



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 rebalot during June-July 1988. Nine of the eleven rebalot proposals passed and two failed.

On the basis of the ballot and rebalot 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 rebalot proposals for consideration by the BSSC member organizations. The rebaloting was completed in August 1991 with the approval by the BSSC member organizations of 19 of the rebalot 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, 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*
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Western States Council Structural Engineers
Association
Westinghouse Electric Corporation*
Wire Reinforcement Institute, Inc.

* Affiliate (non-voting) members.

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BSSC, 1090 Vermont Avenue, N.W., Suite 700, Washington, D.C. 20005
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)