2008, general acute care hospital buildings that are determined to pose certain risks shall only be used for nonacute care hospital purposes" and ". . . no later than January 1, 2030, owners of all acute care inpatient hospitals shall demolish, replace, or change to nonhospital use, all hospital buildings that are not in substantial compliance, or seismically retrofit them so that they are in compliance with the [Office's] standards."

State of California, State Government Code, Sections 8878.50-8878.107, *Earthquake Safety and Public Buildings Bond Act of 1990 (Proposition 122)*, is available from the California Seismic Safety Commission, 1900 K Street, Suite 100, Sacramento, California 95814, (916) 322-4917. Added to California's statutes directly by its voters, this $250 million bond issue's purposes were to: "fund retrofitting, reconstruction, repair, replacement, or relocation of state-owned buildings or facilities which have earthquake or other safety deficiencies" and "provide financial assistance to local governments for earthquake safety improvements in structures housing those agencies critical to the delivery of essential government functions in the event of emergencies or disasters." The statute also funds related research and specifies how priorities, eligibility, fund distribution, and accountability will be maintained.

School District of Clayton, Missouri *Bond Issue Proposals*, available from the District's Community Relations Department, 75 Maryland Ave., St. Louis, Missouri 63105, (314) 726-5210. Of potential use to jurisdictions interested in seismic rehabilitation, but in lower seismic zones, this $18,365,000 bond issue "built in" earthquake resistance improvements to schools as part of a broader agenda. The agenda encompassed the need to accommodate increasing enrollment, to comply with the Americans with Disabilities Act (ADA), to preserve and properly maintain existing schools, to provide student access to modern computer technology, and "the obligation to protect lives of students in the event of an earthquake by strengthening portions of existing schools which do not conform to current building codes."

City and County of San Francisco, Department of City Planning, *Earthquake Hazard Reduction in Unreinforced Masonry Buildings: Program Alternatives*, Final Environmental Impact Report 89.112E, available from the City Planning Department, 1660 Mission St., San Francisco, California 94103, (415) 558-6287. This extremely valuable assessment of the community impacts of a proposed ordinance to require at least partial seismic rehabilitation of URM buildings contains a wealth of information on the issues discussed generally in this publication. One section, "Existing Financing Sources for the Retrofit of San Francisco's Unreinforced Masonry Buildings," was very helpful.

City of Oakland, California, Office of Public Works, *Preliminary List of Financial Resources to Consider in Developing a Local URM Seismic Safety Program*, available from the Office of Public Works, One City Hall Plaza, Oakland, California 94612, (510) 238-3961. Similar to the section of San Francisco's EIR, this list of potential funding alternatives and sources was prepared for the city by the staff of the California Seismic Safety Commission. It contains many of the same references as San Francisco's but also has additional information and some discussion of the purposes and advantages and disadvantages of various financing mechanisms.

Federal Emergency Management Agency, *A Benefit-Cost Model for the Seismic Rehabilitation of Buildings, Volume 1, A User's Manual and Volume 2, Supporting Documentation* (FEMA 227 and 228), is available from the Publication Distribution Facility, 500 C St. S.W., Washington, D.C. 20472, (800) 480-2520. Increasing use is being made of methods to evaluate the benefits and costs of investing public funds, in this case for the seismic rehabilitation of private buildings. Later publications (FEMA 255 and 256) expand the use benefit-cost methods to federally owned buildings. These volumes provide background information and procedures and software for calculating the benefits and costs of seismic rehabilitation. The second volume in each set provides additional supporting data and technical papers.

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In addition to the key items in the preceding annotated bibliography, there exists a myriad of other valuable materials used in preparing this publication. These included the following:

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Appendix A
THE FOUR STEPS IN DETAIL

THE FOUR STEPS

Step 1: Define the Problem

Step 1A: Preliminary Analysis

The measures outlined below are recommended as a starting point. The initial assumptions, estimates, and information collected may be informal, but as the endeavor proceeds to subsequent steps, the information should be improved.

Determine the probability of damaging earthquakes and determine whether it is significant enough to justify further action.

Request a formal statement on seismic risk from the U.S. Geological Survey (USGS), a state geological agency, a university professor of seismology, or a consulting seismologist or risk analyst.

Locate a map that depicts the location of faults and the intensity of ground shaking associated with an earthquake. The USGS, a state geological survey, FEMA, and other organizations have these maps or can help locate them.

Establish criteria, types of buildings considered to be unacceptably vulnerable, and survey the building stock. Useful assistance may be found in the following FEMA publications: Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook and Supporting Documentation (FEMA 154 and 155) and the NEHRP Handbook of Techniques for the Seismic Rehabilitation of Existing Buildings (FEMA 172). The Applied Technology Council (ATC) of Redwood City, California, also has available Evaluating the Seismic Resistance of Existing Buildings (ATC-14).

- Request a formal statement on the vulnerability of the types of buildings in the jurisdiction from a qualified structural engineer or organization, university professor, state agency, or consulting structural engineer.
- Secure photographs or slides showing the effects of earthquakes characterized by probable ground motions on buildings like those under consideration. USGS, FEMA, the Earthquake Engineering Research Institute (EERI), and earthquake professionals can provide these.
- Collect data on the building stock and identify the types (structural systems, number of floors, date of construction), numbers, and locations of buildings considered vulnerable. Initially this information may be a general description based on informed judgment.
- Collect property tax assessment data identifying building characteristics, square footage, values, and owner names and addresses.
- Collect occupancy and use information for each building.
- Identify buildings in which hazardous materials are used or stored.

Anticipate uncertainty in expert knowledge as well as disagreements among experts, but work to eliminate the appearance of significant disagreement among credible scientists and engineers by seeking consensus on the most significant points.

Encourage scientists and engineers to debate differences among themselves, ignore minor differences, and publicly air only those disagreements that bear significantly on the policy decisions to be made. Policy-makers with generalist backgrounds should not be expected to resolve technical disagreements, but they can be expected to delay action when seemingly equally qualified scientists and engineers disagree among themselves.

Arising early in Step 1A is the question of the types of buildings considered to be earthquake-vulnerable. Following is a comprehensive list of suspect building types based on earthquake experience and research:

- Unreinforced masonry bearing wall buildings
- Tilt-up concrete wall buildings
- Reinforced masonry wall buildings
- Nonductile concrete moment resisting frame buildings
- Wood frame buildings with soft stories and inadequate foundation connections
- Moment resisting steel frame buildings
- Buildings in areas of expected ground failure
- Earthquake-vulnerable essential buildings

The following profile of typical building uses should be viewed in conjunction with the above list:

- Schools
- Churches
- Hospitals
- Government offices
- Essential services (fire, police, emergency operations, communications, and coordination centers)
- Nonessential services (planning, park and recreation)
- Parking structures
- Residential
- Office/commercial
- Retail
- Manufacturing
- Warehouse
- Industrial
- Public assembly
- Theaters
- Arenas
- Mixed uses

The following outlines various impacts, positive as well as negative, of seismic rehabilitation:

- Lives saved and injuries prevented
- Businesses and homes saved from future damage
- Business and residential disruption prevented
- Increased owner debt and higher loan service payments avoided
- Changed property values and tax levies
- Increased rents
- Some buildings demolished or vacated
- Historic buildings protected
- Other code upgrades triggered (disabled access, energy conservation, asbestos removal, fire sprinkler installation)
- Changed property and other insurance premiums
- Altered availability of loans and insurance

For the affected buildings and neighborhoods, collect data on or at least estimate: the numbers, ages, income levels, ethnicity, and language capabilities of residents; the numbers and types of businesses and associated employees; the ownership patterns (resident or absent, multiple property and large building owners, government agencies, nonprofit organizations, condominium associations); the property values, loan to equity ratios, mortgage default rates, and rental rates; and the applicable occupancy levels and vacancy rates.

Evaluate economic data on: the range of costs to rehabilitate typical buildings (for various performance levels) based on structure type, local seismic hazard, and size; the time required to rehabilitate individual building types as well as the whole target set; the potential indirect costs due to the disturbance and displacement caused by the rehabilitation work (lost rent, lost businesses, lost tenants, cost of relocating and inconvenience, and lost sales and property tax revenues); and the future financial benefits of reduced damage.

Many private consulting firms have computer programs and the expertise needed to estimate potential earthquake losses for individual buildings, a portfolio of buildings at different locations, or all buildings within a geographical area. In addition, the National Institute for Building Sciences (NIBS) has released, nonproprietary software ("HAZUS") developed for FEMA that anyone with a desktop computer can use to estimate earthquake losses for their geographic areas.

While data on nationwide earthquake hazards and building stock information from the 1990 census and other data bases will provide at least a general perspective, local information such as that collected as part of this approach can be added and will allow for more accurate planning. Consider using the NIBS software or hiring a firm to use a proprietary program.

Review the results of this preliminary analysis and decide if the seismic risk to the community, company, or owner is significant enough to proceed to the more detailed analysis described in Step 1B.

If the decision is to proceed, prepare a rough estimate of the cost and a schedule to adopt and implement a seismic rehabilitation program.

Step 1B. Detailed Analysis

The information, assumptions, and estimates made in Step 1A should be revisited and additional detail on those points should be sought as part of Step 1B.

Set preliminary earthquake risk reduction objectives: Which buildings? What priorities? What pace? What levels of performance? The following summarizes the performance levels (from greater to lesser) discussed in Chapter 1 of the *Guidelines* and volume:

- Collapse Prevention: means that limiting post-earthquake damage state in which the building is on the verge of experiencing partial or total collapse.
- Life Safety: means that post-earthquake damage state in which significant damage to the structure has occurred, but some margin against either total or partial collapse remains.
- Immediate Occupancy: means that post-earthquake damage state in which only limited structural and nonstructural damage has occurred.
- Operational: means that post-earthquake damage state in which the building is suitable for its normal occupancy and use, albeit possibly in a slightly impaired mode.

Performance levels should be matched with building types and functions to determine priorities and pace. In addition, Figure A1 is reproduced here from the *Guidelines* to remind the user of the process for selecting a seismic rehabilitation strategy for a specific building.

Review existing policies, goals, objectives, and requirements in the community to determine how they may "dovetail" or conflict with proposed earthquake risk reduction strategies including land use, economic development, housing, historic preservation, aesthetic and environmental, planned uses for affected areas, future conformance with zoning ordinances, planned changes to infrastructure, compliance with Americans with Disabilities Act (ADA) and other code mandates, compliance with storage and use of hazardous materials regulations, emergency response roles and capabilities, and any other applicable goals, objectives and requirements.

Identify and map hazard areas and affected neighborhoods. Existing maps can be used to identify areas of potential liquefaction and other ground failure as well as areas underlain by soft or saturated soils, including fills over lake and river beds and bay deposits.

Identify neighborhoods or areas where earthquake-vulnerable buildings are highly concentrated.

