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RECOMMENDATIONS OF THE LIFELINE POLICYMAKERS WORKSHOP

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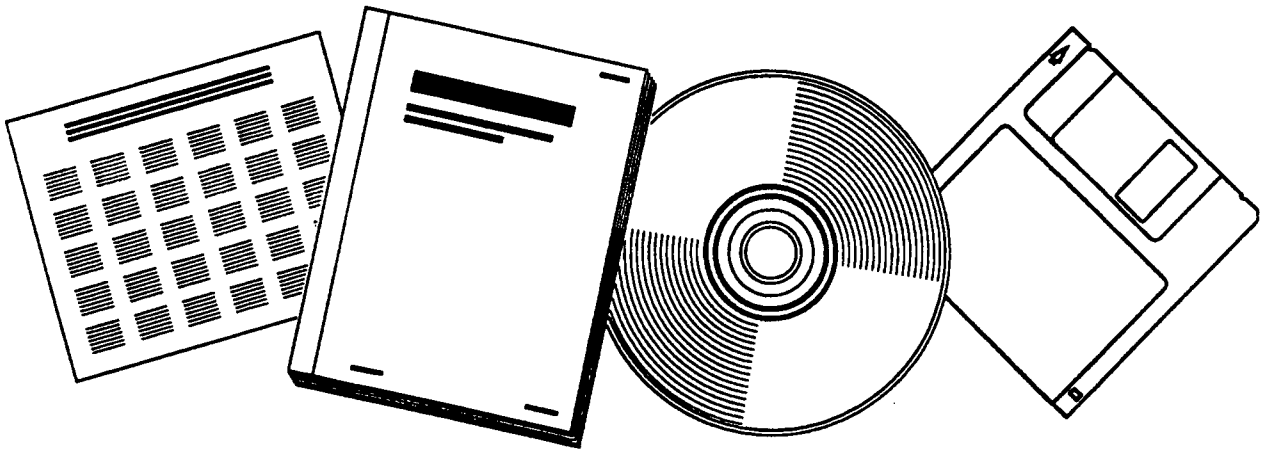

U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

ICSSC TR-19

Interagency Committee on
Seismic Safety in Construction

NISTIR 6085

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Recommendations of the Lifeline Policymakers Workshop

Bijan Mohraz and Riley M. Chung

Building and Fire Research Laboratory
Gaithersburg, Maryland 20899

United States Department of Commerce
Technology Administration
National Institute of Standards and Technology

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My Fellow Colleagues,

During my tenure as President of the American Society of Civil Engineers (ASCE), I had the honor and privilege to participate in the January 1997 Lifeline Policymakers' Workshop, during which the Action Plan herein was developed and approved. This Plan sets forth a rational framework for the development of national guidelines for lifelines, and confronts a problem of immense proportion which has never before been addressed from a uniform, national perspective. Without such a Plan, this nation will continue to face the disruption and devastation of its infrastructure, i.e. electric power and gas lines, water and sewer, telecommunication and transportation systems.

This Plan is a call to action. It requires the wholehearted support of industry and government. As Past President of ASCE, and on behalf of our 123,000 members, I challenge you and your colleagues to support the implementation of this Plan, particularly at the local level, and to help ensure that our country's critical lifelines are strengthened to resist natural hazards.

Yours in Mitigation,

Edward O. Groff
Past President, ASCE
1996 - 1997

ACKNOWLEDGMENT

The authors wish to express their appreciation to the American Society of Civil Engineers, Mr. Thomas R. McLane, and Ms. Megan Prosser of ASCE for their assistance in planning the workshop and conducting the ASCE survey on guidelines for lifeline seismic design and construction. Mr. James D. Cooper, Chief, Structures Division, Federal Highway Administration and Chair of the Interagency Committee on Seismic Safety in Construction Subcommittee 2 on Lifelines, chaired the workshop. His interest and commitment to this workshop are gratefully acknowledged.

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EXECUTIVE SUMMARY

In 1995 the Federal Emergency Management Agency (FEMA) in consultation with the National Institute of Standards and Technology (NIST) prepared a "Plan for Developing and Adopting Seismic Design Guidelines and Standards for Lifelines," FEMA 271, which was submitted to Congress in September 1995. FEMA 271, prepared in response to the National Earthquake Hazard Reduction Program (NEHRP) Reauthorization Act of 1990 (Public Law 101-614), is based on input from experts in private and public sectors who participated in a workshop held in 1991 in Denver, Colorado. It recommends the development and implementation of design guidelines and standards to reduce the vulnerability of lifelines to earthquakes.

In December 1995, the Interagency Committee on Seismic Safety in Construction (ICSSC), through its Subcommittee 2 on Lifelines, suggested that the American Society of Civil Engineers (ASCE), with support from NIST, organize a Lifeline Policymakers Workshop. This workshop, held in January 1997 in Washington, DC, brought together leaders in policy making positions from private and federal sectors to assess FEMA 271 and recommend how it could best be implemented.

The workshop participants strongly endorsed the need for developing and adopting seismic design guidelines for lifelines. They agreed in principle with FEMA 271 and made the following recommendations:

Guideline Development

1. Guidelines should be developed as soon as possible and focus equally on new and existing lifelines. They should address life safety, loss of property, restoration of service, system and component performance, and risk assessment. Guidelines should initially focus on seismic hazard and later address other hazards.
2. Guidelines should incorporate the latest research and be based on provisions, standards, and practices that have been developed by professional organizations, industry, state, and federal government.
3. Demonstration projects should be used to test the guidelines. If possible, demonstration projects should be selected from new or existing construction projects that are being carried out by participating organizations. The use of federally owned utilities and military bases should also be considered for demonstration projects.

Implementation

Implementation will require:

1. A strong partnership between the private and public sectors.
2. Defined goals that ensure all public and private utility and transportation systems resist earthquakes so as to protect lives, limit property damage, and provide resumption of service in a reasonable and timely manner.
3. Defined role of the National Earthquake Hazard Reduction Program (NEHRP) and other federal agencies as well as the Interagency Committee on Seismic Safety in Construction (ICSSC).
4. Defined short and long term responsibilities of lifeline stakeholders (private and public utilities, professional societies, manufacturers and suppliers, and local, state, and federal governments).
5. Leadership at several positions. FEMA should provide the leadership in the federal government. Leadership in Congress and from large utilities and professional societies is also critical.
6. Formation of a streamlined management structure for guideline development and implementation that is representative of lifeline owners, operators, manufacturers, professional societies and trade organizations.

