UNITED STATES

DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

PROCEEDINGS OF CONFERENCE XVIII

A WORKSHOP ON "CONTINUING ACTIONS TO REDUCE LOSSES FROM EARTHQUAKES IN THE MISSISSIPPI VALLEY AREA"

24-26 MAY, 1982
ST. LOUIS, MISSOURI

Reston, Virginia
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CONVENED UNDER AUSPICES OF NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM

SPONSORED BY THE U.S. GEOLOGICAL SURVEY AND THE FEDERAL EMERGENCY MANAGEMENT AGENCY

CONVENOR AND CHAIRMAN OF THE STEERING COMMITTEE

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COMPILED BY
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Reston, Virginia
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by
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Reston, Virginia

INTRODUCTION

The U.S. Geological Survey and the Federal Emergency Management Agency sponsored a workshop on, "Continuing Actions to Reduce Losses from Earthquakes in the Mississippi Valley area," in St. Louis, Missouri, on May 24-26, 1982. Seventy individuals (see Appendix A) representing local, State, and Federal government; business and industry; and the research community participated in the three day workshop. Collectively, the participants had backgrounds in disaster preparedness, disaster response and recovery, geology, geophysics, seismology, engineering, architecture, social science, law, insurance, and land-use planning. Two-thirds of them came from the Mississippi Valley area; about one half of these had also attended an earlier USGS-FEMA workshop held in Knoxville, Tennessee on September 16-18, 1981 (Hays, 1982).

The St. Louis workshop is the 18th in the continuing series of conferences and workshops which the Geological Survey initiated in 1977 to improve the transfer and application of research results throughout the Nation. It is the second workshop to focus on dealing with the earthquake threat in the Eastern United States. The first one, "Preparing for and Responding to a Damaging Earthquake in the Eastern United States," was held in Knoxville, Tennessee, and emphasized the development of a draft 5-year plan to improve the state-of-earthquake-preparedness. The Knoxville workshop demonstrated that policymakers and members of the scientific-technical community can assimilate and synthesize a great deal of information and work together to devise practical plans. The St. Louis workshop, a sequel to the Knoxville workshop, identified those actions out of the range of possible actions which are most achievable; that is, the actions having the highest

payoff and the lowest cost and effort requirements. These action plans, which identify steps that can be undertaken immediately to reduce losses from earthquakes in each of the seven States in the Mississippi Valley area, are contained in this report. The draft 5-year plan for the Central United States, prepared in the Knoxville workshop, was the starting point of the small group discussions in the St. Louis workshop which lead to the action plans contained in this report. For completeness, the draft 5-year plan for the Central United States is reproduced as Appendix B.

The 1811-1812 Earthquakes - The St. Louis workshop served as a reminder to the local populace as well as to the Nation that the Mississippi Valley is subject to the earthquake hazards of ground shaking, ground failures and tectonic deformation. This area experienced three great[1] earthquakes (magnitude of 8 or greater) in the Winter of 1811-1812. These earthquake were centered near New Madrid, Missouri, a town of about 3,100 people in 1811. They caused ground shaking that not only virtually destroyed New Madrid, but also was felt over an area of about 2 million square miles (Figure 1). According to reports, residents in the New Madrid area were aroused from their sleep by the rocking of their log cabins, the cracking of timbers, the clatter of breaking dishes and tumbling furniture, the ratting of falling chimneys, and the crashing of falling trees. New Madrid sank 15 feet and tectonic deformation (the characteristic feature of a great earthquake) took place over a vast area between the confluence of the Ohio and the Mississippi Rivers on the north and Memphis, Tennessee, on the south. Forests were flattened. Chasms opened so wide that people had to fell trees to get across them. Land over a broad area sank and was flooded to depths of several feet. Steep banks collapsed along the Mississippi River and rapids formed. The river even reversed its direction of flow for awhile.

Estimates of the casualties in 1811-1812 are unreliable. The prevailing belief is that only a few of the settlers died, but some of the hundreds of

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1 The last great earthquake to affect the United States was the 1964 Prince William Sound, Alaska, earthquake. It caused widespread tectonic deformation and ground failures. Estimates of economic loss were in the $500 million range.

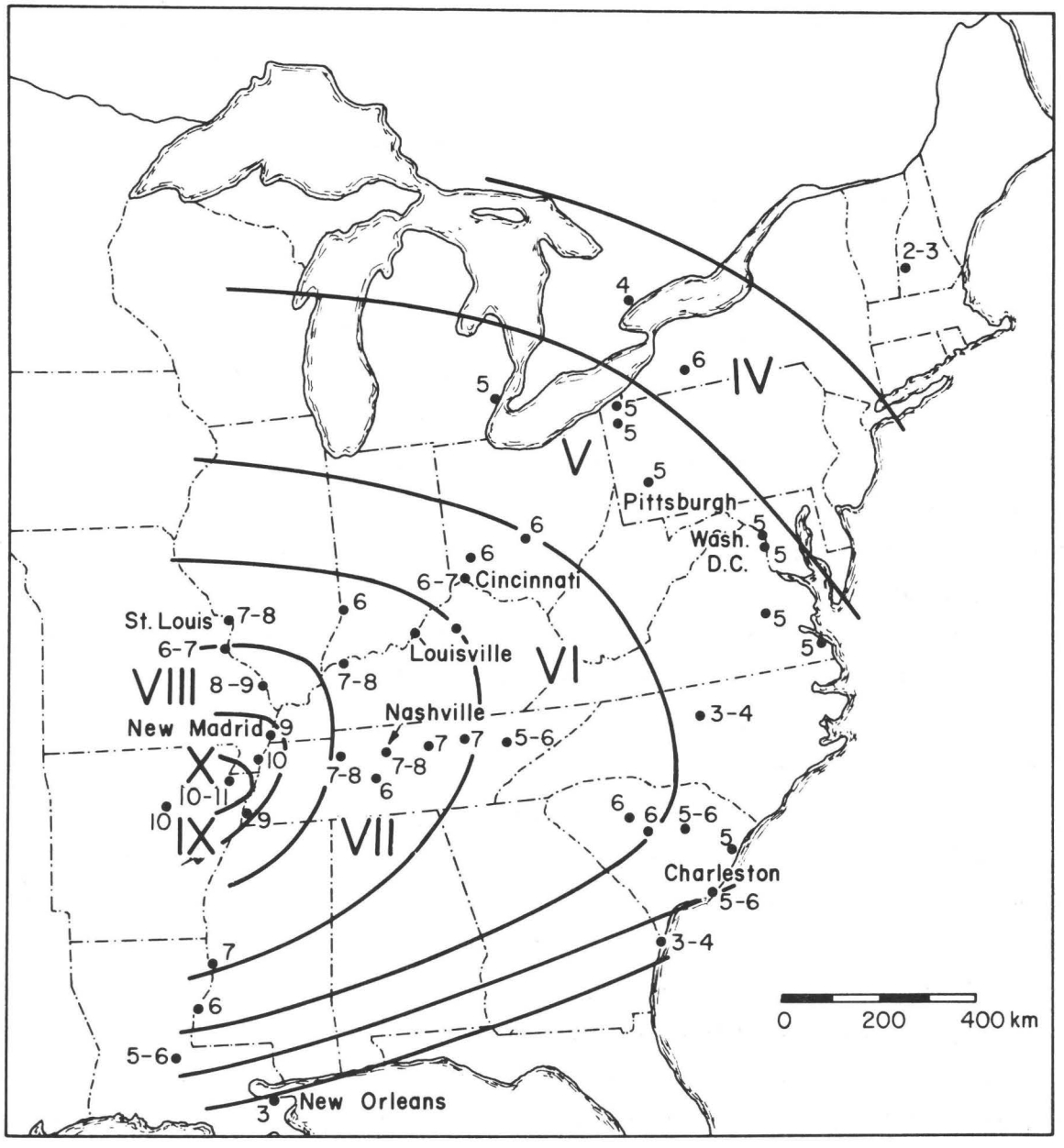

Figure 1.--Generalized isoseismal map of the earthquake of December 16, 1811. Values are in terms of Modified Mercalli intensity and are explained in Appendix C. (From Nuttli, 1973, Bulletin of the Seismological Society of America, V. 63., p. 230).

people who were traveling or transporting goods on the river may have been killed. Hundreds of aftershocks continued intermittently for more than a year. They demoralized the inhabitants, causing many to abandon the area as their home. The most lasting effects of these great earthquakes are the extensive lowlands or "sunken lands" of northeastern Arkansas, southeastern Missouri, and northwestern Tennessee. Reelfoot Lake, in Tennessee, was enlarged and deepened by the quakes. Near Blytheville, Arkansas, an area of more than 25 square miles was covered by about three feet of extruded sand (sand boils) that came from sand deposits 50 feet or less below the surface.

