BSSC PROGRAM ON IMPROVED
SEISMIC SAFETY PROVISIONS

Abatement of Seismic Hazards to Lifelines:

Proceedings of a Workshop on Development of An Action Plan

Volume 1

Papers on Water and Sewer Lifelines

BUILDING
SEISMIC
SAFETY
COUNCIL

BUILDING SEISMIC SAFETY COUNCIL

The Building Seismic Safety Council (BSSC) is an independent, voluntary body that was established under the auspices of the National Institute of Building Sciences (NIBS) in 1979 as a direct result of nationwide interest in the seismic safety of buildings. Its membership (see inside back cover) represents a wide variety of building community interests. 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, 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-type structures and includes explicit consideration and assessment of the social, technical, administrative, political, legal, and economic implications of its deliberations and recommendations. It 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 (for example, 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 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. The BSSC itself assumes no standards-making and/or -promulgating role; rather, it advocates that standards-formulation organizations consider BSSC recommendations for inclusion into their documents and standards.

ABATEMENT OF SEISMIC HAZARDS TO LIFELINES: PROCEEDINGS OF THE BUILDING SEISMIC SAFETY COUNCIL WORKSHOP ON DEVELOPMENT OF AN ACTION PLAN

November 5-7, 1986
Denver, Colorado

VOLUME 1

PAPERS ON WATER AND SEWER LIFELINES

Prepared by the
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BUILDING SEISMIC SAFETY COUNCIL
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Building Seismic Safety Council reports include the following:

Abatement of Seismic Hazards to Lifelines: Proceedings of the Building Seismic Safety Council Workshop on Development of an Action Plan, 1987

- Volume 1, *Papers on Water and Sewer Lifelines*
- Volume 2, *Papers on Transportation Lifelines*
- Volume 3, *Papers on Communications Lifelines*
- Volume 4, Papers on Power Lifelines
- Volume 5, *Papers on Gas and Liquid Fuel Lifelines*
- Volume 6, *Papers on Political, Economic, Social, Legal, and Regulatory Considerations and General Workshop Presentations*

Action Plan for the Abatement of Seismic Hazards to New and Existing Lifelines, 1987

Guidelines for Preparing Code Changes Based on the NEHRP Recommended Provisions (1985 Edition), 1986

Guide to Use of the NEHRP Recommended Provisions in Earthquake-Resistant Design of Buildings, 1987

Improving the Seismic Safety of New Buildings: A Community Handbook of Societal Implications (Revised Edition), 1986

Improving the Seismic Safety of New Buildings: A Non-Technical Explanation of the NEHRP Recommended Provisions, 1986

NEHRP (National Earthquake Hazards Reduction Program) Recommended Provisions for the Development of Seismic Regulations for New Buildings, 1985 Edition, 1985

Overview of Phases I and II of the BSSC Program on Improved Seismic Safety Provisions, 1984

Plan for Stimulating Widespread Use of the NEHRP Recommended Provisions, 1986

Societal Implications: Selected Readings, 1985

For further information concerning any of these documents, contact the Executive Director, Building Seismic Safety Council, 1015 15th St., N.W., Suite 700, Washington, D.C. 20005.

An Action Plan for Reducing Earthquake Hazards of Existing Buildings (1985) and *Proceedings: Workshop on Reducing Seismic Hazards of Existing Buildings* (1985) were developed by the ABE Joint Venture (conducted by the Applied Technology Council, Building Seismic Safety Council, and Earthquake Engineering Research Institute) and are available from FEMA, Earthquake Programs, Washington, D.C. 20472.

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FOREWORD

The Federal Emergency Management Agency (FEMA) is pleased to have had the opportunity to sponsor the BSSC program on the seismic safety of lifeline systems and the resultant action plan and proceedings volumes. These publications are the first in a planned series that will deal with many facets of this topic. Lifeline systems constitute an essential component of the economic and social fabric of the country and their protection from the harmful effects of earthquakes needs to be improved from its present status. This effort, therefore, is in furtherance of the objectives of the National Earthquake Hazards Reduction Program (NEHRP) and an essential part of that program.

FEMA is grateful for the voluntary contribution of expertise and time on the part of the scores of individuals who have prepared and/or reviewed the workshop papers and action plan and otherwise participated in the program. The invaluable contribution of two organizations, the Technical Council on Lifeline Earthquake Engineering of the American Society of Civil Engineers and the Building Seismic Safety Council, deserves special recognition.