Resources

Resources will require:

1. Major funding and in-kind support from the federal government and the utilities that have the greatest stake in guideline development.
2. FEMA, as the lead agency in NEHRP, to assume the primary role to pursue Congressional appropriation.
3. Possible use of the federal disaster assistance and similar funding.
4. Incentives such as tax credits, reduced insurance premiums, and low interest loans to encourage voluntary mitigation programs.

It is estimated that it will require 5 years for development and implementation of seismic guidelines and an additional 5 years for inclusion of guidelines for other hazards. The estimated cost for the development of seismic guidelines is in the order of $1.0M for the first year, $3.0M for the second year, and $4.0M for years three, four, and five.

INTRODUCTION

Lifelines are the transportation (highways, air, rail, waterways, ports and harbors) and utility systems (electric power, gas and liquid fuels, telecommunication, water, and sewer) that support most human activities: individual, family, economic, political, and cultural. Lifeline failures during earthquakes cause loss of life, property, income, as well as adverse environmental impact. These failures also result in post-earthquake fires, hinder post-earthquake emergency and rescue operations, and delay the recovery and reconstruction process. Unlike buildings which have codes that include seismic provisions for their design, and highways that have nationally accepted seismic design standards, there are no nationally accepted seismic design guidelines for utility lifelines and other transportation systems.

Plan for Developing Guidelines

In 1991 the National Institute of Standards and Technology (NIST), with funding from the Federal Emergency Management Agency (FEMA) and technical support from the American Society of Civil Engineers (ASCE) Technical Council on Lifeline Earthquake Engineering (TCLEE), conducted a workshop in Denver, Colorado, to review the state-of-the-art knowledge and recommend development and implementation of guidelines for seismic design and construction standards for lifelines. The findings and recommendations of the workshop led to a "Plan for Developing and Adopting Seismic Design Guidelines and Standards for Lifelines," FEMA 271, which was prepared by FEMA in consultation with NIST and submitted by FEMA to Congress in September 1995. This Plan, referred to herein as "FEMA 271" was prepared in response to Public Law 101-614, the National Earthquake Hazards Reduction Program (NEHRP) Reauthorization Act of 1990. FEMA 271 outlines the need for lifeline seismic design guidelines and standards; a strategy for development and implementation; roles of the private and public sectors in the implementation; a recommended approach to guidelines and standards development; and suggestions for management, coordination, implementation, funding and scheduling. It also discusses the role of NEHRP agencies, particularly the NEHRP lead agency FEMA, and NIST in the formation and operation of a Lifeline Seismic Safety Executive Board (LSSEB), as well as the role of the Interagency Committee on Seismic Safety in Construction (ICSSC).

Assessment of the Plan

ICSSC was established as part of the implementation plan for the Earthquake Hazard Reduction Act of 1977 (Public Law 95-124) to assist federal departments and agencies involved in construction to develop and incorporate earthquake hazard reduction measures in

their ongoing programs. Among ICSSC's five subcommittees, Subcommittee 2 on Lifelines is concerned with activities that relate to lifelines for federally owned or leased facilities. In December 1995, ICSSC asked Subcommittee 2 to explore options to implement FEMA 271. Subcommittee 2 suggested that ASCE organize a workshop with support from NIST, to bring together individuals from the private sector, public utilities, and federal government to assess FEMA 271 and recommend how it could best be implemented. The subcommittee recommended that before scheduling a workshop, ASCE conduct a survey of private sector lifeline stakeholders to identify their interest in developing guidelines; and based on the results of the survey, assess the need for the workshop. The findings of the survey, which are included in a summary in Appendix A, overwhelmingly supported the need for developing seismic design guidelines for lifelines. The subcommittee recognized that for the implementation of FEMA 271 to precede the development of guidelines, the workshop should focus on policy rather than technical issues. Consequently, invitations were extended to leaders in policy making positions: 33 from the private sector and private and public utilities, and 34 from the federal government. The list of the 53 individuals who attended the workshop is presented in Appendix B.

The workshop was held on January 23-24, 1997 at the Radisson Barcello Hotel, Washington, DC.

OBJECTIVE

The objective of the workshop was to assess FEMA 271 and recommend the best way it could be implemented through partnership between the private sector, private and public utilities, and the federal government.

WORKSHOP FORMAT

The workshop agenda is attached as Appendix C. The first day of the workshop consisted of a plenary session in the morning followed by two breakout sessions in the afternoon. The plenary session included two keynote speeches, several presentations describing the impact of lifeline disruptions during earthquakes, a summary of the 1991 Lifeline Workshop, and a briefing on FEMA 271. The final plenary presentation on "Mitigation and Lifelines: FEMA's

Perspective" was held in the morning of the second day. A summary of each presentation is included in Appendix D.

Each of the two breakout sessions included four groups of approximately 12 participants. Each group was given an identical charge. The first breakout session focused on the assessment of FEMA 271, and the second centered on its implementation, identification of resources, and leadership. After each breakout session, the chairs and recorders of the four groups reported on the discussions and recommendations of their group in plenary sessions. In the morning of the second day, the recommendations of the four groups were consolidated and synthesized through extensive discussions. Mel Hensey of Hensey Associates served as the facilitator to assist the participants in focusing on the workshop's objectives.

CHARGE TO PARTICIPANTS

The participants were asked to discuss the following issues in the breakout sessions:

Breakout Session A

The four groups were asked to discuss and comment on FEMA 271 in general and Chapters 3 and 4 in particular. Major topics in Chapter 3, "Private and Public Sector Roles in the Development of Design Guidelines and Standards," include the responsibilities for seismic safety of lifelines and NEHRP support for the development of recommendations for lifeline seismic design guidelines and standards. Major topics in Chapter 4, "The Development of Design Guidelines and Standards," include the process of developing design guidelines and standards, the recommended approach, the policy statement and strategy, and the proposed management structure.

Breakout Session B

The four groups were asked to discuss ways that FEMA 271 could be implemented, consider the future inclusion of multihazard mitigation, identify potential sources of funds and the necessary technical resources, and recommend who should provide leadership in the implementation. The groups were also asked to recommend how FEMA 271 could be implemented through a partnership between the private sector, private and public utilities and the federal government, and how needed resources could be secured for such a collaboration.