Recurrence of the 1811-1812 Earthquakes - An important fact--that destructive earthquakes will occur again in the Mississippi Valley--was reemphasized in the St. Louis workshop. It called attention to the fact that if the 1811-1812 earthquakes recurred today, the impact would be devastating because of the large population (about 33 million) and building wealth that are now exposed to the potential earthquake hazards of ground shaking, ground failure, surface faulting, and tectonic deformation. Building losses from ground shaking alone are estimated to exceed 13-14 billion--possibly reaching $40 billion (Thiel and Morelli, 1981). An area of about 200,000 square miles in the epicentral region, encompassing portions of seven States (Missouri, Arkansas, Mississippi, Tennessee, Kentucky, Indiana, and Illinois), would experience strong ground shaking and damage rated as Modified Mercalli intensity VII or greater (See Figure 1 and Appendix C). Moreover, high rise buildings located as much as 500 miles away from the epicenter could also be damaged by the long-period, nearly sinusoidal components of ground motion that decay slowly as distance from the causative fault increases. Approximately 15 percent of the Nation's work force and more than 15 percent of the Nation's wholesale businesses are located in the seven States. A great earthquake would potentially affect production and distribution of: farm supplies, meats, dairy products, seafood, beer, auto parts, electronic parts, heating and air conditioning, clothing, drugs, and furniture. Pipelines transporting natural gas and petroleum products from Mississippi, Texas, and Louisana to the Central and Northeastern United States could be seriously damaged in the intense zones of ground shaking, ground failure, tectonic deformation and potential surface fault rupture. Lifeline systems[2] in the communities throughout the Mississippi Valley area could be damaged, causing serious social problems. Dams could fail, resulting in

extensive loss from flooding. The overall losses could greatly exceed any past loss the Nation has had with a natural hazard.

WORKSHOP PROCEDURES

In both the Knoxville and the St. Louis workshops the key was to provide the participants, some of whom had never met before, an opportunity to hear suggestions from experts, to discuss interactively the nature and scale of the earthquake threat in the East, and to devise action plans for facing it in their State or region. An important strategy was adopted in the Knoxville workshop--to follow the conference on Earthquakes and Earthquake Engineering: The Eastern United States. The proceedings of this conference (Beavers 1981) established a common level of background knowledge. In the St. Louis workshop, five action plans were prepared--one each for Missouri, Tennessee, Kentucky, Indiana-Illinois, and Arkansas-Mississippi. The reference or starting point for each action plan was the draft 5-year plan, "Preparing for and responding to a damaging earthquake in the Central United States," developed at the Knoxville workshop (see Appendix B). Each action plan expanded and refined the draft 5-year plan, emphasizing those actions that can be undertaken immediately, with a minimum of cost and effort, to improve the state-of-earthquake-preparedness. The individual plans were developed through interactive discussions of about a dozen people representing a specific State (or States). Three types of plenary sessions were used to stimulate all the participants before formation of the small groups. These sessions included:

1) A series of background papers by local experts, emphasizing:

   a) **Earthquake Hazards and Risk** - Nuttli emphasized the scale and nature of the potential earthquake hazards (ground shaking, ground failure, tectonic deformation, and surface faulting) and risk (chance of loss) in the Mississippi Valley area. He described

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2 Lifeline systems include a) energy (electricity, gas, liquid fuel, and steam), b) water (portable, flood, sewage, solid waste, and firewater), c) transportation (highway, railway, airport, harbor, and transit), d) communication (telephone, telegraph, radio, television, mail and press).

what is known about the hazards and suggested ways for reducing potential losses.

b) **The Political Process**- Atkisson suggested specific actions to improve the political process in the Mississippi Valley area, both before and after the socioeconomic impacts of a major earthquake. He noted the hard realities of the political process and cited experience from other geographic areas.

c) **Experience with Regional Earthquake Planning in the Memphis Area** - Mann gave an evaluation of what has been learned after more than a decade of experience in the Memphis, Tennessee, area. He indicated the importance of technical and political considerations, confirming many of Atkisson's observations.

2) Six panel discussions on selected themes using local and national experts:

a) The panel of Mann, Danna, and Leyendecker discussed various aspects of the theme; "What can be realistically achieved with regard to earthquake-resistant design of new buildings, lifeline systems, and the renovation of existing facilties?"

b) The panel of Keefer, Smith, and Mushkatel presented information on the theme "How to gain the attention and commitment of the political leadership at the State and local level."

c) The panel of Given, Beavers, and Prud'homme addressed the theme, "How to gain the attention and commitment of business and industry."

d) The panel of Whitehead, Popkin, and Schiff described their experiences in terms of the theme, "How to gain the attention and commitment of public service organizations, volunteer agencies, and professional societies."

e) The panel of Hartsough, Nigg, Palm, and Metzger suggested some of the priorities in terms of the theme, "A targeted program of public education."

f) The panel of Finley, Adams, Wiman, Newhouse, and Begley addressed the theme, "the role of the mass media."

3) Interactive discussions

a) Patrick Breheny, Director of FEMA, Region VII presented the objectives, milestones, and status of the FEMA Earthquake Vulnerability Study in the Central United States.

b) Mansfield, Smith, Dallenbach, Gurley, Craighead, and Miler described the initial experiences of Kentucky, Tennessee, and Missouri in the FEMA Earthquake Vulnerability Study in the Central United States.

c) Claire Rubin lead a discussion to evaluate the need and possible functions of a seismic safety organization in the Central United States.

d) Papers for each of these presentations are included in this report. The reader may refer to each individual paper for details.

THE NEXT STEP

The St. Louis workshop, like the Knoxville workshop, marks the beginning of a long-term endeavor to strengthen the capability and resolve of the public officials and the scientific-technical community of the Eastern United States to reduce losses from earthquakes. It is important to realize that scientists and engineers have different perspectives than decisionmakers. These differences, which were identified by Szanton (1981) and are summarized in Table 1, can affect decisions about earthquake-resistant design, unless steps are taken to make the differences as small as possible. Additional meetings

are needed to advance the complex process of improving the state-of-earthquake-preparedness in the Eastern United States and are being planning in 1983 for the Boston, Massachusetts, and Charleston, South Carolina, areas.

The draft action plans prepared in the St. Louis workshop follow this summary paper. These plans provide specific ideas for reducing losses from earthquakes in each of the seven States in the Mississippi Valley area.

Table 1.--Differences in the perspective of scientists-engineers and decisionmakers (from Szanton, 1981).

ATTRIBUTES	PERSPECTIVES	
	SCIENTIST/ENGINEER	DECISIONMAKER
1. Ultimate objective	Respect of peers	Approval of electorate
2. Time horizon	Long	Short
3. Focus	Internal logic of the problem	External logic of the problem
4. Mode of thought	Inductive, generic	Deductive, particular
5. Most valued outcome	Original insight	Reliable solution
6. Mode of expression	Abstruse, qualified	Simple, absolute
7. Perferred form of conclusion	Multiple possibilities with uncertainties emphasized	One "best" solution with uncertainties submerged.

ACKNOWLEDGEMENTS

A special note of appreciation is extended to each of the following people for their contributions to the workshop.

- The Steering Committee of Dr. Walter Hays (USGS), Ugo Morelli (FEMA), Dr. Otto Nuttli (St. Louis University), Jerry Mansfield (Special Representative of the Governor of Kentucky), Clarke Mann (Consulting Engineer, Memphis), Jim Beavers (Union Carbide Corporation), Claire Rubin (Academy for State and Local Government), and Susan Tubbesing (Natural Hazard Research and Applications Information Center), planned and organized the workshop.

- Clarke Mann suggested the concept of achievable implementation which was adopted as a key strategy of the workshop.

- Dr. Daniel Barbee (Academy for State and local Government) provided expert advice and guidance to the Steering Committee on the program and the group dynamics process. He implemented this advice as the overall facilator of the workshop.

- Dr. Otto Nuttli made the local arrangements for the workshop utilizing the conference facilities of St. Louis University and Cuzzins Gallery.

- The participants who joined in the plenary sessions and the small discussion groups were the key to the success of the workshop. Their vigorous and healthy exchange of ideas made the workshop practical and interesting. They are the key to the future implementation of the achievable action plans in the Mississippi Valley area.