Consult with the local emergency services manager, fire and police chiefs, and directors of planning, redevelopment, and public works to determine the capability and plans for post-earthquake fire suppression, search and rescue, control of released hazardous materials, damage evaluation, and public safety to see how rehabilitation could reduce post-earthquake demands for their services.

As a collateral benefit, share the information already collected to help these local officials understand their responsibilities and likely problems after an earthquake, use the information derived from these consultations to define problems that can be reduced through seismic rehabilitation, and encourage revision of the emergency response and recovery plans using the information collected.

Identify redevelopment project areas (and funding sources) and consider formation of new projects, possibly expanding the definition of "blight" to include potentially earthquake-vulnerable buildings.

Outline administrative implications including: potential demands for program management (resources and skills); need to support and coordinate proponent activity; need for enhanced enforcement capability (design review and construction inspection); cost of inventories and engineering, economic, social and environmental impact data collection and analysis; cost to support stakeholder participation; cost to implement alternative programs; length of time needed to adopt a program and the approximate duration of the implementation phase; and estimated cost in lost revenues, additional staff requirements, and additional capital outlay to the local government or company.

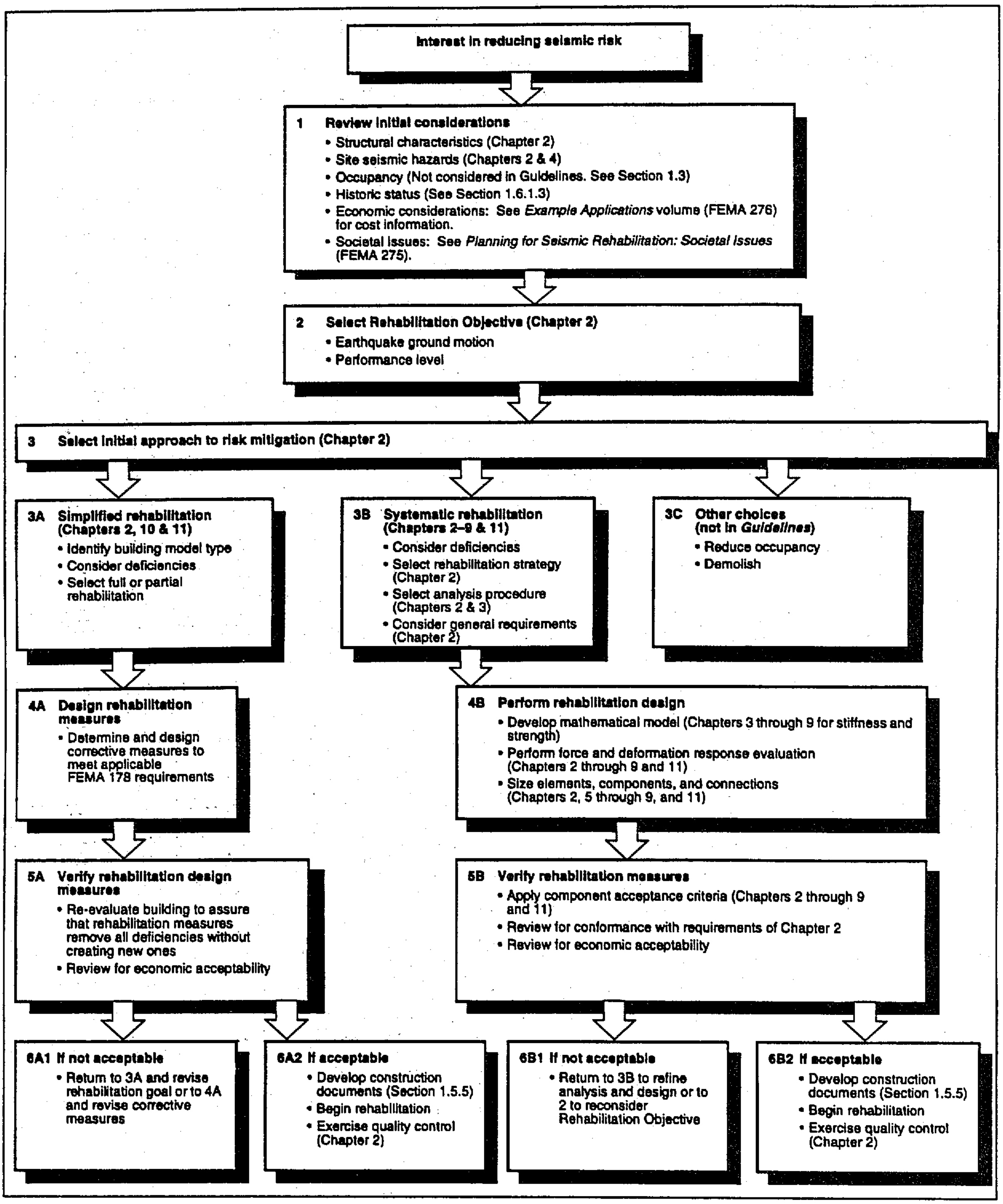

FIGURE A1 Rehabilitation process flowchart
(from Chapter 1, *NEHRP Guidelines for the Seismic Rehabilitation of Buildings*.

Consult legal counsel on the adoption and implementation processes, potential impacts on property rights and leases, and the need to disclose risk information.

Estimate total costs including: cost of engineering and rehabilitation, cost of required other work (ADA compliance, code upgrades), cost of alternative temporary space and relocation, costs of disruption (estimated), possible effect on leases and possible loss of tenants, lost rent and sales during the period of disruption, loss of sales tax revenues, increased debt service for the owner, and increased rent because of the cost of rehabilitation and disruption.

Describe effects that are not quantifiable solely as monetary costs such as loss of housing stock, loss of historical and architecturally important buildings, and business failures, closures and relocations.

Describe trade-off values (amount and cost [direct and indirect]) versus benefits (even if vague, abstract, or probabilistic). The potential bases for justifying seismic rehabilitation include the following:

- Fewer lives lost
- Fewer persons injured
- Less property damage
- Less demand for emergency response
- Less loss of housing resources
- Less loss of historical resources
- Faster economic and social recovery
- Less financial impact of earthquakes
- Less business downtime
- Increased safety for customers/tenants
- Less change for the neighborhood
- Increased building value
- Higher market value for buildings
- Less costly insurance premiums
- More secure equity for loans

Identify existing groups that will be affected by or interested in the seismic rehabilitation program:

- Homeowners associations
- Chambers of commerce
- Merchants associations
- Building and owners managers associations
- Boards of realtors
- Historical and preservation societies
- Ethnic business associations and groups
- Tenant organizations
- Community service clubs
- Labor unions and employee associations
- Civic, religious, fraternal, and other groups

Identify potentially affected autonomous political entities including redevelopment agencies and special districts (fire, police, school, water supply, sanitary, gas, electric and recreation).

Identify expert groups with knowledge to add to the considerations. Some of these groups include:

- Architects
- Civil engineers
- Engineering geologists
- Structural engineers
- Attorneys
- Certified public accountants
- Bankers and financial planners
- Insurers and reinsurers
- University faculties
- Realtors and property managers

Identify those groups directly affected by decisions may not have an effective way to participate in the decision-making process including low income residents of affected buildings, homeless persons, minorities and those with language limitations, elderly and retired persons, and physically challenged persons.

Determine if new organizations are needed to represent previously unorganized groups of affected persons, specific concerns, or issues. If so, identify possible leaders and members to facilitate the formation or representation of the group(s).

Identify potential proponent and opponent leaders, including their respective positions.

Identify news media and meet with reporters and editors to brief them on the concerns and the adoption process, provide background information, and commit to a relationship based on open communication. Media outlets include general circulation daily and weekly papers, ethnic papers, business and legal papers, radio news, television news, and community focused magazines.

Learn how to communicate matters of seismic risk, impacts, conflicting values, and uncertainty to an audience that may not understand the language of science and engineering and may very well have differing values on risk acceptance and the cost of risk reduction.

Accept the idea that people and groups view risk differently and have different values when balancing earthquake risk with other values.

Realize that a mathematical description of risk does not convey a complete message to most people. In addition to describing the probability or chance of an earthquake of a certain magnitude within a year, 30 years or a 100 years, describe what may happen in terms of the damage and the consequences of that damage to a building or the community.

Communicate facts, avoid the temptation to hide impacts or express judgment of others' values, and avoid surprising other participants with information that implies a "hidden agenda."

Deal immediately with concerns raised (even rumors) and solicit expert assistance to address issues and concerns directly.

Provide information on earthquake risk and building vulnerability from trustworthy sources (leaders, officials, expert agencies, professional associations, university faculties).

Provide references where interested parties may obtain more information.

Reconsider loss estimation studies done in Step 1A using new data or, if not done, consider performing these analyses at this point.

Decide whether the seismic risk to the community, company, or owner is significant and whether or not to proceed to Step 2.

Step 2: Develop and Revine Alternatives

Assuming the earthquake hazard and community vulnerability combine to create a seismic risk justifying seismic rehabilitation of certain buildings, Step 2 will result in the definition of practical alternatives. Simply stated, no standard formula or approach will work everywhere. While information already collected may suffice, it often is essential to collect more detailed data (e.g., a property-by-property inventory or consultant analyses of specific issues).

More precise data on the community building stock and its general earthquake-resistance characteristics are almost always needed because many Step 2 discussions of alternative approaches revolve around the performance levels desired for various types of buildings (and therefore the costs) and the number of buildings potentially involved.

Develop a strategy and a process that will address concerns and involve affected organizations in discussions of alternatives, within the limits posed by available resources and in a reasonable period of time.

Meet with building owners and hear concerns, be open to new or unexpected alternatives, and respect different perceptions.

Provide information to interested individuals and groups on the objectives of possible rehabilitation programs, the seismic hazards, building vulnerability, and the consequences of earthquake damage if nothing is done.

Solicit involvement, comments and suggestions from interested individuals and groups, respond to comments and suggestions, and use informal as well as formal meetings.

Consider formation of an advisory committee and evaluate potential chairs. For the chair, look for a person known for openness and objectivity who is experienced at running meetings, willing to find common ground and build consensus rather than highlight differences and polarize, free from conflict of interest, able to devote the considerable time and energy required, and willing to recommend, support and defend tough decisions and recommendations -- often in public forums.

Regularly meet with and brief council members, corporate decision-makers, or clients on the development of alternatives.

Provide photos of typical and relevant damage and provide documentation of possible damage to the community or company.

Show proof of the seismic hazard.

Describe the possible consequences of likely earthquake damage, both direct (damage to buildings and injuries) and indirect (disruption, loss of tax revenues, loss of housing and historical resources).

Explain the scope and cost of alternative approaches.

Propose an implementation program such as one of the following model programs or a hybrid that combines elements of other models: attrition process, voluntary program, informal/encouragement program, and mandatory program.

Decide which of the building types and uses described above to include.

Decide which neighborhood or geographic areas to include.