RECOMMENDATIONS

The following summarizes the recommendations of the workshop participants and suggested modifications to FEMA 271:

Guideline Development

Development of guidelines should begin as soon as possible using current guides, standards, and practices, and incorporating the latest research. Experience with seismic design and mitigation in California, including guideline development for buildings, should be used in the development of seismic design guidelines for lifelines. Guidelines should state the intended region of the country and should address life safety, loss of property, system and component performance as well as risk assessment. The interdependence of different lifeline components and systems should be considered. Guidelines should include the design of new and evaluation and mitigation of existing lifeline systems, beginning with seismic hazards and possibly later including other hazards. Once guidelines are developed and tested, they may be used by the private sector, private and public utilities, and professional societies to develop consensus standards.

Demonstration projects should be carried out as needed to test the guidelines. Demonstration projects, particularly those that involve significant construction, are costly. Furthermore, the private sector may be reluctant to participate because of potential liability issues. The use of federally owned utilities, and possibly military bases, for demonstration projects presents a viable alternative in the initial stages of guideline development as it minimizes the legal issues posed by private demonstration projects.

The implementation of seismic design guidelines for buildings was expedited by the issuance of two Executive Orders - E.O. 12699, "Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction," and E.O. 12941, "Seismic Safety of Existing Federally Owned or Leased Buildings." Thus, future issuance of Executive Order(s) for lifelines, once the guidelines are developed, would accelerate implementation.

Implementation

Workshop participants agreed in principle with the implementation of FEMA 271 with modifications (hereafter referred to as "the modified plan"). They emphasized the need for strong partnership not only between the private sector, public utilities, and the federal government but also between the federal government and state and local governments.

Modifications to FEMA 271 should include identifying the short and long term responsibilities of various lifeline stakeholders - private and public utilities, professional societies, equipment manufacturers and suppliers, and local, state, and federal governments.

Goals must be established and defined in implementing the modified plan. The goals should ensure that all public and private utility and transportation systems withstand earthquakes in order to protect lives, limit property damage, and provide resumption of service in a reasonable and timely manner. Current federal programs that can assist in achieving the goals should be identified and leveraged.

The management plan described in FEMA 271 needs to be streamlined and simplified. In addition to the model presented in FEMA 271, other models should be explored. An alternative was suggested to include a Board of Directors, a Technical Advisory Committee, a Voluntary Guideline Committee (through which working groups can be established), and liaisons between the Board of Directors and utilities, transportation, education, and standards writing communities. The Board of Directors should be housed in an independent and neutral organization in order to maximize participation by different professional societies and trade organizations. Development of guidelines for various lifelines should be carried out by working groups appointed by the Board of Directors. The Board should identify the specific federal agencies that should support and participate in the guideline development. For example, the Department of Energy would be the logical agency to participate and partially fund the development of guidelines for electric power systems.

While FEMA 271 briefly discusses the role of the four NEHRP agencies, participation and the role of other federal agencies and ICSSC in guideline development, implementation and management of the modified plan, should be defined.

Because of the diverse nature of lifelines, the implementation of the modified plan will be a major undertaking requiring leadership at several positions. FEMA should provide and coordinate the leadership in the federal government. Since the federal budget is appropriated through Congress, leadership, or a "champion," in Congress is critical. Leadership by other federal agencies, private companies, large utilities, and professional societies that have interest in lifelines and guideline development is also needed. A partial list of such agencies and organizations include: the Department of Energy, Department of Transportation, National Institute of Standards and Technology, manufacturers and suppliers of lifeline products, Metropolitan Water District of Southern California, Pacific Gas and Electric, Southern

California Gas, Southern California Edison, Los Angeles Department of Water and Power, Pacific Bell, American Society of Civil Engineers, American Society of Mechanical Engineers, American Petroleum Institute, American Water Works Association, Association of American Railroads, American Public Transit Association, Institute of Electrical and Electronic Engineers, Earthquake Engineering Research Institute, Electric Power Research Institute, and National Fire Protection Association.

Resources

Monetary and in-kind support are critical to guideline development and implementation. While a partnership between the private sector, private and public utilities, and the federal, state, and local governments is essential to implement the modified plan, major resources must come from the federal government and the utilities that have the greatest stake in guideline development. This recommendation is also consistent with the results of the 1996 ASCE survey of private sector lifeline stakeholders (Appendix A) which confirms that the federal, state, and local governments, and the private and public utilities should fund the guideline development.

Demonstration projects are important in testing and assessing guidelines. The design phase of the project should be funded primarily by the federal government with possible local community participation, while the construction phase should be funded mainly by the local community with partial federal funding. The use of federally owned utilities and facilities such as military bases should be explored for demonstration projects. The use of federally owned facilities will minimize or eliminate the potential legal issues that private demonstration projects may pose.

FEMA, as the lead agency in NEHRP, should undertake the primary role to pursue federal funding. In addition to NEHRP and direct agency funding, other sources of federal support such as federal disaster assistance should be explored. Tax credits, reduced insurance premiums, and low interest loans which encourage voluntary mitigation programs should also be explored as incentives for private sector participation.

Large utility companies such as Pacific Gas and Electric (PG&E), Southern California Gas (SoCal Gas), and Los Angeles Department of Water and Power (LADWP) have significant experience in development of seismic guidelines for their facilities and may support relevant studies. Collaborative efforts and joint funding and in-kind support for guideline development that is of interest to such organizations should be explored.

CONCLUSIONS

The workshop participants strongly endorse the need for developing and adopting seismic design guidelines for lifelines, and recommend that the guidelines be developed as soon as possible.

FEMA 271, with modifications, presents a sound approach to lifeline hazard mitigation. Successful execution of the modified plan depends on a strong partnership between the lifeline stakeholders in the private and public sectors, including owners, operators, users, manufacturers, suppliers, professional societies and trade organizations. Leadership at several positions: federal government, Congress, private and public utilities, and professional societies is critical for implementing a lifeline plan. FEMA, as the lead agency in NEHRP should provide the leadership in the federal government.

The implementation of the modified plan will require substantial funding and in-kind support. The federal government, utilities, and oil companies that have the greatest stake in guideline development should bear the major cost. Estimates for developing and implementing the guidelines are 5 years for seismic and an additional 5 years for incorporating other hazards, with funding of $1M for the first year, $3M for the second year, and $4M for years three, four, and five for developing and implementing the seismic provisions. FEMA and NIST should discuss the possibility of a "seed" funding to immediately begin the implementation of FEMA 271 and maintain the interest and momentum generated by the workshop.