- Carla Kitzmiller, Susan Pitts, Cheryl Miles, Joyce Costello, and Wanda Seiders of USGS provided strong and capable administrative support.

REFERENCES

Beavers, J. E., 1981, Earthquakes and Earthquake Engineering: The Eastern United States: Ann Arbor Science, Ann Arbor, Michigan, 2 vols.

Hays, W. W., (ed., 1982), A Workshop on "Preparing and Responding to A Damaging Earthquake in the Eastern United States," Knoxville, Tennessee, September 1981, Proceedings of Conference XV, U.S. Geological Survey Open-File Report 82-220, 197 p.

Nuttli, O. W., 1973, A Mississippi Valley Earthquake of 1811-1812, Intensities, Ground Motion, and Magnitudes: Seismological Society of American Bulletin, v. 63, p. 227-248.

Szanton, Peter, 1981, Not Well Advised: Russell Sage Foundation and Ford Foundation, 81 p.

Thiel, Charles C., and Morelli, U., 1981, Enhancing Seismic Safety in the Central United States, in Hays, W. W., ed., A Workshop on "Preparing for and Responding to A Damaging Earthquake in the Eastern United States," Knoxville, Tennessee, September 1981, Proceedings of Conference XV, U. S. Geological Survey Open-File Report 82-220, p 151-174.

ACTIONS TO IMPROVE THE STATE OF EARTHQUAKE PREPAREDNESS IN MISSOURI

by

Ken Craighead
State Emergency Management Agency
Jefferson City, Missouri

FOREWORD

This draft action plan contains recommendations of achievable actions for improving the state-of-preparedness in Missouri. It was developed in discussions among members of the Missouri working group at the workshop held in St. Louis, Missouri, May 24-26, 1982. These recommendations refine the draft 5-year plan developed at the Knoxville, Tennessee, workshop and represent high priority actions which can be implemented with relatively small cost and effort. The membership of the working group included:

Frank Begley	FEMA, Region VII
Rex Bohm	Missouri Geology and Land Survey
Patrick Breheny	FEMA, Region VII
Kenneth Craighead	Missouri State Emergency Management Agency
Harvey Gillerman	Gillerman Associates
Bob Herrman	St. Louis University
Lloyd Miler	Southeast Missouri Civil Defense Asso., Inc.
Brian Miller	Cape Girardeau County Emergency Preparedness
June Miller	American Red Cross
Arthur Monsey	Hornet and Schrifrin Consulting Engineers
Otto Nuttli	St. Louis University
Jerry Vineyard	Office of Missouri State Geologist
Ugo Morelli	FEMA, National Office
Dave Gordon	U.S. Geological Survey
Arthur Atkisson	University of Wisconsin
Donna Higgenbotham	St. Louis, Missouri

Charles Lindbergh	The Citadel, South Carolina
Mary Comerio	University of California at Berkeley
Richard Sanderson	FEMA, National Office

ESTABLISH AN EXPANDED MISSOURI SEISMIC SAFETY PANEL

The consensus of the discussion group was that the Missouri "Seismic Safety" panel should be reestablished, with a much broader overall conception of the problem. The panel's goals and objectives would need to be broadened also. Instead of dealing mainly with what to do following an earthquake, more emphasis should be given to mitigation of the earthquake hazard, which would include building codes, introduction of seismic safety features in construction, and a more concentrated effort of making public officials aware of the problem. Priority issues for the panel would include: education of the public, promotion of seismic safety, review of present building codes, and the establishment of new codes.

The suggested approach would be to use the Missouri State Emergency Management Agency to host this "Seismic Safety" panel and to obtain the support of the office of the Governor. The main strategy is to revitalize and restore the panel, with the expanded goals, and to add to the membership of this panel by including architects, engineers, and other professionals.

The immediate issue to address is that of obtaining the support and assistance of the appropriate State agencies so that official recognition is received. When this recognition is received, the panel would be able to begin work. The first item of business would be to hold an earthquake awareness workshop in Southeast Missoui, with the first phase for public officials and a second phase for business and industry.

Issues to be Addressed by the Seismic Safety Panel

Earthquake-resistant design

The general consensus of the group was that the geotechnical community believes that an earthquake problem exists. However, due mainly to

economic reasons, most building engineers and architects tend to overlook or ignore the earthquake problem. The main reason seems to be that the additional cost would be a penalty, when other engineers and architects are willing to design a building without the earthquake-resistant features. If the seismic design provisions of building codes are required through legislation, most engineers and architects would design earthquake-resistant features with little argument.

Another problem similar to the previously mentioned one is that the general public, at this time, is not willing to tolerate more restrictive building codes in their communities. Most local governments, city councils, and county courts are not willing to restrict the building codes by introducing earthquake-resistant features into the codes. They feel that the cost would be prohibitive; it would cause industry to move out of the area or be unwilling to build in their community.

Encourage earthquake-resistant design

State and local governments should request through the American Society of Civl Engineers (ASCE) and American Institute of Architects (AIA) to endorse a paper emphasizing the need for more restrictive codes. Also, official requests from the Governor for seismic safety regulations would be an additional encouragement.

The State should take advantage of FEMA's contract with the Building Seismic Safety Council to test, by trial designs, a set of seismic building provisions that will then be promulgated for the voluntary use of State and local officials, model-building code formulators, and other interested parties.

Another recommendation is to get the technical community aware of seismic safety standards before taking the awareness and public information campaign to the officials in local and State government. By addressing the problem in this way, it is felt that some architects and engineers will encourage the people who hire them to include the seismic safety features in the building designs, by

explaining to them that it will be less prohibitive to include these features now instead of having to retrofit at a later date.

Public Information

Activities in conjunction with hazard awareness and education need to start with local people telling their own community about the need for seismic safety, rather than outside or professional individuals trying to force it upon the citizens. In other words, if a local community leader can be made aware of the seismic problem and the need for seismic safety standards, they can then work through the local community to inform the general public of the need of having seismic regulations enacted on the local level.

The Executive Directors of the Missouri Association of Counties and the Missouri Municipal League should be approached and a request should be made to attend one of their regularly scheduled meetings to give a presentation on earthquake hazards, risk, and seismic safety.

A workshop explaining the earthquake threat should be planned

A letter should be written by the Missouri State Emergency Management Agency and the Department of Natural Resources, Division of Geology and Land Survey to invite high level city and county officials from seismic risk zones 2 and 3 (as defined by the Uniform Building Code) to attend a meeting that would explain the risk (chance of loss), the need for restrictions on buildings in each area consistent with the level of seismic risk, and the need for seismic design provisions in building codes.

Seismic Safety Commission should increase hazard awareness

Important actions that can be taken include:

1) Designate a contact person to work with local officials. This person should be familiar with local officials and familiar with the problems of earthquakes and seismic safety.

2) Develop a prototype seismic zonation plan for local officials to use to formulate their own plans.

ACTIONS TO IMPROVE THE STATE OF EARTHQUAKE PREPAREDNESS IN TENNESSEE

by

James E. Beavers

Union Carbide Corporation

Oak Ridge, Tennessee

FOREWORD

This draft action plan contains recommendations of achievable actions for improving the state-of-preparedness in Tennessee. It was developed in discussions among members of the Tennessee working group at the workshop held in St. Louis, Missouri, May 24-26, 1982. These recommendations refine the draft 5-year plan developed at the Knoxville, Tennessee, workshop and represent high priority actions which can be implemented with relatively small cost and effort. The membership of the working group included:

James E. Beavers	Union Carbide Corporation
Mike Banker	Allen & Hoshall, Inc.
Don Dallenback	Tennessee Emergency Management Agency
Tom Durham	Tennessee Emergency Management Agency
James R. Gurley	Civil Defense and Emergency Management
Frank Hand	Tennessee Valley Authority
Edward Luther	Tennessee Geological Survey
O. Clarke Mann	O. Clarke Mann Consulting Engineer
Ann Metzger	Tennessee Earthquake Information Center
Paula Gori	U.S. Geological Survey
Joanne Nigg	Arizona State University
Edgar Leyendecker	National Bureau of Standards
Anthony Prud'homme	Atlantic Richfield

NEEDS

More information is needed concerning the earthquake threat, the risks, and mitigation procedures. The Tennessee group looks toward the U.S. Geological Survey (USGS) and the Federal Emergency Management Agency (FEMA) to coordinate such information and to make it available. Sources of funding are also defined as a need. However, specific funding sources can not be identified other than the current USGS and FEMA support.