Determine if existing plans to upgrade facilities or redevelop an area can be amended to incorporate seismic rehabilitation of buildings.

Decide on a process to enforce the regulations including scopes and deadlines for reports, applications, and work and consider penalties for noncompliance including the possibility of condemnation and demolition.

Reconsider the desired seismic rehabilitation performance levels discussed above according to uses and building types selected in the Step 1A. Decide if it is still feasible to meet those levels in light of the costs, and revisit the performance levels to determine if they are too low to provide the benefits desired or possibly unnecessarily high.

Perform benefit-cost analyses. Because of the difficulty in quantifying the costs and benefits of seismic rehabilitation programs, the low probability of damaging earthquakes and the unpredictability and infrequency but high-consequence of these events, the benefit-cost ratio will often appear unfavorable at first. However, it may not be so when the value of life is taken into account. Nonetheless, the benefit-cost analysis is a good tool to compare alternatives and provides a place to start when considering possibilities to improve the ratio. To this end, consider the following incentives to make seismic rehabilitation less costly and less disruptive to those affected:

- Use preservation tax incentives for historic buildings
- Waive permit and inspection fees
- Waive planning requirements (off-street parking, density restrictions, variance request procedures
- Provide guidance and no-cost inspection services for "do-it-yourself" homeowners
- Allow property tax adjustments and other tax incentives
- Offer loans backed by government bonds
- Form a "Redevelopment Area" and "build-in" seismic rehabilitation
- Use "conservation corps" personnel for some of the work (especially for elderly and low-income residents)
- Increase availability of special purpose construction loans
- Encourage bank/lending institutions to provide incentives
- Secure insurance premium reductions

Solicit comments and advice from the affected parties, their organizations, and the involved professional organizations.

Consider a variety of management solutions that vary with the types of buildings covered by the program (performance objectives, length of time for implementation, triggers, level of building department involvement, incentives).

Decide how long owners should be protected from any new retroactive requirements.

Identify actions to mitigate non-financial impacts of the program.

Determine if and how tenant relocation costs may be funded.

Outline special considerations for historical buildings.

Determine criteria and processes for time extensions.

Revisit the benefits of avoiding future losses, the costs of doing nothing, and the costs of the rehabilitation program selected.

Assess the political feasibility of various options and ask two key questions: Is there enough information and sufficient support to push for action? Is an interim decision or a phased decision-making process appropriate?

Recognize likely pressure to delay action if an earthquake is not perceived as imminent, but recognize pressure to act quickly after an earthquake when repairs and possibilities for rehabilitation are suddenly salient to decision-makers.

Review the strategies available (attrition, voluntary, informal/encouragement, or mandatory) and formulate a recommendation.

Step 3: Adopt an Approach and Implementation Strategy

Once a recommendation to rehabilitate earthquake-vulnerable buildings has been forwarded to the final decision-maker(s), for public agency programs an even more public process begins. A seismic rehabilitation advocate must understand that the decision-maker(s) are expected to request both pro and con information and balance the many needs and capabilities of the community, corporation, or owner. Step 3 uses the results from previous steps to provide the expected information.

Explain the seismic risk and support it with expert testimony.

Determine if seismic rehabilitation can be incorporated into other community programs to improve or redevelop specific areas or facilities.

Explain the benefits, costs, and unquantifiable effects.

Explain the views of those affected.

Explain the reasons for the recommended program in comparison to other possible alternatives.

Anticipate and prepare answers for the following questions: How much will it cost (our city, our company) to comply with the proposed program? How much time do we/I have to make this decision? What is the liability associated with going ahead, or doing nothing? Is there a real earthquake hazard affecting this area? Are standards for seismic rehabilitation available? How can we/I justify imposing this measure (to constituents, a board, a boss, or a client)? What will happen (to the community, business, building or client) if nothing is done? What are neighboring jurisdictions (or competitors) doing?

Recommend and participate in formal hearings.

Modify the recommended program to meet any concerns and to address new information raised during hearings or the formal decision-making process.

Step 4: Secure Resources and Implement

Seismic rehabilitation programs do not run without resources and problems. Their execution requires that resources be committed, processes established, materials prepared, monitoring and evaluations carried out, and adjustments made. Owners of earthquake-vulnerable buildings are seldom well financed, often have difficulty securing new loans, and usually are not experienced in hiring engineers or managing complex construction projects, especially ones that affect other community interests. Step 4 recommends anticipating these conditions.

Obtain funding, qualified staff, office space, equipment, and, if necessary, consultant support.

Prepare and disseminate materials oriented toward all affected parties.

Establish a process for monitoring rehabilitation program progress, identifying problems, and reporting results.

Maintain contact with the organizations and individuals involved with developing the alternatives and adopting the program. Hold meetings with affected groups to facilitate open communications.

Maintain quality control to ensure that projects are properly designed and executed.

In order to protect the credibility of the program, maintain vigilance for over-charging or other fraudulent business practices or incompetent work by engineers, architects, and contractors.

Work with and supply information to building owners to assist them in the wise selection of engineers, architects, and contractors.

Ensure that projects meet requirements to mitigate community impacts.

Be sure that those responsible for offering and managing incentives are responsive to owner needs.

Amend technical provisions of the program whenever the engineering-oriented Guidelines documents are amended.

Be prepared to move quickly if unacceptable or unanticipated side effects occur to avoid creating a political backlash caused by the normal inability to see absolutely every problem ahead of time.

Encourage professional organizations, local colleges, and others to offer training for architects, engineers, plan checkers, inspectors, and construction professionals on following and implementing the Guidelines and their proper execution.

Expect the program to be dynamic and in need of further refinements as a result of experience gained during implementation.

Recommend program refinements to decision-makers when needed.

CONCERNS UNIQUE TO USERS

Depending upon the user (jurisdiction with building code enforcement authority, private or corporate owner, consultant) and the intended application of the *Guidelines*, differing perspectives and problems must be taken into account.

Local Government Building Official Tasks

Design, recommend, advocate, and then implement a seismic rehabilitation program for certain types of building within the jurisdiction. Serve as responsible staff person on the many aspects of the program: seismic risk, engineering, administrative, and possibly even socioeconomic and policy.

Learn what other communities are doing and cooperate to share resources.

Although usually licensed by the state, assess the earthquake engineering capability of local design professionals and contractors to carry out the actual seismic rehabilitation of buildings.

Assess the capability of the building department staff and determine appropriate training needed and its cost.

Self-Motivated Owner Tasks

Recommend to management alternatives for addressing seismic risk.

Locate and engage knowledgeable professionals: geologists and geotechnical engineers, structural engineers, and mechanical/electrical/process engineers.

Consider prior rehabilitation experience and experience using the *Guidelines*.

Consider how to evaluate both single buildings and groups of potentially vulnerable buildings.

Determine the relative importance of various buildings to the company.

Consider building(s) occupancy and functions.

Consider corporate image and reputation with customers and suppliers.

Ensure post-disaster business resumption plans are updated.

Consider post-earthquake access to suppliers, customers, and employees.

Determine geographic distribution of the hazard and the probability of seismic events by region. Quantify the expected seismic loads and determine resulting building vulnerabilities (expected performance under specified loads).

Determine the planning horizon.

Conduct a rapid assessment of buildings.

Determine performance objectives for the company, lines of business and specific facilities.

Do a comparative risk evaluation of facilities considering hazard, vulnerability, and importance.

Determine the seismic rehabilitation requirements, if any, of the jurisdictions responsible for building safety.

Determine availability of external financial incentives.

Determine penalties, if any, for not performing rehabilitation.

Determine if local building or planning regulations will require compliance with other health and safety, access, hazardous material, energy conservation, or historical requirements for each of the buildings found to be vulnerable.

Determine the cost of permits, steps involved, and time requirements to rehabilitate each vulnerable building.

Consider how to benefit from community, customer, and client good will earned by rehabilitating buildings, and determine how to capitalize on these benefits.

Determine if uses and functions at risk are critical, or if redundant facilities provide the necessary back-up at locations outside of the same hazard area.

Determine alternative strategies for meeting desired performance objectives. Have the design consultants do conceptual designs for the following: short-term, temporary measures such as shoring collapse-hazard building elements; nonstructural and falling hazard abatement measures to remove the most vulnerable life-threatening elements; and permanent rehabilitation measures consistent with performance objectives

Identify and meet with persons responsible for the following: operations and business resumption, space management, risk management (including insurance and hazardous materials), emergency response and employee safety, legal counsel, finance, public relations, and government relations.

Survey vacancy rates in nearby buildings to determine the cost and feasibility of temporarily relocating functions during rehabilitation.

Determine knowledge and level of commitment of the upper management and Board of Directors.

Determine responsibility of corporate officers, fiduciary responsibility for the corporation, and personal liability.

Determine the status and flexibility of capital replacement schedules and facility obsolescence.

Review short- and long-term use plans for each building.

Consider competing needs for funds including pressure for short-term profits versus long-term protection of assets, including equipment, buildings, inventory.

Describe the consequences of damage including: business interruption; vulnerability to temporary and permanent loss of market share; reputation for reliability; loss of employees to undamaged competitors; injury to employees; political ramifications, especially if a major local employer or multiple residential or commercial property owner; liability for injuries; off-site consequences of release of hazardous materials; and cost of repairs.

Secure lease or purchase options on alternative space before announcing a need for relocating functions from vulnerable buildings.

Meet with employees and tenants to explain the risk and the steps being taken to address it.

Meet with community groups and local government officials as appropriate.

Evaluate the company's in-house emergency response capability and local government's capability to respond to company problems.

Do a benefit-cost analysis and include a qualitative description of the intangible matters relevant to the decision.

Consulting Design Professional Tasks

Provide professional services to a client seeking to reduce and manage the seismic risk to his or her facilities.

Determine the owner's concerns and objectives and which facilities are involved.

Ask how will priorities be established (risk, occupancy, function, vulnerability, or other factors).

Determine desired performance objectives (which very well may change after risk information and the cost of rehabilitation alternatives are known).

Determine whether risk management measures, (e.g., emergency response and business resumption plans), can be considered as alternatives.

Be certain that the owner understands the possible nonengineering issues, (e.g., relocation, business interruption, costs).

Determine who is responsible for each point under "Self-Motivated Owner" section above.

Secure the engineering and risk management know-how if it does not exist.

Outline any required internal training.

Hire subcontractor specialists.

Determine how knowledge of risk will affect the liability of the firm and client.

Determine how designing to the client's performance objectives using the *Guidelines* will affect your liability.

Appendix B
BSSC SOCIETAL ISSUES PROJECT PARTICIPANTS

PROJECT OVERSIGHT COMMITTEE

Chairman
Eugene Zeller, Director of Planning and Building, Department of Planning and Building, Long Beach, California

ASCE Members
Paul Seaburg, Office of the Associate Dean, College of Engineering and Technology, Omaha, Nebraska
Ashvin Shah, Director of Engineering, American Society of Civil Engineers, Washington, D.C.