REFERENCES

1. *Plan for Developing and Adopting Seismic Design Guidelines and Standards for Lifelines*, Federal Emergency Management Agency, FEMA 271, September 1995.

2. *Proceedings of a Workshop on Developing and Adopting Seismic Design and Construction Standards for Lifelines,* edited by Robert D. Dikkers, Riley M. Chung, Bijan Mohraz, H.S. Lew, and Richard N. Wright, National Institute of Standards and Technology, NISTIR 5907, October 1996.

APPENDIX A

ASCE SURVEY ON GUIDELINES FOR LIFELINE SEISMIC DESIGN AND CONSTRUCTION

207 Surveys Mailed
65 Responses Received

32% Response Rate

This survey is intended to identify the activities and interests of stakeholders in the development of seismic guidelines for existing and new lifelines. In answering the questions please note the following lifeline categories:

EP - electric power production and/or distribution
GL - gas or liquid fuel production and/or distribution
HW - highway transportation
AT - air transportation
PH - port/harbor/waterways transportation
RT - rail/transit transportation
TC - telecommunication
WS - water or sewer

1. Does your organization believe that seismic guidelines for existing and new lifelines are desirable?

existing lifelines

yes 60 no 4

non-response 1

new lifelines

yes 64 no 1

2. *Who should develop the guidelines? Please mark more than one if you believe that the guidelines should be developed jointly.*

existing lifelines

a. 49 private and public utilities
b. 23 universities
c. 34 consulting companies
d. 20 product/trade industries
e. 54 prof. societies/tech. associations
f. 40 federal/state/local agencies
g. 3 others:
Joint venture
Individual railroads
ANSI full consensus

new lifelines

a. 52 private and public utilities
b. 29 universities
c. 34 consulting companies
d. 24 product/trade industries
e. 54 prof. societies/tech. associations
f. 43 federal/state/local agencies
g. 3 others:
Joint venture
Individual railroads
ANSI full consensus

3. ***Who should fund the development of guidelines? Please mark more than one if you believe that the guidelines should be funded jointly.***

existing lifelines

a. 48 private and public utilities
b. 5 universities
c. 9 consulting companies
d. 21 product/trade industries
e. 20 prof. societies/tech. associations
f. 55 federal/state/local agencies
g. 4 others:
Port Authorities
ANSI full consensus
Insurance companies
Owner

new lifelines

a. 50 private and public utilities
b. 7 universities
c. 10 consulting companies
d. 22 product/trade industries
e. 22 prof. societies/tech. associations
f. 58 federal/state/local agencies
g. 4 others:
Port Authorities
ANSI full consensus
Insurance companies
Owner

4. ***Is your organization engaged in seismic studies or similar activities related to any of the lifeline categories?*** yes 49 no 16

If yes, circle as many of the categories as appropriate and indicate if the findings are available to the public.

EP	GL	HW	AT	PH	RT	TC	WS
16	14	23	7	16	15	6	28

29 available to the public 9 not available to the public

5. ***Has your organization developed seismic guidelines for existing and/or new lifelines?***
yes 31 no 35

If yes, please circle the appropriate categories and indicate if copies are available to the public.

existing lifelines	EP	GL	HW	AT	PH	RT	TC	WS
	4	4	10	2	8	4	1	14

copies available to the public? yes 12 no 8

new lifelines	EP	GL	HW	AT	PH	RT	TC	WS
	3	5	9	2	5	4	1	14

copies available to the public? yes 12 no 8

6. ***Does your organization plan to develop (or continue to develop) seismic guidelines for existing and/or new lifelines?*** yes 34 no 30

If yes, please circle the appropriate categories and indicate if copies will be available to the public.

existing lifelines	EP	GL	HW	AT	PH	RT	TC	WS
	6	9	12	4	11	9	4	19

will copies be available to the public? yes 15 no 6

new lifelines	EP	GL	HW	AT	PH	RT	TC	WS
	6	8	12	4	10	9	4	18

will copies be available to the public? yes 17 no 4

7. ***Would your organization be interested in participating in the development of comprehensive seismic guidelines for existing and/or new lifelines?***

yes 53 no 10 non-response 2

If yes, **existing lifelines** 48 **new lifelines** 52

APPENDIX B

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APPENDIX C

AGENDA

ASCE Lifeline Policymakers Workshop
Thursday-Friday, January 23-24, 1997
Radisson Barcelo Hotel
Phillips Ballroom
2121 P Street, NW
Washington, DC 20037

Thursday, January 23

8:00-8:45 am	Chairs & Recorders only meet with the Facilitator in Hirshorn Room for breakfast	
8:30-9:00 am	Continental Breakfast	Foyer outside of Phillips Ballroom
9:00-9:05 am	Opening Remarks	James Cooper Chair, Subcommittee 2, Interagency Committee on Seismic Safety in Construction (ICSSC)
9:05-9:15 am	Welcome	Edward Groff President, ASCE
9:15-9:45 am	Keynote Speeches	Joanne Nigg President-Elect, Earthquake Engineering Research Institute (EERI) Lloyd Cluff Manager, Geosciences Pacific Gas and Electric
9:45-10:10 am	Impact of Lifeline Disruption in Recent in Earthquakes	Ian Buckle Deputy Director, National Center for Earthquake Engineering Research (NCEER)
10:10-10:30 am	BREAK	
10:30-11:00 am	Summary of 1991 Denver Workshop on Lifelines	Ronald Eguchi Vice President, EQE International

11:00-11:20 am	The Lifeline Plan *FEMA 271*	Richard Wright Director, Building and Fire Research Laboratory , NIST
11:20-11:30 am	ASCE Lifeline Survey	Thomas McLane ASCE
11:30-11:40 am	Workshop Objectives and Charge to Participants/ Introduction of Facilitator	James Cooper
11:40-12:00 pm	Preparing for Breakout Sessions	Mel Hensey, Facilitator
12:00-1:00 pm	LUNCH	
1:00-2:45 pm	Four Breakout Sessions (A)	Chairs, recorders, and breakout room locations to be announced
2:45-3:15 pm	BREAK	
3:15-3:45 pm	Breakout Session Reports (Phillips Ballroom)	Chairs and Mel Hensey
3:45-5:30 pm	Four Breakout Sessions (B)	Chairs, recorders and breakout room locations to be announced
6:00-7:30 pm	RECEPTION Freer Room	

Friday, January 24

7:45-8:30 am	Continental Breakfast Foyer outside of Phillips Ballroom	
8:30-9:30 am	Breakout Sessions Reports (Phillips Ballroom)	Chairs and Mel Hensey
9:30-10:45 am	Discussions	Mel Hensey
10:45-11:00 am	BREAK	
11:00-11:15 pm	Mitigation and Lifelines: FEMA's Perspective	Margaret Lawless Director, Division of Program Development and coordination, FEMA

11:15-12:15 pm	Development of Consensus and Recommendations	Mel Hensey
12:15-12:30 pm	Closing Remarks	James Cooper
12:30 pm	Adjournment	

APPENDIX D

SUMMARY OF PRESENTATIONS

The presentations were designed to provide the workshop participants an overview of the importance of lifeline systems in the event of a major earthquake, the need for design guidelines for lifelines, the proposed plan for implementing the development of the guidelines, and what was expected to be accomplished at the workshop.