A common thread that the discussion group kept coming back to was the need for the development and establishment of regional and local seismic safety commissions involving leaders from industry, government, engineering, etc. Finally, the group recognized that an effective action plan to reduce losses could be achieved. However, it would only occur over a long time frame (5 to 10 years, or longer), would require dedicated support, and would require direct and/or indirect funding.

ACTION PLAN

The Tennessee group proposed an informal action plan that would lay the stage for later developments of more specific and well defined plans.

Formation of a State Seismic Commission

The group proposed the formation of a losely-knit Seismic Safety Commission (SSC) representing the entire State of Tennessee (west, middle, and east).

A local SSC was tentatively established in the Memphis and Shelby County area. As success is encountered with a program in the Memphis/Shelby County area, such activities would be gradually applied throughout the State.

Public Education

An overall objective of the action plan is the education of the public, as well as business, industry, and government leaders, so that a reasonable understanding of the seismic threat is developed where sound decisions can be made and the appropriate actions taken. The group is to begin developing such a program, focusing on the city of Memphis and Shelby County.

Earthquake Resistant Design

The group recognized that to institute changes in codes and standards would result in new facilities containing mitigation measures. The retrofit of older buildings was considered just as important, especially for critical facilities such as schools and hospitals, as the seismic design of new facilities.

The enlistment of professional groups for the development of codes and standards was defined as a need at some point in time during the mitigation activities.

CONCLUSION

The Tennessee group found the workshop to be an excellent format for discussing the problems and for exchanging ideas and information, especially with the Tennessee Emergency Management Agency (TEMA), the Tennessee Earthquake Information Center (TEIC), and each other. The group recognized the need for planning and the need for cooperation among the various agencies, industries, academic institutions and others participating in the discussion group. The enlistment of professional groups for the development of codes and standards was defined as an urgent need at some future point in time during the mitigation activities.

ACTIONS PROPOSED FOR REDUCING LOSSES FROM EARTHQUAKES IN THE MISSISSIPPI VALLEY REGION AFFECTING THE COMMONWEALTH OF KENTUCKY

by

Jerome Mansfield
Governor's Representative
Owensboro, Kentucky

FOREWORD

This draft action plan contains recommendations of achievable actions for improving the state-of-preparedness in Kentucky. It was developed in discussions among members of the Kentucky working group at the workshop held in St. Louis, Missouri, May 24-26, 1982. These recommendations refine the draft 5-year plan developed at the Knoxville, Tennessee, workshop and represent high priority actions which can be implemented with relatively small cost and effort. The membership of the working group included:

Joseph Bills	Kentucky Division of Disaster and Emergency Services
Benny Cooper	Murray State University
John Kiefer	Kentucky State Geological Survey
Jerry Mansfield	Office of the Governor
Richard Mayson	FEMA, Region IV
Burl Naugle	Murray State University
Buddy Smith	McCracken County Disaster Services
Corrine Whitehead	League of Women Voters of Kentucky
David Vargo	American Red Cross
Walter Hays	U.S. Geological Survey

SUMMARY OF RECOMMENDED ACTIONS

Formation of State Seismic Group

In the close examination of the New Madrid fault and its potential for a catastrophic event, our discussion group focused on the two main ingredients of any program: Alerting political leadership to the hazard and informing the public of the problem and preparedness steps to take. While these two goals must be attacked concurrently, the group realized that without the support of the public policymakers, that other objectives such as improved response plans, enhanced building codes, and additional technical research would not materialize.

With this in mind, our first decision was to recommend the establishment of a Seismic Working Group within the State. This group would take a comprehensive look at the status of earthquake preparedness in the Commonwealth along the New Madrid fault. The group would be comprised of representatives of government agencies and representatives from business and industry, and others in the public sector.

The Kentucky discussion group felt that the following approach would be appropriate to establishing the State earthquake hazards working group:

1) Begin the working group immediately with establishment at gubernatorial level with coordination through the State's Director of Disaster and Emergency Services.

2) Seek initial support for the working group from the Federal Emergency Management Agency and the U.S. Geological Survey.

3) Report to the Governor, indicating the need for the Working Group. This activity should be completed by the end of 1983 in order to prepare any required legal proposals for the 1984 General Assembly of the legislature.

Hazard Awareness and Public Information

In the area of public awareness, the discussion group recommended an information program be developed which would include written and audio-visual material for presentation to community service organizations, local government bodies, and schools. Schools were deemed especially important as a fertile training ground for all types of emergency preparedness programs. Additionally, the State's Division of Disaster and Emergency Services has two public information officers whom the discussion group felt could be used to integrate earthquake material into existing seminars, workshops, and television productions. It was also suggested that an "Earthquake Awareness Week" be instituted.

CONCLUSION

The dual goals of activating the political process and increasing the public's level of awareness about damaging earthquakes are formidable, but certainly achievable. At the very least, a State Seismic Working Group in Kentucky could outline a practical route to improve earthquake mitigation, preparedness, and response programs. At the very most, the activites of the Working Group could save countless lives.

ADDENDUM

Following the St. Louis workshop, the Commonwealth of Kentucky, under an executive order of the Honorable Governor John Y. Brown Jr., established a Governor's Task Force on Earthquake Hazards and Safety on October 25, 1982. The Task Force was charged with the following responsibilities.

1) Assess the vulnerability of Kentucky to damaging earthquakes;

2) Determine the need for improved emergency plans and response capabilities;

3) Evaluate public awareness of earthquake hazards and to determine the need for information and education programs;

4) Investigate the need for and current applications of mitigation techniques;

5) Advise the need for a public forum to consider and make recommendations on earthquake issues;

6) Determine the need for improved coordination among State, Federal, and local agencies and other institutions in dealing with earthquake issues;

7) Make policy recommendations for Federal and State agencies and local governments.

ACTIONS TO IMPROVE THE STATE-OF-EARTHQUAKE-PREPAREDNESS IN INDIANA AND ILLINOIS

by
Anshel J. Schiff
Purdue University,
West Lafayette, Indiana

FOREWORD

This draft action plan contains recommendations of achievable actions for improving the state-of-preparedness in Indiana and Illinois. It was developed in discussions among members of the Indiana-Illinois working group at the workshop held in St. Louis, Missouri, May 24-26, 1982. These recommendations refine the draft 5-year plan developed at the Knoxville, Tennessee, workshop and represent high priority actions which can be implemented with relatively small cost and effort. The membership of the working group included:

Anshel J. Schiff	Purdue University
Robert F. Blakely	Indiana Geological Survey
Walter Hays	U.S. Geological Survey
Paul B. DuMontelle	Illinois Geological Survey
Don Hartsough	Purdue University
Terry Reuss-Birman	FEMA, Region V
David Russ	U.S. Geological Survey
Thomas Zimmerman	Illinois Emergency Services and Disaster Agency
Clement Shearer	U.S. Geological Survey
Ed Sergent	FEMA, National Office

RECOMMENDED ACTIONS

Formation of State Seismic Groups

The working group recommended that Illinois and Indiana each form a Seismic Group consisting of a representative from the State Geological Survey, State Office of Emergency Services (or Civil Defense), and other appropriate organizations in

each State. The groups are to be formed with the understanding that very limited resources will be available to them (about one man-day per month or so for the participating organizations) and that they operate with no budgeted funds. Such seismic groups are to be formed by the end of the summer.

Charge or Charter of the Group

While each group will formulate its own charge or charter, the thrust of each group is to initiate steps to improve the earthquake response should there be significant earthquake damage within the State. This is to be done through improved emergency preparedness and the implementation of mitigation measures which are appropriate in terms of the level of the seismic risk in the region.

Each group will adopt an agenda for its activities.

New Information to be Considered by the Seismic Group

The working group developed the following list of items which each seismic group may want to consider in its agenda of activities:

1) Material which would be appropriate to training sessions of the Office of Emergency Services and Civil Defense as well as other State agencies should be scheduled, if possible, during the next year.

2) The U.S. Geological Survey[1] will publish Open-File Report 82-1033 in December 1982, containing seismic risk maps for the Midwestern States, including Indiana and Illinois. Following publicity it would be appropriate for the State Geological Survey to work with the USGS in interpreting the implication of these maps to the impacted units of

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1 Algermissen, S. T., Perkins, D. M., Thenhause, P. C., Hanson, S. L., and Bender, B. L., 1982, Probabilistic Estimates of Maximum Accelerations and Velocities in Rock in the United States: U.S. Geological Survey Open-File Report 82-1033, p. 99.

government, inlcuding: offices of emergency services, dam safety groups, etc.