ATC Members
Thomas G. Atkinson, Atkinson, Johnson and Spurrier, San Diego, California
Christopher Rojahn, Executive Director, Applied Technology Council, Redwood City, California

BSSC Members
Gerald H. Jones, Consultant, Kansas City, Missouri
James R. Smith, Executive Director, Building Seismic Safety Council, Washington, D.C.

BSSC PROJECT COMMITTEE

Chairman
Warner Howe, Consulting Structural Engineer, Germantown, Tennessee

Members
Gerald H. Jones, Kansas City, Missouri
Harry W. Martin, American Iron and Steel Institute, Auburn, California
Allan R. Porush, Structural Engineer, Dames and Moore, Los Angeles, California
F. Robert Preece, Preece/Goudie and Associates, San Francisco, California
William W. Stewart, FAIA, Stewart·Schaberg/Architects, Clayton, Missouri

Societal Issues Consultant
Robert A. Olson, President, Robert Olson Associates Inc., Sacramento, California

SEISMIC REHABILITATION ADVISORY PANEL

Chairman
Gerald H. Jones, Kansas City, Missouri

Members
David E. Allen, Structures Division, Institute of Research in Construction, National Research Council of Canada, Ottawa, Ontario, Canada
John Battles. Southern Building Code Congress, International, Birmingham, Alabama

David C. Breiholz, Chairman, Existing Buildings Committee, Structural Engineers Association of California, Lomita, California
Michael Caldwell, American Institute of Timber Construction, Englewood, Colorado
Terry Dooley, Morley Construction Company, Santa Monica, California
Steven J. Eder, EQE Engineering Consultants, San Francisco, California
S. K. Ghosh, Mt. Prospect, Illinois
Barry J. Goodno, Professor, School of Civil Engineering, Georgia Institute of Technology, Atlanta
Charles C. Gutberlet, US Army Corps of Engineers, Washington, D.C.
Harry W. Martin, American Iron and Steel Institute, Auburn, California
Margaret Pepin-Donat, National Park Service Retired, Edmonds, Washington
William Petak, Professor, Institute of Safety and Systems Management, University of Southern California, Los Angeles, California
Howard Simpson, Simpson, Gumpertz & Heger, Arlington, Massachusetts
James E. Thomas, Duke Power Company, Charlotte, North Carolina
L. Thomas Tobin, Tobin & Associates, Mill Valley, California

EERI Committee Advisory Committee on Social and Policy Issues

Mary Comerio, University of California, Berkeley
Cynthia Hoover, City of Seattle, Washington
George Mader, Spangle Associates
Robert Olshansky, University of Illinois
Douglas Smits, City of Charleston, South Carolina
Susan Tubbesing, Earthquake Engineering Research Institute
Barbara Zeidman, City of Los Angeles, California

BUILDING SEISMIC SAFETY COUNCIL

Of the National Institute of Building Sciences

THE COUNCIL: ITS PURPOSE AND ACTIVITIES

The Building Seismic Safety Council (BSSC) was established in 1979 under the auspices of the National Institute of Building Sciences as an entirely new type of instrument for dealing with the complex regulatory, technical, social, and economic issues involved in developing and promulgating building earthquake risk mitigation regulatory provisions that are national in scope. By bringing together in the BSSC all of the needed expertise and all relevant public and private interests, it was believed that issues related to the seismic safety of the built environment could be resolved and jurisdictional problems overcome through authoritative guidance and assistance backed by a broad consensus.

The BSSC is an independent, voluntary membership body representing a wide variety of building community interests (see pages 15-16 for a current membership list). Its fundamental purpose is to enhance public safety by providing a national forum that fosters improved seismic safety provisions for use by the building community in the planning, design, construction, regulation, and utilization of buildings. To fulfill its purpose, the BSSC:

- Promotes the development of seismic safety provisions suitable for use throughout the United States;
- Recommends, encourages, and promotes the adoption of appropriate seismic safety provisions in voluntary standards and model codes;
- Assesses progress in the implementation of such provisions by federal, state, and local regulatory and construction agencies;
- Identifies opportunities for improving seismic safety regulations and practices and encourages public and private organizations to effect such improvements;
- Promotes the development of training and educational courses and materials for use by design professionals, builders, building regulatory officials, elected officials, industry representatives, other members of the building community, and the public;
- Advises government bodies on their programs of research, development, and implementation; and
- Periodically reviews and evaluates research findings, practices, and experience and makes recommendations for incorporation into seismic design practices.

The BSSC's area of interest encompasses all building types, structures, and related facilities and includes explicit consideration and assessment of the social, technical, administrative, political, legal, and economic implications of its deliberations and recommendations. The BSSC believes that the achievement of its purpose is a concern shared by all in the public and private sectors; therefore, its activities are structured to provide all interested entities (i.e., government bodies at all levels, voluntary organizations, business, industry, the design profession, the construction industry, the research community, and the general public) with the opportunity to participate. The BSSC also believes that the regional and local differences in the nature and magnitude of potentially hazardous earthquake events require a flexible approach to seismic safety that allows for consideration of the relative risk, resources, and capabilities of each community.

The BSSC is committed to continued technical improvement of seismic design provisions, assessment of advances in engineering knowledge and design experience, and evaluation of earthquake impacts. It recognizes that appropriate earthquake hazard risk reduction measures and initiatives should be adopted by existing organizations and institutions and incorporated, whenever possible, into their legislation, regulations, practices, rules, codes, relief procedures, and loan requirements so that these measures and initiatives become an integral part of established activities, not additional burdens. Thus, the BSSC itself assumes no standards-making or -promulgating role; rather, it advocates that code- and standards-formulation organizations consider the BSSC's recommendations for inclusion in their documents and standards.

IMPROVING THE SEISMIC SAFETY OF NEW BUILDINGS

The BSSC program directed toward improving the seismic safety of new buildings has been conducted with funding from the Federal Emergency Management Agency (FEMA). It is structured to create and maintain authoritative, technically sound, up-to-date resource documents that can be used by the voluntary standards and model code organizations, the building community, the research community, and the public as the foundation for improved seismic safety design provisions.

The BSSC program began with initiatives taken by the National Science Foundation (NSF). Under an agreement with the National Institute of Standards and Technology (NIST; formerly the National Bureau of Standards), *Tentative Provisions for the Development of Seismic Regulations for Buildings* (referred to here as the *Tentative Provisions*) was prepared by the Applied Technology Council (ATC). The ATC document was described as the product of a "cooperative effort with the design professions, building code interests, and the research community" intended to "...present, in one comprehensive document, the current state of knowledge in the fields of engineering seismology and engineering practice as it pertains to seismic design and construction of buildings." The document, however, included many innovations, and the ATC explained that a careful assessment was needed.

Following the issuance of the *Tentative Provisions* in 1978, NIST released a technical note calling for ". . . systematic analysis of the logic and internal consistency of [the *Tentative Provisions*]" and developed a plan for assessing and implementing seismic design provisions for buildings. This plan called for a thorough review of the *Tentative Provisions* by all interested organizations; the conduct of trial designs to establish the technical validity of the new provisions and to assess their economic impact; the establishment of a mechanism to encourage consideration and adoption of the new provisions by organizations promulgating national standards and model codes; and educational, technical, and administrative assistance to facilitate implementation and enforcement.

During this same period, other significant events occurred. In October 1977, Congress passed the *Earthquake Hazards Reduction Act of 1977* (P.L. 95-124) and, in June 1978, the National Earthquake Hazards Reduction Program (NEHRP) was created. Further, FEMA was established as an independent agency to coordinate all emergency management functions at the federal level. Thus, the future disposition of the *Tentative Provisions* and the 1978 NIST plan shifted to FEMA. The emergence of FEMA as the agency responsible for implementation of P.L. 95-124 (as amended) and the NEHRP also required the creation of a mechanism for obtaining broad public and private consensus on both recommended improved building design and construction regulatory provisions and the means to be used in their promulgation. Following a series of meetings between representatives of the original participants in the NSF-sponsored project on seismic design provisions, FEMA, the American Society of Civil Engineers and the National Institute of Building Sciences (NIBS), the concept of the Building Seismic Safety Council was born. As the concept began to take form, progressively wider public and private participation was sought, culminating in a broadly representative organizing meeting in the spring of 1979, at which time a charter and organizational rules and procedures were thoroughly debated and agreed upon.

The BSSC provided the mechanism or forum needed to encourage consideration and adoption of the new provisions by the relevant organizations. A joint BSSC-NIST committee was formed to conduct the needed review of the *Tentative Provisions*, which resulted in 198 recommendations for changes. Another joint BSSC-

NIST committee developed both the criteria by which the needed trial designs could be evaluated and the specific trial design program plan. Subsequently, a BSSC-NIST Trial Design Overview Committee was created to revise the trial design plan to accommodate a multiphased effort and to refine the *Tentative Provisions*, to the extent practicable, to reflect the recommendations generated during the earlier review.

Trial Designs

Initially, the BSSC trial design effort was to be conducted in two phases and was to include trial designs for 100 new buildings in 11 major cities, but financial limitations required that the program be scaled down. Ultimately, 17 design firms were retained to prepare trial designs for 46 new buildings in 4 cities with medium to high seismic risk (10 in Los Angeles, 4 in Seattle, 6 in Memphis, 6 in Phoenix) and in 5 cities with medium to low seismic risk (3 in Charleston, South Carolina, 4 in Chicago, 3 in Ft. Worth, 7 in New York, and 3 in St. Louis). Alternative designs for six of these buildings also were included.

The firms participating in the trial design program were: ABAM Engineers, Inc.; Alfred Benesch and Company; Allen and Hoshall; Bruce C. Olsen; Datum/Moore Partnership; Ellers, Oakley, Chester, and Rike, Inc.; Enwright Associates, Inc.; Johnson and Nielsen Associates; Klein and Hoffman, Inc.; Magadini-Alagia Associates; Read Jones Christoffersen, Inc.; Robertson, Fowler, and Associates; S. B. Barnes and Associates; Skilling Ward Rogers Barkshire, Inc.; Theiss Engineers, Inc.; Weidlinger Associates; and Wheeler and Gray.

For each of the 52 designs, a set of general specifications was developed, but the responsible design engineering firms were given latitude to ensure that building design parameters were compatible with local construction practice. The designers were not permitted, however, to change the basic structural type even if an alternative structural type would have cost less than the specified type under the early version of the *Provisions*, and this constraint may have prevented some designers from selecting the most economical system.

Each building was designed twice – once according to the amended *Tentative Provisions* and again according to the prevailing local code for the particular location of the design. In this context, basic structural designs (complete enough to assess the cost of the structural portion of the building), partial structural designs (special studies to test specific parameters, provisions, or objectives), partial nonstructural designs (complete enough to assess the cost of the nonstructural portion of the building), and design/construction cost estimates were developed.