1. Opening Remarks

James D. Cooper, Chief, Structures Division, Federal Highway Administration; Chair, ICSSC Subcommittee 2 - Lifelines and Chair of the Lifeline Policymakers Workshop

I would like to welcome everyone to the workshop. The workshop was organized by ASCE and ICSSC Subcommittee 2 on Lifelines. ICSSC was established to assist federal departments and agencies involved in construction to develop and incorporate earthquake hazard reduction measures in their ongoing programs. It objectives are to a) develop seismic design and construction standards for federal projects, b) develop guidelines to ensure serviceability following an earthquake, c) develop guidelines for the inclusion of earthquake hazard reduction activities in ongoing federal programs, and d) develop strategy to identify existing federal buildings and other structures that pose unacceptable earthquake related risks.

ICSSC has five subcommittees: 1) Standards for New and Existing Buildings, 2) Lifelines, 3) Site Hazards, 4) Federal Domestic Assistance and Regulatory Programs, and 5) Postearthquake Response Activities. The objectives of the Subcommittee 2 on Lifelines are to a) identify existing guidelines or standards for earthquake design, construction, and retrofit, b) recommend federal adoption of guides/standards when found adequate, c) encourage development of new guide/standards when current practices are not adequate, d) study techniques for evaluating seismic vulnerability of existing lifelines, e) provide guidance for appropriate levels of seismic protection, and f) establish liaison with existing professional and industrial groups.

Substantial work has been performed in the area of lifelines. FEMA report 271, "Plan for Developing and Adopting Seismic Design Guidelines and Standards for Lifelines," was submitted to Congress in September 1995, as a recommended National Plan for implementing the development and adoption of lifeline design guidelines. I would encourage everyone in

breakout sessions to offer their thoughts to implement the Plan, as well as to suggest where needed information for guidelines can be found.

2. Welcoming Remarks

Ed Groff, President, American Society of Civil Engineers

As President of the American Society of Civil Engineers, I am pleased to welcome each of you to this Lifeline Policymakers Workshop, hosted by ASCE and funded under a cooperative agreement with the National Institute of Standards and Technology. ASCE is an organization of over 120,000 members. As a profession, civil engineers have been challenged by all types of natural hazards throughout history. Proper functioning of a modern society depends heavily on the continued functioning of its lifeline systems. Disruption of any of these systems would result in tremendously adverse effects on our society, as evidenced by the two most recent earthquakes: the 1994 Northridge earthquake in California and the 1995 Kobe earthquake in Japan.

Unlike building codes, which include seismic provisions, there are no nationally accepted design guidelines for lifelines. As Mr. Cooper mentioned earlier we now have the FEMA report 271, often referred as the Lifeline Plan, that includes a series of recommendations on how to proceed with developing and adopting seismic design guidelines for lifelines. You will hear those recommendations in a short while from Dr. Richard Wright of NIST.

As mentioned by Mr. Cooper the purpose of this workshop is to discuss the Lifeline Plan (FEMA 271) and recommend how to proceed with its implementation through a partnership between the private sector and the federal government. As many of you may know, for 23 years, ASCE, through its Technical Council on Lifeline Earthquake Engineering (TCLEE), has been providing the leadership in the area of lifeline research, post-earthquake reconnaissance, and development of monographs on lifeline practices. I will be meeting FEMA Director, James Lee Witt, next week to continue ASCE's ongoing dialogue with FEMA to help implement its National Mitigation Strategy. Experts are telling us that the key to future natural disaster reduction hinges upon mitigation, which is defined as sustained action taken to reduce or eliminate long term risk to people and property from hazards and their effects, with a focus on actions that produce repetitive benefits over time. In other words, dollars spent on mitigation will significantly reduce human suffering, economic losses, and the future demand for even larger amount of money through disaster relief when natural disasters occur.

I am delighted that ASCE is hosting this workshop with the input of the Interagency Committee on Seismic Safety in Construction, Subcommittee 2 on Lifelines. The workshop signifies an important step toward furthering the private/public partnership, an absolute necessity for developing consensus-based lifeline design guidelines.

3. The Societal Context for Lifeline Policies

Joanne Nigg, Professor of Sociology and Co-Director, Disaster Research Center, University of Delaware; President, Earthquake Engineering Research Institute

I am going to provide you, very briefly, with a societal context for the issues surrounding the topic of this workshop, i.e., how to reduce or prevent impacts to the economic and social systems when lifelines are disrupted by extreme physical events, or disasters.

"Lifelines" refers to a variety of constructed systems that make up the physical infrastructure of our country, providing us with a desirable quality of daily life and supporting our national and local economic activities. These are our "taken-for-granted-systems" that we only begin to notice when their service is disrupted, causing us some type of inconvenience. During this workshop, you are going to be considering how to safeguard these systems from disruption by natural disaster events, as well as by those caused by hazardous technological failures. Whatever the cause of the disruption, these systems need to be physically and organizationally resilient to withstand these impacts, allowing our social and economic systems to continue to operate with some degree of normalcy.

The importance of continuity in the provision of lifeline services has long been recognized. The more resistant these systems are, the more quickly and effectively a community can lessen further life and property losses following the disaster event. The more these systems are able to resist the natural disaster forces, the more quickly and effectively the emergency response phase of a disaster can end, allowing the community to begin recovery process.