3) The Federal Emergency Management Agency is planning to release, in about 6-months a report, "Damage and Loss Assessments," which will make use of the FEMA inventory of structures in the Central United States and USGS isoseismal maps (see paper by Patrick Breheny).

4) FEMA will release in about a year, the "Federal Emergency Plan," which will be developed from the "Damage and Loss Assessments."

Activities to be undertaken by the Seismic Group:

The following actions can be undertaken:

1) Prepare a list of professionals interested in the seismic problem - Individuals interested in the earthquake problem will be identified along with their area of interest. This list will be distributed to other State seismic groups, FEMA, USGS, etc.

2) Assess physical security of emergency communications - Communication is one of the key elements of effective disaster response. It is suggested that emergency communications that are used by government agencies responsible for emergency response should be assessed for their resistance to earthquake damage. For communications equipment that does not have self-contained power, the earthquake resistance of emergency power should be evaluated. In most cases, inadequate earthquake resistance can be remedied with low cost measures.

3) Survey seismic security of vital facilities - The objective of this effort is to determine the state of vital facilities from the perspective of their earthquake resistance. This is to be done primarily by contacting appropriate organizations to ask them specific questions about the safety of their facilities Examples include: the safety of Red Cross blood banks, emergency power for hospitals, and others. Emphasis is on items which are important and whose earthquake resistance can be

upgraded at low cost. In many cases, the organizations, when they find out about their potential vulnerability, may take it upon themselves to upgrade their facilities.

4) Assess the possibility of improving seismic safety of new critical State facilities - The Seismic Group should explore what options are available for improving the seismic resistance of critical facilities that are to be constructed using State funds. Facilities such as hospitals, emergency operations centers, fire stations, police stations, dams, etc., because of their importance, may warrant special considerations in their construction.

5) Increase utilization of seismic information - seismic hazard maps and other information should be utilized as they become available. For example, hazard maps could be incorporated with other suitability maps used by the State.

6) Information exchange - Descriptions of activities of the State Seismic Group should be sent to Ms. Terry Reuss-Birman, FEMA, for distribution to other State seismic groups.

ACTIONS TO IMPROVE THE STATE-OF-EARTHQUAKE-PREPAREDNESS IN ARKANSAS AND MISSISSIPPI

by

Edward Stallcup

Office of Emergency Services

Conway, Arkansas

FOREWORD

This draft action plan contains recommendations of achievable actions for improving the state-of-preparedness in Arkansas and Mississippi. It was developed in discussions among members of the Arkansas working group at the workshop held in St. Louis, Missouri, May 24-26, 1982. These recommendations refine the draft 5-year plan developed at the Knoxville, Tennessee, workshop and represent high priority actions which can be implemented with relatively small cost and effort. The membership of the working group included:

Bill Campbell	FEMA, Region VI
Homer Given	International Business Machines
Ugo Morelli	FEMA, National Office
Al Mushkatel	Arizona State University
Risa Palm	University of Colorado
Roy Popkins	American Red Cross
James Maher	Mississippi Emergency Management Agency
Jerry Sanders	State Architect of Arkansas
Edward Stallcup	Office of Emergency Services of Arkansas

RECOMMENDED ACTIONS

Public Education Program

Mississippi and Arkansas should initiate public education programs to increase the perception of the earthquake threat. A multihazard approach should be used.

1) The priority need is to create **awareness** of earthquake hazards and risk by volunteer and professional societies (including architects, engineers, insurance companies, lending institutions, hospital administrators, etc.).

2) Sessions similar to the Mississippi Office of Emergency Services recent meeting of Architects and Engineers on flood management should be conducted on the earthquake threat.

3) "Experts" within each State should be identified--people who can make substantial contributions to the earthquake preparedness effort. Institutions of higher learning can make a unique contribution.

Earthquake-resistant design

The codes regulating design of new buildings should be improved.

1) Knowledgeable individuals should contact the State Building Commission, express their concern about the lack of use of the seismic provisions of building codes, urge the commission to study this issue, and report to the Governor and to the legislature.

2) The Mississippi State Preparedness Committee, composed of about 30 State agencies, chaired by the Director of the Office of Emergency Services, should address the issue of building codes.

3) Experts in other agencies; e.g., Federal agencies, American Institute of Architects (AIA), should be brought in to assist the State, as required.

OVERVIEW OF EARTHQUAKE HAZARDS AND RISK IN THE MISSISSIPPI VALLEY

by

Otto W. Nuttli
Saint Louis University
St. Louis, Missouri

With regard to earthquake hazards and risk, the Mississippi Valley has certain unique features. First, the region is the most active earthquake area of the United States east of the Rocky Mountains. Second, in spite of this, major earthquakes occur very infrequently in the Mississippi Valley. The last moderately large earthquake occurred in 1895, and the last great earthquakes occurred in the winter of 1811-1812. Third, the attenuation of earthquake energy with distance is so much less in the Mississippi Valley than in most major earthquake regions of the world that there is no experience in dealing with earthquake devastation over as large an area as will result from our next great earthquake or earthquakes. Thus, one of the problems we are faced with is the problem of dealing with a low probability event that can cause unprecedented losses.

Although there are a number of earthquake source zones in the Mississippi Valley that are capable of producing damaging earthquakes, experience and present-day minor earthquake activity both indicate that the New Madrid fault zone is potentially the source of greatest destruction. Less than 200 years ago, in 1811-1812, the fault broke loose and produced three great earthquakes of magnitude (surface-wave) of about 8.5 each plus 15 other large ones that by themselves were of a size capable of producing loss of life and large property damage, all within a 2-month time period.

The New Madrid fault zone (or at least the most active part of it) extends from a point in eastern Arkansas about 25 miles northwest of Memphis to approximately Cairo, Illinois, a distance of about 125 to 150 miles. There are two ways in which we can estimate what the ground shaking will be like for future great earthquakes. The first uses historical information, namely the accounts of the great earthquakes of 1811-1812 and the moderately large

earthquakes of 1843 and 1895. The second makes use of extensive research concerning the source characteristics of the earthquakes and the transmission of wave energy through the Earth's crustal layers, which enables us to estimate the nature of the ground movement for an earthquake of a specified size at any particular location. Either method tells us that a great earthquake will produce severe damage to most buildings and to the Earth itself over an area of approximately 5,000 square miles (an area the size of 6 typical counties in Missouri). Ground transportation will, at best, be difficult in that region because of sunken lands, rifts in the Earth, numerous sand and water craters, the breaking up of highway pavement, and the collapse of overpasses and bridges. The residents of that area will be on their own for at least several days, before any kind of emergency relief can be provided. Structural damage to buildings will occur over an area of about 50,000 square miles, with attendant major loss of life. A much larger area of approximately 500,000 square miles (1/7 of the land area of the 48 States) will experience damaged chinmeys, falling plaster and ceilings, overturned water heaters and similar kinds of damage, such as books and merchandise thrown off shelves. These can cause injury, loss of life, and fire, which can be more damaging than the direct effects of the earthquake. Tall buildings have natural periods of oscillation of 1 second and more. Earthquake wave energy in the Mississippi Valley for these periods experiences almost no attenuation; therefore, tall buildings (particularly at their upper levels) located at distances of as much as 500 or more miles from the epicenter of a great earthquake will experience significant shaking. The buildings likely will not fail structurally, but the contents and the interior may suffer extensive and costly damage, and injuries or even loss of life may result from falling objects and from panic.

It is important to emphasize that the probability of the Mississippi Valley area experiencing another great earthquake in our lifetime is small. For example, a probabilistic hazard study showed that there is only a 10% probability that in a 50-year time period St. Louis will have an earthquake with a MM intensity exceeding VII, and Memphis will have an earthquake with a MM intensity exceeding VIII.

Although the possibility of the Mississippi Valley experiencing such a great earthquake in our lifetime is small, there is a higher probability that the New Madrid fault or one of the other source zones will produce a moderately large-sized earthquake in our lifetime. Earthquakes of magnitude about 6 occurred at the southern end of the New Madrid fault in 1843, and at the northern end in 1895. The former did extensive chimney damage in the Memphis area, in northern Mississippi and in eastern Arkansas. The latter caused fallen plaster and damaged chimneys as far away as St. Louis.