This phase of the BSSC program concluded with publication of a draft version of the recommended provisions, the *NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings*, an overview of the *Provisions* refinement and trial design efforts, and the design firms' reports.

The 1985 Edition of the *NEHRP Recommended Provisions*

The draft version represented an interim set of provisions pending their balloting by the BSSC member organizations. The first ballot, conducted in accordance with the BSSC Charter, was organized on a chapter-by-chapter basis. As required by BSSC procedures, the ballot provided for four responses: "yes," "yes with reservations," "no," and "abstain." All "yes with reservations" and "no" votes were to be accompanied by an explanation of the reasons for the vote and the "no" votes were to be accompanied by specific suggestions for change if those changes would change the negative vote to an affirmative.

All comments and explanations received with "yes with reservations" and "no" votes were compiled, and proposals for dealing with them were developed for consideration by the Technical Overview Committee and, subsequently, the BSSC Board of Direction. The draft provisions then were revised to reflect the changes deemed appropriate by the BSSC Board and the revision was submitted to the BSSC membership for balloting again.

As a result of this second ballot, virtually the entire provisions document received consensus approval, and a special BSSC Council meeting was held in November 1985 to resolve as many of the remaining issues as possible. The 1985 Edition of the *NEHRP Recommended Provisions* then was transmitted to FEMA for publication in December 1985.

During the next three years, a number of documents were published to support and complement the 1985 *NEHRP Recommended Provisions*. They included a guide to application of the *Provisions* in earthquake-resistant building design, a nontechnical explanation of the *Provisions* for the lay reader, and a handbook for interested members of the building community and others explaining the societal implications of utilizing improved seismic safety provisions and a companion volume of selected readings.

The 1988 Edition

The need for continuing revision of the *Provisions* had been anticipated since the onset of the BSSC program and the effort to update the 1985 Edition for reissuance in 1988 began in January 1986. During the update effort, nine BSSC Technical Committees (TCs) studied issues concerning seismic risk maps, structural design, foundations, concrete, masonry, steel, wood, architectural and mechanical and electrical systems, and regulatory use. The Technical Committees worked under the general direction of a Technical Management Committee (TMC), which was composed of a representative of each TC as well as additional members identified by the BSSC Board to provide balance.

The TCs and TMC worked throughout 1987 to develop specific proposals for changes needed in the 1985 *Provisions*. In December 1987, the Board reviewed these proposals and decided upon a set of 53 for submittal to the BSSC membership for ballot. Approximately half of the proposals reflected new issues while the other half reflected efforts to deal with unresolved 1985 edition issues.

The balloting was conducted on a proposal-by-proposal basis in February-April 1988. Fifty of the proposals on the ballot passed and three failed. All comments and "yes with reservation" and "no" votes received as a result of the ballot were compiled for review by the TMC. Many of the comments could be addressed by making minor editorial adjustments and these were approved by the BSSC Board. Other comments were found to be unpersuasive or in need of further study during the next update cycle (to prepare the 1991 *Provisions*). A number of comments persuaded the TMC and Board that a substantial alteration of some balloted proposals was necessary, and it was decided to submit these matters (11 in all) to the BSSC membership for reballot during June-July 1988. Nine of the eleven reballot proposals passed and two failed.

On the basis of the ballot and reballot results, the 1988 *Provisions* was prepared and transmitted to FEMA for publication in August 1988. A report describing the changes made in the 1985 edition and issues in need of attention in the next update cycle then was prepared. Efforts to update the complementary reports published to support the 1985 edition also were initiated. Ultimately, the following publications were updated to reflect the 1988 Edition and reissued by FEMA: the *Guide to Application of the Provisions*, the handbook discussing societal implications (which was extensively revised and retitled *Seismic Considerations for Communities at Risk*), and several *Seismic Considerations* handbooks (which are described below).

The 1991 Edition

During the effort to produce the 1991 *Provisions*, a Provisions Update Committee (PUC) and 11 Technical Subcommittees addressed seismic hazard maps, structural design criteria and analysis, foundations, cast-in-place and precast concrete structures, masonry structures, steel structures, wood structures, mechanical-electrical systems and building equipment and architectural elements, quality assurance, interface with codes and standards, and composite structures. Their work resulted in 58 substantive and 45 editorial proposals for change to the 1988 *Provisions*.

The PUC approved more than 90 percent of the proposals and, in January 1991, the BSSC Board accepted the PUC-approved proposals for balloting by the BSSC member organizations in April-May 1991.

Following the balloting, the PUC considered the comments received with "yes with reservations" and "no" votes and prepared 21 reballot proposals for consideration by the BSSC member organizations. The reballoting was completed in August 1991 with the approval by the BSSC member organizations of 19 of the reballot proposals.

On the basis of the ballot and reballot results, the 1991 *Provisions* was prepared and transmitted to FEMA for publication in September 1991. Reports describing the changes made in the 1988 Edition and issues in need of attention in the next update cycle then were prepared.

In August 1992, in response to a request from FEMA, the BSSC initiated an effort to continue its structured information dissemination and instruction/training effort aimed at stimulating widespread use of the *NEHRP Recommended Provisions*. The primary objectives of the effort were to bring several of the publications complementing the *Provisions* into conformance with the 1991 Edition in a manner reflecting other related developments (e.g., the fact that all three model codes now include requirements based on the *Provisions*) and to bring instructional course materials currently being used in the BSSC seminar series (described below) into conformance with the 1991 *Provisions*.

The 1994 Edition

The effort to structure the 1994 PUC and its technical subcommittees was initiated in late 1991. By early 1992, 12 Technical Subcommittees (TSs) were established to address seismic hazard mapping, loads and analysis criteria, foundations and geotechnical considerations, cast-in-place and precast concrete structures, masonry structures, steel structures, wood structures, mechanical-electrical systems and building equipment and architectural elements, quality assurance, interface with codes and standards, and composite steel and concrete structures, and base isolation/energy dissipation.

The TSs worked throughout 1992 and 1993 and, at a December 1994 meeting, the PUC voted to forward 52 proposals to the BSSC Board with its recommendation that they be submitted to the BSSC member organizations for balloting. Three proposals not approved by the PUC also were forwarded to the Board because 20 percent of the PUC members present at the meeting voted to do so. Subsequently, an additional proposal to address needed terminology changes also was developed and forwarded to the Board.

The Board subsequently accepted the PUC-approved proposals; it also accepted one of the proposals submitted under the "20 percent" rule but revised the proposal to be balloted as four separate items. The BSSC member organization balloting of the resulting 57 proposals occurred in March-May 1994, with 42 of the 54 voting member organizations submitting their ballots. Fifty-three of the proposals passed, and the ballot results and comments were reviewed by the PUC in July 1994. Twenty substantive changes that would require reballoting were identified. Of the four proposals that failed the ballot, three were withdrawn by the TS chairmen and one was substantially modified and also was accepted for reballoting. The BSSC Board of Direction accepted the PUC recommendations except in one case where it deemed comments to be persuasive and made an additional substantive change to be reballoted by the BSSC member organizations.

The second ballot package composed of 22 changes was considered by the BSSC member organizations in September-October 1994. The PUC then assessed the second ballot results and made its recommendations to the BSSC Board in November. One needed revision identified later was considered by the PUC Executive Committee in December. The final copy of the 1994 Edition of the *Provisions* including a summary of the differences between the 1991 and 1994 Editions was delivered to FEMA in March 1995.

1997 Update Effort

In September 1994, NIBS entered into a contract with FEMA for initiation of the 39-month BSSC 1997 *Provisions* update effort. Late in 1994, the BSSC member organization representatives and alternate representatives and the BSSC Board of Direction were asked to identify individuals to serve on the 1997 PUC and its TSs.

The 1997 PUC was constituted early in 1995, and 12 PUC Technical Subcommittees were established to address design criteria and analysis, foundations and geotechnical considerations, cast-in-place/precast concrete structures, masonry structures, steel structures, wood structures, mechanical-electrical systems and building equipment and architectural elements, quality assurance, interface with codes and standards, composite steel and concrete structures, energy dissipation and base isolation, and nonbuilding structures.

As part of this effort, the BSSC has developed a revised seismic design procedure for use by engineers and architects for inclusion in the 1997 *NEHRP Recommended Provisions*. Unlike the design procedure based on U.S. Geological Survey (USGS) peak acceleration and peak velocity-related acceleration ground motion maps developed in the 1970s and used in earlier editions of the *Provisions*, the new design procedure is based on recently revised USGS spectral response maps. The proposed design procedure involves new design maps based on the USGS spectral response maps and a process specified within the body of the *Provisions*. This task has been conducted with the cooperation of the USGS (under a Memorandum of Understanding signed by the BSSC and USGS) and under the guidance of a five-member Management Committee (MC). A Seismic Design Procedure Group (SDPG) has been responsible for developing the design procedure.

More than 200 individuals have participated in the 1997 update effort, and more than 165 substantive proposals for change have been developed. A series of editorial/organizational changes also have been made. All draft TS, SDPG, and PUC proposals for change were finalized in late February 1997. In early March, the PUC Chairman presented to the BSSC Board of Direction the PUC's recommendations concerning proposals for change to be submitted to the BSSC member organizations for balloting, and the Board accepted these recommendations.

The first round of balloting concluded in early June 1997. Of the 158 items on the official ballot, only 8 did not pass; however, many comments were submitted with "no" and "yes with reservations" votes. These comments were compiled for distribution to the PUC, which met in mid-July to review the comments, receive TS responses to the comments and recommendations for change, and formulate its recommendations concerning what items should be submitted to the BSSC member organizations for a second ballot. The PUC deliberations resulted in the decision to recommend to the BSSC Board that 28 items be included in the second ballot. The PUC Chairman subsequently presented the PUC's recommendations to the Board, which accepted those recommendations.

The second round of balloting was completed on October 27. All but one proposal passed; however, a number of comments on virtually all the proposals were submitted with the ballots and were immediately compiled for consideration by the PUC. The PUC Executive Committee met in December to formulate its recommendations to the Board, and the Board subsequently accepted those recommendations.

The PUC also has identified issues remaining for consideration in the next update cycle and has identified technical issues in need of study. The camera-ready version of the 1997 *NEHRP Recommended Provisions*, including an appendix describing the differences between the 1994 and 1997 edition, was transmitted to FEMA in February 1998. The contract for the 1997 update effort has been extended by FEMA to June 30, 1998, to permit development of a CD-ROM for presentation of the design map data.

Code Resource Development Effort

In mid-1996, FEMA asked the BSSC to initiate an effort to generate a code resource document based on the 1997 Edition of the *Provisions* for use by the International Code Council in adopting seismic provisions for the first edition of the *International Building Code* to be published in 2000.

The orientation meeting of the Code Resource Development Committee (CRDC) appointed to conduct this effort was held in Denver on October 17. At this meeting, the group was briefed on the status of the *Provisions* update effort and formulated a tentative plan and schedule for its efforts.