PREFACE

The Building Seismic Safety Council (BSSC) was established in 1979 as an independent, voluntary body with a membership of 57 organizations representing the full spectrum of building community interests. 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. Given the fact that buildings will continue to be useful in a seismic emergency only if the services on which they depend continue to function, the BSSC conducted the Program on Development of an Action Plan for Abatement of Seismic Hazards to Lifelines, which generated an action plan as well as the six-volume set of workshop proceedings of which this volume is a part.

The objective of the lifelines program, funded by the Federal Emergency Management Agency (FEMA), was to develop a seismic hazard abatement action plan for new and existing lifelines that FEMA and other government agencies and private sector organizations can use as a basis for long-range planning. This plan was developed through a consensus process utilizing the special talents of individuals and organizations involved in the planning, design, construction, and regulation of lifeline facilities and systems.

In order to provide the basis for development of the action plan, a workshop was held in Denver, Colorado, on November 5-7, 1986. In order to provide for an effective workshop that would result in the needed data, a considerable amount of effort was devoted to structuring and organizing the workshop by a specially appointed BSSC Lifelines Management Committee.

It was determined that the workshop should be structured to focus on five lifeline categories:

- Water and sewer facilities
- Transportation facilities
- Communication facilities
- Power facilities
- Gas and liquid fuel lines

It also was decided that six topics needed to be addressed for each of the lifeline categories:

- Assessment of available methods of identifying and retrofitting vulnerable in-place lifeline systems.

- Assessment of available criteria, methods, and techniques for the design and construction of new seismic-resistant lifelines.

- Survey of relevant ongoing lifeline activities.

- Identification of political, economic, and social problems associated with abatement of seismic hazards to new and existing lifeline facilities.

- Review of regulatory approaches, legal issues, and case law concerning new lifelines and abatement of hazards to existing lifelines.

- Identification of scientific and engineering information needs.

Early in 1986 a large number of individuals possessing expertise in the various technical disciplines and professions involved in the earthquake problem (i.e., geoscientists, geotechnical engineers, structural engineers, mechanical engineers, electrical engineers, architects, urban planners, lawyers, economists, social scientists, researchers, teachers, design practitioners, government policymakers, and building officials) were invited to participate in the November workshop and/or prepare papers on these topics for review and coordination prior to discussion at the workshop. Of those invited, more than 40 individuals indicated that they would participate actively (see Appendix B for a list of workshop participants and Appendix C for their biographies) and 41 issue papers were prepared.

The workshop was structured to provide for consideration of each lifeline category by a separate panel and for consideration of issues spanning the lifeline categories (i.e., political, economic, and social issues; legal and regulatory issues; and seismic risk) by overview groups composed of a chairman and a member from each of the category panels. In addition, an Action Plan Committee, composed of the chairman of each panel and overview group, was appointed.

As the issue papers were drafted, they were submitted to the appropriate panel and overview group for review and suggestions. The issue papers then were modified as appropriate by their authors and all issue papers were distributed to the workshop participants (including those who were asked to attend as guests) in October 1986.

At the workshop itself (see Appendix A for the agenda), each panel and overview group had the opportunity to meet as a group so that each participant would have the opportunity to contribute to action plan development. Plenary discussions permitted each panel and group to present its findings and receive meaningful contributions from those in other groups and from the workshop guests. At the conclusion of the workshop, the chairman of each panel and overview group had developed

the basis of a "mini" action plan for the specific topic that had the consensus approval of the panel or group. Following the workshop, the various participants further contributed to the action plan being developed by the panel or group to which they had been assigned and all the "mini" action plans were submitted to the BSSC Action Plan Committee in early 1987. They then were integrated and refined to form the draft of the final action plan for FEMA and distributed once again to all workshop participants for comment. The final action plan then was developed and transmitted to FEMA in May 1987.

The workshop proceedings were published in six volumes--one covering each of the five lifeline categories and one covering political, social, economic, legal, and regulatory issues and including the general workshop presentations (see Appendix D for a list of the contents of each volume).

ACKNOWLEDGEMENTS

All those who wrote and reviewed issue papers, participated in the workshop, and contributed to the final action plan development process devoted considerable time, effort, and expertise to the program and the Building Seismic Safety Council is most grateful. The BSSC is especially grateful to all the organizations whose previous work contributed to the knowledge base upon which the program could build. In this respect, the BSSC recognizes the important work of the Technical Council on Lifeline Earthquake Engineering (TCLEE) of the American Society of Civil Engineers (ASCE), without whose efforts over the past decade the BSSC program would not have been possible. Indeed, many of the issue paper authors and all the lifeline category panel chairman are members of TCLEE.

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