Earthquake risk (chance of economic loss) in the Mississippi Valley comes in part from: 1) the very low-probabiltiy, great earthquakes that will cause extreme damage and large loss of life over a big area, and 2) the more probable, moderate earthquakes that will cause damage, injuries, and possible loss of life over a smaller area. Until the present time, the earthquake ground shaking hazard in the Mississippi Valley area has been, on the whole, ignored by government officials, planners, architects, and engineers, as indicated by the general lack of earthquake-resistant design features in building codes and by the general lack of adequate plans for responding to a large earthquake. Ignorance of the hazard can no longer be accepted as a reason for inaction by public officials; they can legitimately be criticized after the area experiences the next damaging earthquake. The only possible justification could be an economic one, that the low probability of occurrence does not warrant the expense. At the minimum, however, it would appear prudent that all critical facilities (those whose continued operation is essential to the welfare of the populace or whose failure could cause great loss of life) be designed to withstand the worst expected earthquake ground motion, and that all structures where large numbers of people congregate (schools, high-rise office and apartment buildings, auditoriums, sports stadiums, etc.) be designed and built so that no great loss of life will occur if they are severly shaken. Along with this, there should be realistic plans for emergency response to a great earthquake, whose damage will extend over a number of States.

THE POLITICS OF COMMUNITY SEISMIC SAFETY

by

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Green Bay, Wisconsin
and
William J. Petak
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Los Angeles, California

INTRODUCTION

Rational approaches to the predisaster planning and implementation of measures targeted on mitigating the effects of future earthquakes must inevitably consider the political variables which can influence the success of such activities during both pre- and post-disaster periods. Indeed, it seems likely that political variables may currently be of far greater importance to the initiation and success of earthquake mitigation activities than the current state of scientific knowledge concerning this hazard, the technologic remedies available for its solution, and the economic costs and benefits associated with the application of such remedies.

THE IMPEDIMENTS TO ACTION

However important the effects of future earthquakes may appear to be to the professional community, several major factors continue to act as a brake on efforts to mount successful policy attacks on seismic safety problems. These factors include the following:

1) **Other contemporary problems appear to be more important:**

Like factory workers or college students, legislators have a limited capacity for work. The whole of a curriculum cannot be taken in a single semester, no single worker can concurrently deal with

assembly of the engine and the upholstery of the rear seat, and no legislative body can tackle all the present and future ills of society in a single session. Comparatively few policy issues of major significance make it to the action agendas of legislative bodies in any particular session, and few of these draw the kind of attention and support that is necessary to translate incipient problem concerns into effective problem-solving action. Although many factors may influence whether or not a potential problem makes it to the policymaker's agenda, one of the more important is the perceived magnitude of the problem, as compared with all other problems competing for policymaker attention.

Weighed against these criteria, the effects of future earthquakes appear to be comparatively unimportant to most legislative bodies, in most jurisdictions of Government, during most periods of time.

A comparatively recent survey of the problem perceptions held by policymakers and political influentials revealed that the most serious issues perceived at state and local levels in three States - California, Massachusetts, and Utah - were inflation, unemployment, the cost of welfare, and other similar phenomena. Other problem categories making a strong showing in one or more of these survey sites include pollution, crime, too little economic growth, drugs, education, housing, and pornography.

The seriousness attributed by policymaking or policy-influencing elites to natural hazards problems was uniformly low in all surveyed areas. No hazard problems finished among the top five problems in any site. Fire finished among the top ten problems in two sites: California and Massachusetts; and earthquakes were rated as the tenth most serious problem on the list in Los Angeles; likewise, floods finished tenth in Salt Lake City. With these few exceptions, natural hazards issues were concentrated toward the bottom of the list. The seriousness attributed to earthquakes in particular was consistently low in all sites. In Los Angeles, earthquakes received a score of 5.5 on a 1 to 10 scale, making them the tenth most

serious problem on the Los Angeles political agenda (thus, finishing just ahead of pornographic literature and movies). Elsewhere, earthquakes finished only thirteenth on the list among State of California respondents, fifteenth in Utah, sixteenth in Salt Lake City, and dead last in both Boston and the State of Massachusetts. The vast majority of all respondents in the four non-California sites rated earthquakes as "1" - that is, "no problem at all in this State or community." Thus, neither Salt Lake City nor Boston evidenced much political concern over seismic hazards. A fair reading of these data is that earthquakes are preceived as a nonproblem in both sites, despite an objective and scientifically confirmed seismic hazard in both cities.

Consistent with results for other eastern cities and States, the problem of too little economic growth finished quite strongly in both Boston and Massachusetts as a whole; in the State, this problem ranked third on the list, and in Boston, itself, it was seen as the most serious problem. This suggests that economic growth is a particularly sensitive issue in Massachusetts, and therefore, a possible source of negative political leader reaction to any risk-mitigation proposal that might be perceived as interfering with economic development. This appears to be substantially less true in Los Angeles and Salt Lake City.

Thus, the results of this single survey suggest both that earthquake effects are perceived as constituting comparatively minor present and future problems to communities, and that other potential problems are perceived as being far more important. Hence, it is the other problems which typically attract the attention of policymakers and policy-influencing elites.

2) **The absence of earthquake-oriented political constituencies:**

Lest anyone misread this observation, it is important to recognize that policymaker agendas are not always packed with topics representing the most important problems faced by the relevant

community. Nero may fiddle while Rome is burning, and some of the potentially major problems of a community may go unaddressed while community legislators expand their energies on what future historians might view as comparatively minor subjects. That such situtations should prevail is pretty much a function of the way in which our political and policymaking system is fueled.

Contrary to the folklore of American Government, the typical legislator and public policymaker is neither a molder of public opinion, a pioneer in public problem identification and problem-solving activities, a designer of legislation, or the creator of a legislative political environment within which it becomes possible to enact or successfully oppose the enactment of any specific policy proposal. One distinguished professor of law who also served for many years as a Senator in the legislature of his home State has described the role and functions of the typical legislator in the following words:

> Legislatures work almost exclusively as boards to review to judge proposals brought forward by various groups. Legislatures respond, they seldom lead. Those who want something from a legislature must ask for it . . . Legislators themselves seldom invent an idea, draft that idea into a bill, educate the press and public to a bill's merits, or lead a lobbying effort in both Houses of the Legislature and with the Executive Branch. It is unrealistic to expect them to. What actually happens is that new ideas in the form of bill drafts come to legislators from citizens, scholars, lawyers, bureaucrats, and lobbyists; these nonlegislators then help pass the bill by explaining its merits to legislators and to the public. A bill coming from outside the Legislature has a political legitimacy - a credential - that the few bills legislators think up on their own do not possess . . . the effective position is served on a silver platter as a soundly-conceived and well-drafted bill.
>
> It is accompanied by supporting advocacy which convinces legislators that the bill is sound and that they will not incure serious political vulnerabilities if they support it. [1]

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1 Jack Davies, Legislative Law and Process (St. Paul, Minnesota: West Publishing Company, 1975), pp. 2-3.

In short, it is "squeaking wheels" which "get the grease" in the American public policy system. It is not enough that a problem be perceived by some acute observer of the social scene. Some substantial segment of the community must become convinced that the problem exists, must be sufficiently exercised about the problem to mobilize their political energies, and their voices must be raised to a pitch at least loud enough to be heard by the relevant policymakers. As in the economic marketplace, problem-oriented political constituencies then compete with each other to secure the placement of their respective issues and concerns on the action agendas of policymaking bodies. The competition may take place over very long periods of time and a comparatively large allocation of human resources, money, energy, and talent may be necessary to shape the political environment, identify the relevant issues, articulate the appropriate problem-solving alternatives, and to build support for the perferred alternative. The legislator who acts without support from such a system-altering constituency is one who risks his future political life. In a Pulitzer Prize winning book, John Kennedy once documented the political fate of several United States Senators who violated this cardinal rule of American politics.[2]

In the field of seismic safety, this rule also must be honored.

3) <u>The absence of "inside" advocates:</u>

The internal workings of a legislative body are not much different than the workings of any other human group. Like other human beings, legislators are human beings whose time, talents, and capacities are strictly limited. Few of us can concurrently deal intelligently with issues of war and peace, domestic tranquility, the balance of international payments, the issues associated with the unionization

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1 Jack Davies, <u>Legislative Law and Process</u> (St. Paul, Minnesota: West Publishing Company, 1975), pp. 2-3.

2 John F. Kennedy, <u>Profiles in Courage.</u>

of public employees, and the appropriate allocation of limited public resources. Instead, most of us specialize and give intensive concern to only a few subjects, while deferring to other respected parties who shape our views on the numerous other important issues which may be of concern to us but which we cannot personally address either because there are just not simply enough hours in the day or because we lack an appropriate foundation of understanding concerning the technical content of the issue. So it is with legislators.