The group next met in January 1997 to review a preliminary code language/format version of the 1997 *Provisions* and to develop additional needed input. As a result of this meeting, several task groups were established to focus on specific topics and to provide revisions to the preliminary draft. A new draft incorporating these comments then was developed for further refinement by the CRDC. A copy also was delivered to the members of the IBC Structural Subcommittee so that they would begin to have a feeling for where and how the seismic provisions would fit into their code requirements.

The CRDC met again in February to review the second draft of the code language/format version of the 1997 *Provisions*. This meeting was held just preceding a PUC meeting and changes made by the PUC subsequently were incorporated into the CRDC draft. NIBS and CRDC Chairman Gerald Jones presented this composite draft to the IBC Structural Subcommittee on March 1, 1997.

In July, the CRDC met to develop comments on the IBC working draft to be submitted to the ICC in preparation for an August public comment forum. The comments generally reflect actions taken by the PUC in response to comments submitted with the first ballot on the changes proposed for the 1997 *NEHRP Recommended Provisions* as well as CRDC recommendations concerning changes made in the original CRDC submittal by the IBC Structural Subcommittee. CRDC representatives then attended the August forum to support the CRDC recommendations.

The CRDC next met in mid-December to prepare comments on the first published version of the IBC. The proposed "code changes" developed by the committee were submitted to the IBC on January 5, 1998. Subsequent CRDC efforts are expected to focus on supporting the CRDC-developed provisions throughout the code adoption process.

The 2000 Edition

In September 1997, NIBS entered into a contract with FEMA for initiation of the 48-month BSSC effort to update the 1997 *NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures* for re-issuance in 2000 and prepare code changes based on the 2000 *Provisions* for submittal to the *IBC*. The BSSC member organization representatives and alternate representatives and the BSSC Board of Direction were asked to identify candidates to participate; the individuals serving on the 1997 update committees were contacted to determine if they are interested in participating in the new effort; and a press release on the 2000 update effort was issued. In addition, the BSSC Board asked 1997 PUC Chair William Holmes of Rutherford and Chekene, San Francisco, if he would be willing to chair the 2000 PUC and he accepted.

In lieu of the Seismic Design Procedure Group (SDPG) used in the 1997 update, the BSSC will re-establish Technical Subcommittee 1, Seismic Design Mapping, used in earlier updates of the *Provisions*. This subcommittee will be composed of an equal number of representatives from the earth science community, including representatives from the USGS, and the engineering community. A sufficient number of members of the SDPG will be included to ensure a smooth transition.

An additional 11 subcommittees will address seismic design and analysis, foundations and geotechnical considerations, cast-in-place and precast concrete structures, masonry structures, steel structures, wood structures, mechanical-electrical systems and building equipment and architectural elements, quality assurance, composite steel and concrete structures, base isolation and energy dissipation, and nonbuilding structures and one ad hoc task group to develop appropriate anchorage requirements for concrete/masonry/wood elements. Unlike earlier updates, it is not anticipated that a technical subcommittee will be appointed to serve as the interface with codes and standards; rather, the PUC will appoint a task group to serve as the liaison with the the model code and standards organizations and three model code representatives will serve on the PUC.

The BSSC, through the PUC and its TS's, will identify major technical issues to be addressed during the 2000 update of the *NEHRP Recommended Provisions*, assess the basis for change to the 1997 Edition, resolve technical issues, and develop proposals for change. The results of recent relevant research and lessons learned from earthquakes occurring prior to and during the duration of the project will be given consideration at all stages of this process. Particular attention will be focused on those technical problems identified but unresolved during the preparation of the 1997 Edition. Attention also will be given to the improvement of criteria to eventually allow for design based on desired building performance levels reflecting the approach taken in the *NEHRP Guidelines for the Seismic Rehabilitation of Buildings*.

The PUC also will coordinate its efforts with those individuals working with the ICC to develop the *IBC*. Changes recommended by those individuals will be submitted to the PUC for consideration and changes developed by the PUC will be formatted for consideration in the *IBC* development process.

As part of the update process, the BSSC also will develop a simplified design procedure in order to improve use of the *Provisions* in areas of low and moderate seismic hazard. This process will be performed by a separate task group reporting directly to TS2, Seismic Design and Analysis.

As in previous update efforts, two rounds of balloting by the BSSC member organizations are planned, and delivery of the final consensus-approved 2000 *Provisions* is expected to occur in December 2000. A report identifying the major differences between the 1997 and the 2000 editions of the *Provisions* and a letter report describing unresolved issues and major technical topics in need of further study also will be prepared.

Following completion of the 2000 *Provisions*, the BSSC will establish a procedure whereby the PUC will prepare code language versions of changes of the *Provisions* for submittal as proposed code changes for the 2003 Edition of the *IBC*. These code changes will be developed for PUC consideration and approval by a Code Liaison Group with the assistance of a consultant experienced in the code change process. In addition, the BSSC will designate three members of the PUC who, along with the consultant, will formally submit the code changes prior to the *IBC* deadline.

Information Dissemination/Technology Transfer

The BSSC continues in its efforts to stimulate widespread use of the *Provisions*. In addition to the issuance of a variety of publications that complement the *Provisions*, over the past seven years the BSSC has developed materials for use in and promoted the conduct of a series of seminars on application of the *Provisions* among relevant professional associations. To date, more than 90 of these seminars have been conducted with a wide variety of cosponsors and more than 70,000 reports have been distributed.

Other information dissemination efforts have involved the participation of BSSC representatives in a wide variety of meetings and conferences, BSSC participation in development of curriculum for a FEMA Emergency Management Institute course on the *Provisions* for structural engineers and other design professionals, issuance of press releases, development of in-depth articles for the publications of relevant groups, work with Building Officials and Code Administrators International (BOCA) that resulted in use of the *Provisions* in the BOCA *National Building Code* and the Southern Building Code Congress International's *Standard Building Code*, and cooperation with the American Society of Civil Engineers (ASCE) that resulted in use of the *Provisions* in the 1993 and 1995 Editions of Standard ASCE 7. In addition, many requests for specific types of information and other forms of technical support are received and responded to monthly.

During 1996, as part of the efforts of a joint committee of the BSSC, Central U.S. Earthquake Consortium, Southern Building Code Congress International and Insurance Institute for Property Loss Reduction to develop mechanisms for the seismic training of building code officials, the BSSC contributed its expertise in the development of a manual for use in such training efforts.

Information dissemination efforts during 1997 have been somewhat curtailed so that resources can be devoted to introduction of the 1997 *Provisions* and related efforts. In this regard, NIBS has requested and received an extension of its existing information dissemination contract with FEMA through September 1998 to permit, among other things, the development of a revised version of a *Nontechnical Explanation of the NEHRP Recommended Provisions* that reflects the 1997 Edition and the structuring of an updated plan to provide informative materials concerning the *Provisions* and the update process.

IMPROVING THE SEISMIC SAFETY OF EXISTING BUILDINGS

Guidelines/Commentary Development Project

In August 1991, NIBS entered into a cooperative agreement with FEMA for a comprehensive 6-year program leading to the development of a set of nationally applicable guidelines for the seismic rehabilitation of existing buildings. Under this agreement, the BSSC serves as program manager with the American Society of Civil Engineers (ASCE) and the Applied Technology Council (ATC) working as subcontractors. Initially, FEMA provided funding for a program definition activity designed to generate the detailed work plan for the overall program. The work plan was completed in April 1992 and in September FEMA contracted with NIBS for the remainder of the effort.

The major objectives of the project were to develop a set of technically sound, nationally applicable guidelines (with commentary) for the seismic rehabilitation of buildings to serve as a primary resource on the seismic rehabilitation of buildings for the use of design professionals, model code and standards organizations, state and local building regulatory personnel, and educators; to develop building community consensus regarding the guidelines; and to develop the basis of a plan for stimulating widespread acceptance and application of the guidelines.

The project work was structured to ensure that the technical guidelines writing effort benefits from: consideration of the results of completed and ongoing technical efforts and research activities as well as societal issues, public policy concerns, and the recommendations presented in an earlier FEMA-funded report on issues identification and resolution; cost data on application of rehabilitation procedures; the reactions of potential users; and consensus review by a broad spectrum of building community interests.

While overall management remained the responsibility of the BSSC, responsibility for conduct of the specific project tasks were shared by the BSSC with ASCE (which organized user workshops and conducted literature review and other research activities) and ATC (which was responsible for drafting the *Guidelines*, its *Commentary*, and a volume of example applications as well as conducting a study to assess the validity of several concepts being proposed for use in the *Guidelines*). Specific BSSC tasks were conducted under the guidance of a BSSC Project Committee. To ensure project continuity and direction, a Project Oversight Committee (POC) was responsible to the BSSC Board for accomplishment of the project objectives and the conduct of project tasks. Further, a Seismic Rehabilitation Advisory Panel was established to review project products and to advise the POC and, if appropriate, the BSSC Board, on the approach being taken, problems arising or anticipated, and progress being made. In addition, three workshops were held over the course of the project to provide the *Guidelines/Commentary* writers with input from potential users of the documents.

The BSSC Board of Direction accepted the 100-percent-complete draft of the *Guidelines* and *Commentary* for consensus balloting in mid-August 1996. The first round of balloting occurred in October-December with a ballot symposium for the voting representatives held in November 1996.

The *Guidelines* and *Commentary* were approved by the BSSC membership; however, a significant number of comments were received. The ATC Senior Technical Committee reviewed these comments in detail and commissioned members of the technical teams that developed the *Guidelines* to develop detailed responses and to formulate any needed proposals for change reflecting the comments. This effort resulted in 48 proposals for change to be submitted to the BSSC member organizations for a second round of balloting.

Following acceptance of the second ballot materials by the BSSC Board, the voting occurred in June-July 1997. Again the results were compiled for review by ATC. Meeting in September 1997, the Project Oversight Committee received recommendations from ATC regarding comment resolution; it was concluded that none of the changes proposed in response to ballot comments were sufficiently substantive to warrant reballoting. Subsequently, the POC conclusion was presented to the BSSC Board, which agreed and approved finalization of the *Guidelines* and *Commentary* for submittal to FEMA for publication. The camera-ready versions of the documents then were prepared and transmitted to FEMA on September 30, 1997.

During the course of the project, BSSC Project Committee recommendations resulted in the following additions to the NIBS/BSSC contract with FEMA for the project: the BSSC ballot symposium for voting representatives mentioned above; the case studies program described below; and an effort to develop the curriculum for and conduct a series of two-day educational seminars to introduce and provide training in use of the *Guidelines* to practicing structural and architectural engineers, seismic engineering educators and students, building officials and technical staff, interested contractors, hazard mitigation officers, and others.