Although each new disaster illustrates how fragile these physical and organizational systems can be and provides us with new "lessons learned," few local or state governments have formally integrated lifeline systems in their emergency response plans. Our research at the Disaster Research Center (DRC) indicated that larger companies or agencies have their own disaster response plans. Often, each company has its own operational center which makes restoration

decisions independently. Further, most jurisdictions do not have an understanding of the impacts of lifeline outages on their own ability to respond to community problems. For example, communities need 1) alternative compatible communication systems, 2) backup power generation, and 3) alternative transportation systems or backup plans when key operational employees couldn't get to their assigned stations.

Very little attention has been focused on the secondary social and economic impacts that the continued disruption of these systems has on a community's ability to recover from a disaster. Research at DRC in the past four years indicates that since local governments receive a great deal of their operational income by collecting fees and taxes, the longer it takes the private sector to resume normal operations, the more likely community-based services will have to be cut back, delayed, or eliminated.

One of the surprising findings concerning the impacts of disasters on businesses is that the effect of lifeline-induced losses produce independent effects. That is, even if businesses are not structurally affected by a disaster, they can sustain significant economic loss and disruption due to lifeline service interruption. A case in point was the 1993 Midwest floods in Des Moines, Iowa. Only 15% of the businesses reported that their commercial property sustained direct flood damage. However, 42% were forced to close their businesses for some period. Of these, 63% closed because of loss of water, 42% because of loss of electricity, and 35% because of loss of sewer or wastewater service. Similar examples could be given for recent earthquakes in California, ice storms in the Midwest, and hurricanes along the Atlantic and Gulf coasts. Even when businesses try to prepare themselves and to engage in structural and non-structural mitigation for their own operations, they may still experience significant economic losses due to their reliance on their community's or region's "taken-for-granted" lifeline systems.

As you begin your task today, I would like you to keep in mind one aspect of the policy environment concerning lifeline systems, i.e., the variability both within and across these systems is great. For example, the regulatory environments are quite different, some are exceedingly complex; and the extent to which previous standards and guidelines already exist differs. Further, the size of the companies or agencies operating the same type of lifeline differs greatly, which has implications for the resources and expertise they can be expected to have available to undertake changes. The extent to which different operating companies are dependent on other parts of the system for provision of services to a customer differs, resembling in a "Swiss-cheese" pattern; i.e., some parts of the system may have the most recent innovations and technologies in use while others may be "just getting by" under normal

conditions. Finally, the extensiveness of research on mitigation or rehabilitation techniques for different types of disaster agents varies greatly, as does the research on which techniques are most cost-effective for different levels of risk.

This diversity and unevenness must be kept in mind throughout the workshop in order to develop design guidelines that have a greater likelihood of being used by the large variety of agencies and companies that operate these vital systems. Your challenge is great, but the outcome of your efforts may result in a safer, disaster-resistant local and national infrastructure. Good luck in your deliberations on the next two days.

4. Implementation Plan for Seismic Performance Guidelines

Lloyd Cluff, Manager, Geoscience Department and Director, Department of Research and Development, Pacific Gas and Electric, San Francisco, California; Chair, California Seismic Safety Commission

I would like to share my experiences dealing with development of seismic design guidelines and standards, especially the experiences and knowledge from California and PG&E, as well as comments regarding the Lifeline Plan (FEMA 271). California has adopted seismic guidelines and standards for utilities--gas, electric, telecommunication, and some transportation systems.

PG&E's operation encompasses 75% of the St. Andreas fault system. It has about 3,200 buildings. Any earthquake above Magnitude 7 stands a good chance to damage the PG&E systems in operation. PG&E is self-insured. The company has decided that the premiums paid to the insurers are too high and money is better spent for mitigation efforts. We have recently created a Department of Research and Development. Collectively between the two departments that I am responsible for, we have about $38M that can be used to create opportunities to develop utility earthquake risk reduction programs and to share collective experiences and knowledge. PG&E has recently initiated several efforts with the State of California, with USGS on risk mapping, and with EERI on public education. With regard to the latter, there is no short term solution for educating the public. There are plenty of experts on the factual side, but not many on the value side.

Any plan for developing guidelines and standards has to be cost effective. It needs a lot of hard work as well as strong leadership. It should also focus on issues toward implementation. Other issues need to be considered in the plan are: 1) the need to address regulatory and market-place pressure to reduce costs of improving utility, 2) the process should not be complex, expensive,

and time consuming, 3) applied research is only marginally useful unless it is user driven, and 4) the California process is simple, cost effective, and quick, which can be referred as a model process when implementing a lifeline plan.

5. Impact of Lifeline Disruption in Recent Earthquakes

Ian Buckle, Professor of Civil Engineering, State University of New York at Buffalo; Deputy Director, National Center for Earthquake Engineering Research, Buffalo, New York

Lifelines generally refer to five key categories; water and wastewater systems, transportation facilities (highways, railroads, mass transmit, ports, waterways, airports), gas and liquid fuels, electric power, and communication systems. The U.S. inventory of some selected lifelines are given below:

Rural roads and urban streets	3,906,000	miles
Interstate freeways	45,583	miles
Highway bridges	576,460	
Mass transit	6,939	million passenger miles
Railroads	1,200,000	million ton-miles freight
Airports	17,671	civil and general aviation
Water	58,999	community water systems
Electric power	4,551	stations and substations
	276,238	miles transmission lines
Gas and liquid fuels	48,193	miles crude oil pipelines
	53,413	miles refined oil pipelines
	42,436	miles natural gas pipelines

The 1971 San Fernando earthquake in Southern California was a wake up call on the significance of lifelines and also the beginning of the ASCE Technical Council on Lifeline Earthquake Engineering (TCLEE).

Lifeline vulnerability may be viewed from the following perspectives. First, buried lifelines are sensitive to permanent ground deformation and spatial variation in soil types and ground motion. Components of some lifelines, especially older ones, are not ductile and have little reserve capacity for unintended loads. Further, some lifeline networks are surprisingly fragile

despite redundancy, such as bridges across river. Collocation and interdependence of different lifelines can also disrupt an otherwise hardened lifeline.

Consequences resulting from disruption of lifeline services include direct loss of life, direct loss of property, secondary losses due to interruption of services and loss of access, inability to respond to secondary catastrophes such as fire and medical crises, release of hazardous products, and disruption of local and global business and/or trade.

The most vivid example of the lifeline impact is from the poor lifeline performance during the 1995 Kobe earthquake in Japan. Kobe is the 6th largest container port in the world. Its major industries include steel, sake, footwear, electronics, fashion, shipbuilding, beef, and tourism. Approximately 1.27 million households were without water after the earthquake; however, 99% of the water supply was restored in 60 days. Nearly 900,000 customers lost their gas services; 99% of them were restored in 75 days. About 2.6 million customers lost their power supply; 80% regained the use of it in 36 hours.