Outside, problem-focused political constituencies must inevitably establish linkage with a comparatively small number of policymakers within the system who, individually, will devote substantial blocks of time and energy to promotion of the constituencies' cause(s) within the legislative body. Similarly, a legislator who brings a pre-existent concern for a problem to his or her office-holding activities may not only perform this role but may actually stimulate the formation and effective operation of the necessary "outside" political constituencies.

"Public problems", "political issues," and "policy proposals" tend to be "owned" by specific legislators, committees, or institutional entities. Like stray dogs, issues, problems, and policy proposals which are not owned by responsible and attentive parties swiftly become undernourished and have a way of disappearing into the night.

So it is in the field of seismic safety. To a considerable extent, the recent efforts to more fully examine the seismic safety problems and issues within the State of Utah may be viewed as the result of initial and sustained interests of a single geologically-trained legislator to whom earthquakes and their effects were no stranger. She could intelligently address the several issues and problems related to this subject, win fellow legislators to her support, and extend aid and comfort to the comparatively few outsiders who shared similar concerns. Similarly, the sustained interest of a few policymakers in the California State Legislature have produced similar results, and the formation of State level seismic safety

councils in a few States have led to similar outcomes. Where problems are "institutionalized" the interests and energies of individual policy-influencing human beings are linked to the fate of such problems and issues, and the probabilities that these matters will be heard and acted upon by the policy system are considerably increased.

4) The debilitating problems of complexity and uncertainty:

In American politics "simplicity" is the cousin of a "squeaking wheel." When disturbed by the cacophony created by numerous squeaking wheels, conventional rationality dictates that limited legislative resources be allocated first to those "squeaks" which can most easily and economically be eliminated or reduced. Accordingly, "big problems" which can be simply understood, or which are perceived as being solvable through simple remedies may receive first attention. Similarly, "smaller problems" which can readily be solved may also be given a higher priority than bigger problems whose solution seems more elusive.

5) The cost of problem-solving policies:

Many "candidate" public problems are never placed on public policy agendas for action, and many which are so placed are either thereafter ignored or lead to decisions that "nothing should be done to solve the problem." Granted, a variety of factors may lead to such outcomes (uncertainties concerning the causes of the problem and the efficacy and impacts of alternative solutions, the relative importance of the problem as compared with others competing for the policymaker's attention, the practical politics of the decisionmaking situation, etc.), but one of the major factors is frequently the perceived cost of framing a problem-solving policy and implementing a problem-solving solution. Some problems may be so fraught with controversy, and/or so complex in their characteristics as to require solutions that are extraordinarily difficult to design and implement and which involve costs (in money, time, information acquisition,

political difficulty, inconvenience, and conflict) which appear to be so heavy as to cast doubt on the immediate wisdom of tackling the problem. In short, policymakers properly ask whether or not the development of a solution to any specified problem is worth the mix of costs associated with the design and implementation of a solution.

Legislators know quite well that public policies frequently involve the conferring of benefits on one set of groups, and the imposition of costs on still another set. Even under situations where the aggregated benefits of public activity may far outweigh the aggregated costs, the disproportionate allocation of these costs and benefits may therefore deter legislators from acting to resolve a problem. In circumstances where such disproportionate allocation of benefits and costs occurs, the legislative pain produced by the resulting intergroup conflicts may be further exacerbated if the elemental issues of fact associated with the situation are also too numerous and appear to be too difficult to resolve.

6) Issues of fact and value:

In the fast-moving contemporary world, a large fraction of public policies are made under conditions fraught with factural uncertainity. Numerous "issues of fact" may be associated with various perceptions of past, present, and future reality concerning the situations in which problems are believed to be presented and concerning the impact of alternative approaches to the solution of those problems. Although scientific inquiry may ultimately resolve such "issues," the exigencies of the moment may require policymakers to act before the efforts of science can reduce or resolve the uncertainties and therefore dispose of the issues. Under these circumstances the policymaker is cast in the role of one who must resolve the issues of facts, but in the absence of the kind and breadth of information which is required in typical scientific processes.

An issue is here defined as a statement which exhibits the following attributes:

a) it is a question which can be answered only in the affirmative or negative;

b) what makes the question an issue is that some parties answer the question in the affirmative, while still other parties answer in the negative.

Issues of fact have to do with what was, what is, or what will i.e. Under normal circumstances, the resolution of issues of fact falls uniquely within the province of science. Resolution of such questions occurs when the use of agreed upon methods and bodies of data result in answers to questions which are more likely to be true than not true.

Issues of value are questions which have to do with what ought to be. Such issues originate, and are resolved, through commitment of different parties to guiding value propositions. Value judgments, rather than decisons of fact, are the central ingredients in the processes which lead to the origination and resolution of value issues.

Typically, important policy questions arise from interrelated sets of factual and value issues. The resolution of the factual issue may lead to the subsequent revision of a stakeholder's value commitment. Alternatively, however, commitments to ideology may result in such unshakeable support of and commitment to value propositions that no body of act will sway the person or group from their value judgments concerning the central question.

Sadly, in the field of seismic safety, numerous issues of fact and value currently pervade the policymaking process. Uncertainties concerning the future frequencies and intensitites of area earthquakes may freeze the policymaker into inactivity; conflicts concerning the aseismic quality of specific types of building materials or systems may lead to similar results. Conflicts concerning the cost escalations which will result from escalations in building standards or from the adoption of building retrofit policies may produce similar results.

"If the technical community cannot resolve these basically scientific and technical issues," asks the legislator, "how can I be expected to dispose of the problem at this time?"

The careful and methodical efforts which were undertaken by the Structural Engineers Association of Southern California, and the parallel activites by the professional community in Massachusetts, may therefore explain much about the succcessful efforts of both areas to develop building codes which were both compatible with the dimensions of the problems in those two commmunities and ultimately acceptable to policymaking bodies.

Finally, "complexity" may be the equal to "uncertainty" in its debilitating effect on policymaker activity. Even under circumstances where uncertainties can be resolved and the issues of fact reduced to manageable proportions, legislators may be reluctant to act if overly complex patterns of problem-solutions are demanded of them in a single sitting. In short, the problem associated with "harnessing the team" may influence whether or not the wagon is sent to pick up the supplies waiting at the general store.

If concurrent action is necessary to modify State professional licensing laws, to grant new powers of land use zoning to local governments, to provide for state audits of local building department activities to authorize interjurisdictional contracting for acquisition of needed prefessional seismic safety engineering services, and to fix minimum State standards for construction of new buildings and the retrofitting of existing structures, then legislative bodies may be frozen into inactivity. Too many pots bubbling on the same stove at the same time may distress the cook.

When the solution of problems requires complex patterns of problem solving activity, legislative bodies seem to prefer that the outside constituencies resolve the priority questions: "Which corrective action should be initiated first, and which can be ignored for at least a reasonable period of time?"

Of course, what is a "reasonable" period of time to a legislative body may appear unnecessarily long to an outside constituency. Illustratively, almost fifty years lapsed between the occurrence of the Long Beach earthquake of 1933 and the time when California finally brought all existing public school buildings into compliance with the schoolhouse seismic safety standards which were justified on the basis of the effect produced by that earthquake.

7) **Inadequate preparation for timely political activity:**

In the ebb and flow of American political life the probability of political success is sometimes determined by the time in which a specific issue is addressed.

So it is with earthquakes.

More political action has been taken to cope with earthquake effects during the immediate wake of earthquake events, than at any other time. In the immediate wake of a disaster, the nose of the policymaking mule still smarts, and his interest in responding to the problem is at the highest point. It is during such periods that well-considered earthquake mitigation policy proposals exhibit the highest probability of enactment, but it is also during these same periods that public passions, legislator emotions, and the limitation of time and resources most deter reasoned and rational activity.

This attribute of the seismic safety policy process has been illustrated in a study published by James Slosson 1975 . In a study of earthquake mitigation legislation in the State of California over the three year period preceeding and following the San Fernando earthquake of 1971, Slosson notes that during 1969 and 1970 ten earthquake-related bills were introduced, but only one passed. Immediately after the 1971 earthquake 47 seismic bills were introduced, of which 23 passed; and the following year, 24 bills were introduced, 12 of which passed. During the next two years, 50 bills were introduced and 16 passed; of these, the majority were amendments or corrections to bills that were passed in

1971 and 1972. Slosson interprets the results of this analysis as a response by legislators in California to the emotional desires of a public affected by major catastrophes. Between disasters, there is generally a lack of legislative action, but during the emotional period following a disaster, many hurriedly prepared and ill-conceived legislative bills are introduced, requiring corrective legislation. As indicated by the 1973-74 legislative result, he found that good, well-prepared, and technically sound legislation generally fails. This sequence strongly suggests, according to Slosson, that it is the responsiblity of concerned people in science and technology to have technically sound legislation prepared prior to a disaster and then be willing to volunteer time and effort to assist the legislators when the emotional reaction runs high.