Case Studies Project

The case studies project is an extension of the multiyear project leading to publication of the *NEHRP Guidelines for the Seismic Rehabilitation of Buildings* and its *Commentary* in late 1997. The project is expected to contribute to the credibility of the *Guidelines* by providing potential users with representative real-world application data and to provide FEMA with the information needed to determine whether and when to update the *Guidelines*.

Although the *Guidelines* documents reflect expert experience, current research, and innovative theories, the case studies project is expected to answer a number of critical questions: Can the *Guidelines* and its *Commentary* be understood and applied by practicing design professionals of varying levels of experience? Do the *Guidelines* result in rational designs generated in a reasonable and logical way? What are the costs involved in seismically rehabilitating various types of buildings to the optional levels of performance both above and below the *Guidelines'* "basic safety objective"? Are the requirements to achieve the "basic safety objective" equivalent to, less stringent than, or more stringent than current practice for new construction?

Specifically, the objectives of the project are to: (a) test the usability of the *NEHRP Guidelines for the Seismic Rehabilitation of Buildings* in authentic applications in order to determine the extent to which practicing design engineers and architects find the *Guidelines* documents, including the structural analysis procedures and acceptance criteria, to be presented in understandable language and in a clear, logical fashion that permits valid engineering determinations to be made, and evaluate the ease of transition from current engineering practices to the new concepts presented in the *Guidelines*; (b) assess the technical adequacy of the *Guidelines* design and analysis procedures to determine if application of the procedures results (in the judgment of the designer) in rational designs of building components for corrective rehabilitation measures and whether the designs that result adequately meet the selected performance levels when compared to current practice and in light of the knowledge and experience of the designer; (c) assess whether the *Guidelines* acceptance criteria are properly calibrated to result in component designs that provide permissible values of such key factors as drift, component strength demand, and inelastic deformation at selected performance levels; (d) develop data on the costs of rehabilitation design and construction to meet the *Guidelines'* "basic safety objective" as well as the higher performance levels included and assess whether the anticipated higher costs of advanced engineering analysis result in worthwhile savings compared to the cost of constructing more conservative design solutions arrived at by a less systematic engineering effort; and (e) compare the acceptance criteria of the *Guidelines* with the prevailing seismic design requirements for new buildings in the building location to determine whether requirements for achieving the *Guidelines'* "basic safety objective" are equivalent to or more or less stringent than those expected of new buildings.

It is planned that seismic rehabilitation designs will be developed for over 40 buildings selected insofar as practicable from an inventory of buildings already determined to be seismically deficient under the implementation program of Executive Order 12941 and considered "typical of existing structures located throughout the nation." Where federal buildings from this inventory do not represent the full spectrum of buildings which need to be studied, case study candidates will be sought from among privately owned buildings or those owned by other levels of government. Qualified structural engineering or architectural/engineering (A/E) firms will be engaged to produce detailed designs for seismic rehabilitation of the lateral-load-resisting systems, foundations, and critical nonstructural elements of the selected buildings, and to make specified comparisons with current practices and costs. Each design contractor's products and experiences using the *Guidelines* will be assessed in order to generate credible data that will establish the technical validity of the *Guidelines*, define their economic impact, and identify any needed changes in the *Guidelines* or highlight areas in need of research and investigation before a *Guidelines* update is planned. Many parameters and possible combinations thereof will be considered in addition to basic building types and seismic deficiencies.

The case studies will include consideration of numerous design approaches, options, and determinations to give a balanced representation, within the resources available, of the following factors: different performance levels and ranges, both systematic (linear/nonlinear, static/dynamic) and simplified analysis methods as presented in the *Guidelines*, alternate designs and cost comparisons for the same building provided by more than one design firm, different structural systems, varying seismicity (high, medium, and low), short and stiff versus tall and flexible building types, rehabilitation *Guidelines* compared to current new construction practices, geographic dispersion of cases among seismic risk areas, presence of auxiliary energy dispersion systems or base isolation, and historical preservation status of building.

The project is being guided by the Case Studies Project Committee (CSPC) chaired by Daniel Shapiro, Principal Engineer, SOH and Associates, Structural Engineers, San Francisco, California. The members are: Andrew A. Adelman, P.E., General Manager, Department of Building and Safety, City of Los Angeles, California; John Baals, P.E., Interior Seismic Safety Coordinator, Structural Analysis Group, U.S. Bureau of Reclamation, Denver, Colorado; Jacob Grossman, Principal, Rosenwasser/ Grossman, Consulting Engineers, New York, New York; Edwin T. Huston, Vice President, Smith & Huston, Inc., Seattle, Washington; Col. Guy E. Jester, St. Louis, Missouri; Clarkson W. Pinkham, President, S B Barnes Associates, Los Angeles, California; William W. Stewart, FAIA, Stewart·Schaberg/Architects, Clayton, Missouri; Lowell Shields, Capitol Engineering Consultants, Sacramento, California; Glenn Bell (alternate Andre S. Lamontagne), Simpson, Gumpertz & Heger Inc., Arlington, Massachusetts; Steven C. Sweeney, U.S. Army Construction and Engineering Research Laboratory, Champaign, Illinois.

At its organization meeting in May 1997, the CSPC reviewed the background and structure of the project, developed an initial work plan/project schedule, and defined the roles of the various participants. The CSPC also established three subcommittees to address the development of criteria for building selection, design professional selection, and contractor requests for proposals. In addition to the architects/engineers who will be engaged to perform the case studies designs, the project will utilize a paid Project Technical Advisor and a Design Assessment Panel of professionals knowledgeable about the content and use of the *Guidelines.*

In July, the CSPC met again to review letters of interest and resumes for the advertised position of the Project Technical Advisor; initial selection recommendations were developed for action by the BSSC Board and subsequently resulted in a contract with Andrew T. Merovich of A. T. Merovich and Associates, San Francisco, California. The subcommittee responsible for development of building selection criteria also presented a matrix for the selection and matching of available buildings.

The case studies project was posted in the *Commerce Business Daily* and in the Official Proposals section of *Engineering News Record.* These postings resulted in receipt of 149 expressions of interest; of these, 133 appear to be qualified to move into the next stage of the selection process.

The CSPC is scheduled to meet again on December 2 to finalize the list of buildings recommended for study, approve a draft of the "Request for Qualifications" (RFQ) and contractor selection criteria currently being developed, and identify individuals to serve on the Design Assessment Panel. FEMA has asked that two of the case studies be coordinated with its Disaster Resistant Communities effort by incorporating one building in Seattle, Washington, and one in Oakland, California.

The latest project schedule shows the case study designs being accomplished from May through September 1998 with the final project report to be submitted to FEMA by the end of March 1999.

Earlier Projects Focusing on Evaluation and Rehabilitation Techniques

An earlier FEMA-funded project was designed to provide consensus-backed approval of publications on seismic hazard evaluation and strengthening techniques for existing buildings. This effort involved identifying and resolving major technical issues in two preliminary documents developed for FEMA by others – a handbook for seismic evaluation of existing buildings prepared by the Applied Technology Council (ATC) and a handbook of techniques for rehabilitating existing buildings to resist seismic forces prepared by URS/John A. Blume and Associates (URS/Blume); revising the documents for balloting by the BSSC membership; balloting the documents in accordance with the BSSC Charter; assessing the ballot results; developing proposals to resolve the issues raised; identifying any unresolvable issues; and preparing copies of the documents that reflect the results of the balloting and a summary of changes made and unresolved issues. Basically, this consensus project was directed by the BSSC Board and a 22-member Retrofit of Existing Buildings (REB) Committee composed of individuals representing the needed disciplines and geographical areas and possessing special expertise in the seismic rehabilitation of existing buildings. The consensus approved documents (the *NEHRP Handbook for the Seismic Evaluation of Existing Buildings* and the *NEHRP Handbook of Techniques for the Seismic Rehabilitation of Existing Buildings*) were transmitted to FEMA in mid-1992.

The BSSC also was involved in an even earlier project with the ATC and the Earthquake Engineering Research Institute to develop an action plan for reducing earthquake hazards to existing buildings. The action plan that resulted from this effort prompted FEMA to fund a number of projects, including those described above.

Assessment of the San Francisco Opera House

In October 1994, the NIBS-BSSC initiated an effort to provide FEMA with objective expert advice concerning the San Francisco War Memorial Opera House. The Opera House, constructed circa 1920 with a steel frame clad and infilled with masonry, was damaged in the Loma Prieta earthquake and the city of San Francisco subsequently petitioned FEMA for supplemental funding of approximately $33 million to cover the costs of a complete seismic upgrade of the building under the *Stafford Act*, which provides funding for work when local building code upgrade requirements are met. In this case, the *San Francisco Building Code* was the local code in effect. The effort was structured to involve three phases, if warranted, and was to be conducted by a three-member Independent Review Panel of experts knowledgeable and experienced in building codes and building code administration.

During Phase I, the Review Panel conducted an unbiased, expert review of the applicable code sections pertinent to the repair of earthquake damage in order to provide FEMA with a definitive interpretation of such terms as "how much" change/repair of "what nature" would be sufficient to require complete seismic upgrading of a building of the same general type and construction as the Opera House. It reviewed all relevant, immediately available information about the Opera House case provided by FEMA and the city and the relevant portions of the *San Francisco Building Code* and other similar building codes pertinent to the repair of earthquake-caused damage to buildings and prepared and delivered to FEMA in February 1995 a preliminary report of its findings.

At this point, the Panel was informed by FEMA that the city of San Francisco had rescinded its request indicating that the "proposed determination on eligibility for funding through review and recommendation by an independent and impartial review body from NIBS" would not be necessary. Later, however, FEMA asked that NIBS-BSSC complete Phase I so that it would be better prepared should other similar situations arise. Thus, the Panel continued and delivered a final report to FEMA in July 1995.

IMPROVING THE SEISMIC SAFETY OF NEW AND EXISTING LIFELINES

Given the fact that buildings continue to be useful in a seismic emergency only if the services on which they depend continue to function, the BSSC developed an action plan for the abatement of seismic hazards to lifelines to provide FEMA and other government agencies and private sector organizations with a basis for their long-range planning. The action plan was developed through a consensus process utilizing the special talents of individuals and organizations involved in the planning, design, construction, operation, and regulation of lifeline facilities and systems.

Five lifeline categories were considered: water and sewer facilities, transportation facilities, communication facilities, electric power facilities, and gas and liquid fuel lines. A workshop involving more than 65 participants and the preparation of over 40 issue papers was held. Each lifeline category was addressed by a separate panel and overview groups focused on political, economic, social, legal, regulatory, and seismic risk issues. An Action Plan Committee composed of the chairman of each workshop panel and overview group was appointed to draft the final action plan for review and comment by all workshop participants. The project reports, including the action plan and a definitive six-volume set of workshop proceedings, were transmitted to FEMA in May 1987.