Spectacular failures were shown by the damage to elevated transportation systems and the port facilities. Forty five miles of elevated freeway were damaged. Three commuter rail lines and Shinkansen railway closed due to collapsed structures. All rail lines and highways (except Hanshin Expressway Public Corporation Route 3) were opened for traffic in three months. Nevertheless, before that the lost revenue was $2M per day, including both road and rail. In the Port of Kobe, more than 35 container cranes on Port and Rokko Islands were damaged, along with 5 miles of quay damage due to lateral spreading up to one meter. It was estimated that the Japanese authorities were able to restore 75% of the port's capacity in 12 months.

Some of the key issues related to the state of the art practices in lifeline earthquake engineering are 1) seismic design and/or retrofit of lifelines are not mandatory, 2) voluntary standards were adopted only by some agencies, 3) design aids and manuals are rare, 4) system performance assessment methodologies are required, and 5) cost-effective design and retrofit methodologies are lacking.

There are no current studies to demonstrate the benefit of using modern design methods for lifelines. However, there is one study in the building area. A recent Obayashi Corporation survey, correlating the Japanese building codes with the percent of buildings red-tagged, showed a strongest indication of the benefits of modern code adoption and enforcement. This finding can be a powerful argument for the need to develop consensus-based lifeline design

guidelines utilizing modern design and construction practices. I am looking forward to the deliberations in the next two days.

6. Plan for Developing and Adopting Seismic Design Guidelines and Standards for Lifelines -- Summary of the 1991 Denver workshop on Lifelines

Ronald T. Eguchi, Vice President and Director, Center for Advanced Planning and Research, EQE International, Inc.

When we first began this effort some six years ago, we hadn't experienced the Northridge or Kobe earthquakes. A lot has changed since our initial efforts; however, the need for developing and adopting seismic design guidelines and standards for lifelines remains the same. The 1991 workshop was instrumental in forming the basis of the plan that we will be discussing today.

Before I discuss the details of the 1991 workshop, I thought I would use the following to provide a brief chronology of the events that have shaped our understanding of lifelines and earthquake:

Year	Milestones
1971	**San Fernando earthquake (M6.4)**--First attention to the performance of lifeline systems--the birth of lifeline earthquake engineering.
1974	**Formation of the Technical Council on Lifeline Earthquake Engineering (TCLEE)**--Formed to promote a forum for engineers and researchers to discuss issues affecting lifeline earthquake engineering.
1985	**BSSC Workshop**--Also held in Denver. It addressed four major areas: (1) public policy and legal and financial strategies, (2) information transfer and dissemination, (3) emergency planning and (4) scientific and engineering issues. Published a report, "Abatement of Seismic Hazards to Lifelines - An Action Plan."
1986	**Establishment of the National Center for Earthquake Engineering Research (NCEER)**--One of its focuses has been on lifeline interaction issues and estimation of indirect losses caused by a disrupted lifeline service.
1989	**Loma Prieta earthquake (M7.1)**--Tested design procedures initiated after the 1971 San Fernando earthquake.
1990	**Public Law 101-614**--Required FEMA to work with NIST to develop a plan for developing and adopting design and construction standards for lifelines.

1991	**Workshop sponsored by NSF & NCS**--The first workshop focused on the performance of communication systems.
1991	**Lifeline Standards Workshop**--to be discussed later
1994	**Northridge earthquake (M6.7)**--Allowed the examination of the effectiveness of mitigation programs begun after the 1971 San Fernando earthquake.
1995	**Kobe earthquake (M6.9)**--Allowed us to look at the effects of a catastrophic earthquake, particularly with respect to the impact due to the disruption of lifeline systems.
1995	**FEMA/NIST Plan for Developing and Adopting Seismic Design Guidelines and Standards for Lifelines**--FEMA report 271 was submitted to Congress in September 1995.
1997	**ASCE Lifeline Policymakers Workshop**--Solicit input from stakeholders on how to implement the Plan developed by FEMA/NIST.

Now let me get back to present to you in more detail the 1991 Denver Workshop. The workshop focused on five lifeline areas based on the lifeline type and one policy area to focus on implementation issues. Each area was headed by a plan author who was charged with developing the initial plans and recommendations. These authors were:

Electric power	Anshel J. Schiff, Precision Measurement Instruments and Stanford University
Gas & liquid fuels	Douglas J. Nyman, D.J. Nyman & Associates
Telecommunication	Alex Tang, Northern Telecom
Transportation	Ian G. Buckle, SUNY - Buffalo and NCEER
Water & Sewer	Donald B. Ballantyne, Kennedy/Jenks Consultants
Federal roles in development, adoption, and implementation	H. Crane Miller, Attorney at Law

There was strong involvement of TCLEE in the workshop; over half (30 of 52) participants were TCLEE members.

The workshop objectives were to 1) introduce the FEMA/NIST lifelines Standards Development Plan, 2) present "commissioned" papers on proposed plan development for each

lifeline system, 3) discuss federal roles in implementing the plan, 4) obtain input from workshop participants in prioritizing development tasks and establishing "order of magnitude" budgets, and 5) produce a workshop proceedings that would serve as background material for a Plan to Congress.

The work plan, that the authors developed their writeup from, focused on four areas: policy statement/philosophy, system performance standards, element standards, and equipment material standards. Policy statement/philosophy defines what seismic hazards should be considered, what system performance levels are appropriate for each lifelike system. Response issues were also considered. System performance standards define procedures for evaluating system performance and assess whether the desired levels of performance identified above can be met. Element standards focus on element or component performance standards for both new and existing elements or components. These standards are largely based on the objectives set forth for the system. Equipment and materials standards establish seismic design criteria for new equipment and materials.

The following recommendations were developed at the workshop:

1. Address design and construction issues as well as planning and emergency response questions--examining emergency response issues is important because there are many actions that can be taken to facilitate the restoration of damaged lifeline systems.
2. Focus on both new and existing construction--It is important to ensure prudent design and construction for new facilities, but the biggest risks lie with existing facilities. Innovative approaches will have to be developed for existing facilities to ensure that mitigation efforts are implemented.
3. Emphasize system performance standards--These standards must concentrate on those elements that are critical for providing continued service.
4. Identify participants/stakeholders in standard development process--this is critical to insuring a well accepted plan and process.
5. Provide timetables and budgets for all research and development activities--They are established to ensure a manageable program.
6. Recommend that an "umbrella" lifeline standards group be formed to monitor and coordinate the standards development process

The workshop participants also developed a recommended funding structures for each lifeline system:

Power	$ 5.0 M
Gas and Fuels	5.9
Telecommunication	6.8
Transportation	31.3
Water & Sewer	5.7
Total	$ 54.7 M

The budgets shown include a combination of research efforts, demonstration projects, and education and dissemination programs.

Finally, I would like to offer my visions for the year 2000 in terms of the status of lifeline earthquake engineering. I would expect that we will reach consensus on appropriate lifeline system performance measures and goals, that standards will be developed and adopted by all public lifeline agencies in moderate to high seismic hazard zones, that earthquake standards will be integrated with those for other natural hazards, that public/private community partnerships will be formed to achieve long-term lifeline risk reduction goals, that research program will be established to examine timely lifeline performance issues, and that a lifeline council will be formed to implement the FEMA/NIST Plan.

7. Plan for Developing and Adopting Seismic Design Guidelines and Standards for Lifelines (FEMA 271)

Richard N. Wright, Director, Building and Fire Research Laboratory, National Institute of Standards and Technology

Lifelines are public works and utilities that include systems of electric power, gas and liquid fuels, telecommunications, transportation, and water supply and sewage. The impact on a community resulting from the disruption of lifeline systems has been illustrated by several previous speakers. They have also mentioned the needs for developing and adopting seismic design guidelines for lifelines. As presented in FEMA 271, Developing and Adopting Seismic Design Guidelines and Standards for Lifelines, these guidelines should focus on increasing our ability to improve the performance of existing lifelines since they dominate the risk of losses. Performance criteria should consider design, construction, and operation phases of the lifelines. These criteria should serve as the basis for specifications of buyers as well as sellers. Likewise they should be the basis for regulations for public health, safety, and welfare.

Development and adoption of seismic design guidelines should involve the whole lifeline community: owners, manufacturers and suppliers, design professionals, general and specialty contractors, researchers, and governments. The approach to their development should focus on priority needs and begin drafting guidelines from existing knowledge and practices. Once drafted, the guidelines should be tried out through demonstration projects for their adequacy, as well as for identifying knowledge gaps where further research efforts should be placed. They should be updated through the experiences gained from using them and through problem-focused research. And finally, the guidelines should be standardized and maintained through mechanisms of existing
standards development organizations.

Successful execution of FEMA 271 requires effective management and coordination formulated through a private sector Lifeline Seismic Safety Executive Board (LESSB). Under LSSEB, there will be a Directorate for each type of lifeline. ICSSC will provide representation of federal agencies. Funding for LSSEB should be provided by federal agencies with responsibilities for lifelines. Program management and technical support responsibilities for the Board are assigned to NIST. Although the level of funding is not addressed in FEMA 271, our original discussions when putting the report together indicated that $1M in Year 1, $3M in Year 2, and $4M in Years 3 and 4 are needed to properly execute the Plan.

8. Mitigation and Lifelines: FEMA's Perspective

Margaret Lawless, Director, Division of Program Development and Coordination, Mitigation Directorate, Federal Emergency Management Agency

I would like to discuss with you FEMA's role in hazard mitigation and lifelines. First, let me state that FEMA is supportive of NIST's role in lifelines. What is being discussed in this workshop fits well with FEMA's concerns. Repair and mitigation of infrastructures, which include lifelines, constitute one of the largest drains on our disaster funding resources.

FEMA's role in lifelines in the past has mostly been centered on post-disaster relief. FEMA delivers post-disaster assistance for lifelines under two primary sections of the Robert T. Stafford Disaster Relief and Assistance Act, as amended. Under Section 406 of the Act, FEMA's programs center on repair and mitigation of specific, damaged projects, including infrastructure such as lifelines, that are owned by government entities or eligible private non-

profit organizations. Under Section 404 of the Act, FEMA's mitigation program is broader and may be used, within certain guidelines, for damaged or undamaged projects and other mitigation efforts, whether or not they are related to the hazard that caused the declared disaster under which the funding is being made available. Under Section 404 of the Act, priorities must be set by the State.

Since Mr. Witt has been the Director, FEMA's mitigation programs emphasize more creativity and more public buy-in. The idea is not to focus assistance solely on the traditional methods of providing relief after a disaster but rather, encourage pre-disaster mitigation. FEMA does not want to go back to a community year after year to provide disaster relief. Pre-disaster mitigation is where we need to put more of our efforts and resources. Director Witt has discussed with Congress concepts concerning how we should do that. One idea is to use a portion of the Disaster Relief Fund for pre-disaster mitigation.

Listening to the workshop participants this morning, I hear a clear call for FEMA to take a lead role in the lifeline arena. Of course, since both the President and the Congress are trying to balance the budget, FEMA, like all federal agencies, is operating in a context of budget restraint. So while I can't guarantee anything, I will discuss the participants' recommendations and funding possibilities with the FEMA management.

9. Closing Remarks

James D. Cooper, Chief, Structures Division, Federal Highway Administration; Chair, ICSSC Subcommittee 2 - Lifelines and Chair of the Lifeline Policymakers Workshop

Where do we go from here and what do we do with the information generated at this workshop? We need some kind of strategy -- short term and long term -- and we have several opportunities to use the results and the recommendations of this workshop.

In the short term, we should prepare a report (an Action Plan) and submit it to FEMA, the lead agency in NEHRP and NEP. NEHRP Reauthorization hearing is in April and FEMA may decide to incorporate the workshop recommendations in their report. The report should also be submitted to other NEHRP and NEP agencies, ICSSC, and the private sector stakeholders in lifelines. Next Tuesday (January 28, 1997) morning, Ed Groff, ASCE President, will meet with James Lee Witt, FEMA Director, as part of ASCE and FEMA on going discussions on hazard mitigation. Mr. Groff will discuss the consensus reached at the workshop with Mr. Witt. It is also important to obtain some "seed" funding to support a paid staff to bring the

private and public sectors together, seek additional resources, and begin the process of guideline development and implementation.

In the long term we must work through NEHRP and NEP process to advance the state of practice in lifeline earthquake engineering. I look forward to working with each of you in the future as we strive to raise the level of seismic safety in our nation's lifeline facilities. Thank you for your participation.

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