In recognition of both the complexity and importance of lifelines and their susceptibility to disruption as a result of earthquakes and other natural hazards (hurricanes, tornadoes, flooding), FEMA subsequently concluded that the lifeline problem could best be approached through a nationally coordinated and structured program aimed at abating the risk to lifelines from earthquakes as well as other natural hazards. Thus, in 1988, FEMA asked the BSSC's parent institution, the National Institute of Buildings Sciences, to provide expert recommendations concerning appropriate and effective strategies and approaches to use in implementing such a program.

The effort, conducted for NIBS by an ad hoc Panel on Lifelines with the assistance of the BSSC, resulted in a report recommending that the federal government, working through FEMA, structure a nationally coordinated, comprehensive program for mitigating the risk to lifelines from seismic and other natural hazards that focuses on awareness and education, vulnerability assessment, design criteria and standards, regulatory policy, and continuing guidance. Identified were a number of specific actions to be taken during the next three to six years to initiate the program.

MULTIHAZARD ACTIVITIES

Multihazard Assessment Forum

In 1993, FEMA contracted with NIBS for the BSSC to organize and hold a forum intended to explore how best to formulate an integrated approach to mitigating the effects of various natural hazards under the National Earthquake Hazards Reduction Program. More than 50 experts in various disciplines concerning natural hazards risk abatement participated in the June 1994 forum and articulated the benefits of pursuing an integrated approach to natural hazards risk abatement. A BSSC steering committee then developed a report, *An Integrated Approach to Natural Hazards Risk Mitigation*, based on the forum presentations and discussion that urged FEMA to initiate an effort to create a National Multihazard Mitigation Council structured and charged to integrate and coordinate public and private efforts to mitigate the risk from natural hazards. This report was delivered to FEMA in early 1995.

Multihazard Council Program Definition and Initiation

In September 1995, the BSSC negotiated with FEMA a modification of an existing contract to provide for conduct of the first phase of a longer term effort devoted to stimulating the application of technology and experience data in mitigating the risks to buildings posed by multiple natural hazards and development of natural hazard risk mitigation measures and provisions that are national in scope for use by those involved in the planning, design, construction, regulation, and utilization of the built environment. During this first phase, the BSSC is conducting a program definition and initiation effort expected to culminate in the establishment of a National Multihazard Mitigation Council (NMMC) to integrate and coordinate public and private efforts to mitigate the risks associated with natural hazards as recommended in the report cited above.

To conduct the project, the BSSC established a 12-member "blue ribbon" Multihazard Project Steering Committee (MPSC) composed of well-respected leaders in the natural hazards risk mitigation community. The MPSC, which met in July and December 1996 and February 1997, to developed an organizational structure for the proposed council, a draft charter, a draft mission statement, and a preliminary outline for a work plan. Due consideration has been given to the fact that the proposed council will need to maximize the use of resources through mitigation of risks utilizing common measures; promote cost-effective loss reduction, effective technology transfer, conflict identification, and coordination of performance objectives; improve efficiency in the development of codes and standards; provide an open forum for articulation of different needs and perspectives; facilitate policy adoption and implementation; fill educational and public awareness needs; and provide a single credible source for recommendations and directions. In addition, the MPSC is responsible for formulating and directing implementation of a strategy for effectively stimulating the level of interest and degree of cooperation among the various constituencies needed to establish the proposed council.

One of the major project milestones was the organization and conduct of a September 8-10 forum to review the proposed charter, mission statement, and five-year plan. Almost 80 individuals attended. Following background presentations and status reports on current mitigation-related activities, the forum was devoted primarily to presentation and discussion of the preliminary goals and objectives of the proposed council; the proposed NMMC Charter, home/organization, and membership; proposed activities to be included in the five-year plan for the NMMC; and the Steering Committee's candidates for the initial NMMC board. In essence, the forum participants gave consensus approval to the proposed goals, objectives, charter, and membership of the Council and accepted NIBS as the most likely candidate to serve as the home organization of the NMMC.

At its November 1997 meeting, the NIBS Board of Directors reviewed the goals/objectives and activities statements and charter for the NMMC as discussed at the forum. They accepted the charter with some changes. The new council, to be called the Multihazard Mitigation Council (MMC), will now be a sister council to the BSSC and other NIBS councils.

EMI Multihazard Building Design Summer Institute

In 1994, NIBS, at the request of FEMA's Emergency Management Institute (EMI), entered into a contract for BSSC to provide support for the of the EMI Multihazard Building Design Summer Institute (MBDSI) for university and college professors of engineering and architecture. The 1995 MBDSI, conducted in July 1995, consisted of four one-week courses structured to encourage widespread use of mitigation techniques in designing/rehabilitating structures to withstand forces generated by both natural and technological hazards by providing the attending academics with instructional tools for use in creating/updating building design courses.

BSSC MEMBER ORGANIZATIONS

AFL-CIO Building and Construction Trades Department
AISC Marketing, Inc.
American Concrete Institute
American Consulting Engineers Council
American Forest and Paper Association
American Institute of Architects
American Institute of Steel Construction
American Insurance Services Group, Inc.
American Iron and Steel Institute
American Plywood Association
American Society of Civil Engineers
American Society of Civil Engineers--Kansas City Chapter
American Society of Heating, Refrigeration, and Air-Conditioning Engineers
American Society of Mechanical Engineers
American Welding Society
Applied Technology Council
Associated General Contractors of America
Association of Engineering Geologists
Association of Major City Building Officials
Bay Area Structural, Inc.*
Brick Institute of America
Building Officials and Code Administrators International
Building Owners and Managers Association International
Building Technology, Incorporated*
California Geotechnical Engineers Association
California Division of the State Architect, Office of Regulation Services
Canadian National Committee on Earthquake Engineering
Concrete Masonry Association of California and Nevada
Concrete Reinforcing Steel Institute
Earthquake Engineering Research Institute
General Reinsurance Corporation*
Hawaii State Earthquake Advisory Board
Insulating Concrete Form Association
Institute for Business and Home Safety
Interagency Committee on Seismic Safety in Construction
International Conference of Building Officials
International Masonry Institute
Masonry Institute of America
Metal Building Manufacturers Association
National Association of Home Builders
National Concrete Masonry Association
National Conference of States on Building Codes and Standards
National Council of Structural Engineers Associations
National Elevator Industry, Inc.
National Fire Sprinkler Association
National Institute of Building Sciences
National Ready Mixed Concrete Association
Permanent Commission for Structural Safety of Buildings*
Portland Cement Association
Precast/Prestressed Concrete Institute
Rack Manufacturers Institute
Seismic Safety Commission (California)
Southern Building Code Congress International
Southern California Gas Company*
Steel Deck Institute, Inc.
Steel Joist Institute*
Steven Winter Associates, Inc.*
Structural Engineers Association of Arizona
Structural Engineers Association of California
Structural Engineers Association of Central California
Structural Engineers Association of Colorado
Structural Engineers Association of Illinois
Structural Engineers Association of Northern California
Structural Engineers Association of Oregon
Structural Engineers Association of San Diego
Structural Engineers Association of Southern California
Structural Engineers Association of Utah
Structural Engineers Association of Washington
The Masonry Society
U. S. Postal Service*
Western States Clay Products Association
Western States Council Structural Engineers Association
Westinghouse Electric Corporation*
Wire Reinforcement Institute, Inc.

* Affiliate (non-voting) members.

(January 1998)

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Phone 202-289-7800; Fax 202-289-1092; e-mail cheider@nibs.org

NEW BUILDINGS PUBLICATIONS

The NEHRP (National Earthquake Hazards Reduction Program) Recommended Provisions for Seismic Regulations for New Buildings, 1997 Edition, 2 volumes and maps (FEMA Publication 302 and 303)—printed copies expected to be available in early 1998.

The NEHRP (National Earthquake Hazards Reduction Program) Recommended Provisions for Seismic Regulations for New Buildings, 1994 Edition, 2 volumes and maps (FEMA Publications 222A and 223A).

The NEHRP (National Earthquake Hazards Reduction Program) Recommended Provisions for the Development of Seismic Regulations for New Buildings, 1991 Edition, 2 volumes and maps (FEMA Publications 222 and 223) — limited to existing supply.

Guide to Application of the 1991 Edition of the NEHRP Recommended Provisions in Earthquake Resistant Building Design, Revised Edition, 1995 (FEMA Publication 140)

A Nontechnical Explanation of the NEHRP Recommended Provisions, Revised Edition, 1995 (FEMA Publication 99)

Seismic Considerations for Communities at Risk, Revised Edition, 1995 (FEMA Publication 83)

Seismic Considerations: Apartment Buildings, Revised Edition, 1996 (FEMA Publication 152)

Seismic Considerations: Elementary and Secondary Schools, Revised Edition, 1990 (FEMA Publication 149)

Seismic Considerations: Health Care Facilities, Revised Edition, 1990 (FEMA Publication 150)

Seismic Considerations: Hotels and Motels, Revised Edition, 1990 (FEMA Publication 151)

Seismic Considerations: Office Buildings, Revised Edition, 1996 (FEMA Publication 153)

Societal Implications: Selected Readings, 1985 (FEMA Publications 84)

EXISTING BUILDINGS PUBLICATIONS

NEHRP Guidelines for the Seismic Rehabilitation of Buildings, 1997 (FEMA Publication 273)

NEHRP Guidelines for the Seismic Rehabilitation of Buildings: Commentary, 1997 (FEMA Publication 274)

Planning for Seismic Rehabilitation: Societal Issues, 1998 (FEMA Publication 275)

Example Applications of the NEHRP Guidelines for the Seismic Rehabilitation of Buildings, to be available in mid-1998 (FEMA Publication 276)

NEHRP Handbook of Techniques for the Seismic Rehabilitation of Existing Buildings, 1992 (FEMA Publication 172)

NEHRP Handbook for the Seismic Evaluation of Existing Buildings, 1992 (FEMA Publication 178)

An Action Plan for Reducing Earthquake Hazards of Existing Buildings, 1985 (FEMA Publication 90)

MULTIHAZARD PUBLICATIONS

An Integrated Approach to Natural Hazard Risk Mitigation, 1995 (FEMA Publication 261/2-95)

LIFELINES PUBLICATIONS

Abatement of Seismic Hazards to Lifelines: An Action Plan, 1987 (FEMA Publication 142)

Abatement of Seismic Hazards to Lifelines: Proceedings of a Workshop on Development of An Action Plan, 6 volumes:

Papers on Water and Sewer Lifelines, 1987 (FEMA Publication 135)

Papers on Transportation Lifelines, 1987 (FEMA Publication 136)

Papers on Communication Lifelines, 1987 (FEMA Publication 137)

Papers on Power Lifelines, 1987 (FEMA Publication 138)

Papers on Gas and Liquid Fuel Lifelines, 1987 (FEMA Publication 139)

Papers on Political, Economic, Social, Legal, and Regulatory Issues and General Workshop Presentations, 1987 (FEMA Publication 143)