SUGGESTIONS FOR PLANNERS

If one accepts the above description of the political environment within which seismic safety policies in the United States are framed and executed, then rational planning to cope with the effects of future earthquakes should target on completion of the following steps:

1) **Technical issues of fact should be identified and appropriately addressed:**

The time to candidly list and discuss the numerous technical issues of fact which pervade the seismic safety field, is before problem-solving proposals are submitted to legislative bodies. Position papers which eschew unnecessarily technical language and mysterious mathematical symbols, lucid and easy-to-understand discussions of technical disagreements and uncertainties, and reasoned assessment of the policy-importance of such disagreements should be prepared by appropriate technical bodies as necessary preparation for legislator discussions of these same issues.

2) **Model legislation and action programs:**

Documents appropriate for use by local and State governing bodies should be prepared, collated, and made ready for use and consideration before earthquakes occur. We should frankly acknowledge that the probability of policymaker enactment of seismic safety legislation and standards is higher in the immediate wake of an earthquake disaster than during other periods of time. The kinds of activities which are preferred should therefore be identified before such disasters occur and be embedded in model documents which can readily be transmitted to legislators in the immediate wake of such disasters.

3) **The formation and education of constituent groups:**

In California and Massachusetts the engineering communities have constituted the prime constituencies for effective earthquake-hazard mitigation legislation. In other States and communities, these same groups might well serve as the nucleus around which political constituencies may form in the future to support effective seismic safety legislation, standards, and regulations. Whatever the nucleus group, however, it is clear that such constituencies must be formed, educated, and prepared for effective political activity if much dramatic progress is to be made in the future in coping with the earthquake hazards in any region of the United States.

4) **Legislator interest and education:**

A legislator without a problem to solve or a constituency to serve is a legislator without a future. As seismic safety political constituencies are formed, it is therefore necessary that these same groups identify and cultivate individual legislators at National, State, and local levels whose continuing and sustained support for seismic safety legislation can be enlisted. Targeted efforts to prepare such legislators for the political battles that will ensue then will become necessary.

There are no shortcuts to successful policy activity in this, or any other, problem arena. Those who choose to take shortcuts will soon be disappointed.

MEMPHIS AREA SEISMIC PREPAREDNESS EXPERIENCES

by

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INTRODUCTION

The participants of this workshop have an opportunity never before held. Through this workshop, it is possible to lay the foundations for an organized effort to make the Central United States a safer place to live. Twenty million people live within the range of damaging seismic hazards from the New Madrid fault zone. Only one-in-a-hundred have any idea of the threat it poses. Participation in this workshop places on us a special responsibility and gives us a special opportunity.

I want to talk about the experiences in seismic preparedness of the city of Memphis. I think that you will find those experiences very valuable as you proceed through this workshop because the city of Memphis may be looked upon as a microcosm of the Central United States. It is a city whose efforts at earthquake preparedness are 15 to 20 years ahead of the region; a city whose efforts have met with both success and failure. The experiences of Memphis can help you to plan a preparedness program for the Central United States.

Memphis lies about 90 miles from the estimated epicenter of the 1811-1812 earthquakes and within the zone of potentially severe ground motion during future earthquakes. The buildings, for the most part, have not been designed for seismic loading. The utility services (gas, water, electricity, and sewers) have not been designed to withstand seismic vibrations or ground movements. The bridges predate the current period of seismic awareness, except for the recently built Mississippi River Bridge. Like many other cities a large part of the population of 3/4 million people live, work, and play in an environment that would not fare very well during a severe earthquake.

In the late 1960's, a number of local engineers became increasingly aware of the potential seismic danger faced by the city. Meetings of the technical groups became forums of seismic risk discussions led by engineers and geologists. These meetings were often attended by the media and the interest of a substantial part of the community awakened. Fortuitously, Ted Algermissen's paper, entitled "Seismic Risk Studies in the United States," was published in 1969 and gave added impetus to the local seismic interest. By 1970, interest and conviction had grown to the point that serious attention was given to the seismic problem of the city. It was recognized that a formal risk analysis was needed in order to determine the danger of life and property.

RISK EVALUATION PROGRAM

Since 1950, our firm, Mann and Howe, Consulting Engineers, had designed structures in areas with seismic hazards in this country and abroad. In the course of that work an analysis program had been evolved whereby the influence of seismic hazards on property damages and life losses from a given installation could be estimated. It occurred to us that this program, with modification, could be used to quantify the seismic risk of an entire city. After an in-house pilot program had confirmed that the analysis method would work, our firm proposed such a program to the city and county governments. The response was positive. The regional planning agency, Memphis Area Tennessee Council of Government (MATCOG), was selected by the city and county to administer the program, and through MATCOG the interest and participation of the U.S. Department of Housing and Urban Development (HUD) was secured. In 1972 a contract for the seismic risk analysis was authorized. (See Mann, O. Clarke; Howe, Warner; and Kellogg, F. H.; Regional Earthquake Risk Study - Technical Report," Memphis, Tenness, September, 1974.)

The risk analysis was based on mathematically modeling the construction found in the city and surrounding areas and exposing the model to earthquakes of intensities 7, 8 and 9. From this simulation, the damages to property and life losses were computed. These projected losses were horrendous. For example, if an earthquake equal to the 1811-1812 should occur during the day time in the year 1990, the expected property losses would be $1.6 billion; 2800 people would be killed; over 10,000 people would be seriously injured; and an equal number would

suffer severe psychological disturbances. Athough no modeling was done on the socioeconomic system, there was no doubt that there would be damages to that system so severe as to be felt thorughout the United States.

Such losses were difficult to comprehend because such devastation had never occurred to an American city. But it was not difficult to realize that in the face of such danger something should be done. From experience with earthquake damages as well as engineering analysis, we knew that losses could be reduced in many ways. In Memphis relocating inhabitants to nonhazardous areas, retrofitting existing buildings, and constucting seismic resistant buildings were the most promising protective strategies immediately available. The last option was considered the least difficult to implement and easiest to model so it was chosen for further analysis. The analysis of the aseismic construction showed that if all buildings built after 1975 were designed to resist severe earthquakes, the expected property and life losses would be reduced by 25 percent. It was also found that if architects and engineers could be persuaded to properly shape the new buildings, the cost increases would be modest and seismic protection could be cost effective. A short paper on cost effectiveness is in the proceedings of the USGS-FEMA Knoxville workshop entitled "Earthquake Preparedness Can Be Cost Effective". In order to save time, I recommend that you review the article at a later time. Relocating people to safe structures and retrofitting or reinforcing hazardous construction could reduce the losses in excess of another 25 percent. In short, Memphis could be made twice as safe from earthquake damages.

The objective of this series of workshops is to formulate a regional seismic strategy for the Central United States. To this end, an analysis of the regional risk, similar to the Memphis risk evaluation program, is a necessary step. The losses should be expressed in terms of lives lost and property damaged. These human terms are the terms that are understood by the public, the decisionmakers of our city and county governments, and the private sector. These are the terms which will ultimately persuade those decisionmakers to finance a community safe from earthquake damages.

It would be misleading if I left you with the impression that all went well during the time when the Memphis Regional Earthquake Risk Study was being made, for all was not "sunshine and roses!" A substantial number of people, spread

throughout the community, was opposed to the program. They spoke derisively of it as "a witch hunt," "a pot of trouble," and "a waste of money." But the city, county, and HUD officials stood firmly in their support, and the risk evaluation program went forward.

Knowing that misunderstanding and opposition were inevitable, we requested at the beginning of the work that the administrative agency establish an advisory panel. This panel was made up of highly responsible respresentatives of all major institutions of the city such as government departments, industries, businesses, hospitals, schools, etc. Each month a report of progress and problems was given the panel. Through the panel a two-way flow of accurate information was developed between the community and consultant. This flow of information was very valuable to those of us doing the work for it kept us in contact with the community and its perception of what was valuable. Through the panel, accurate information on seismic risk flowed quietly but effectively to all levels of the community.

IMPROVEMENTS IN SEISMIC SAFETY

When the analysis was completed, it was clear that the city stood at great risk. Our firm and the advisory panel recommended to the city and county that they adopt a seismic protection policy. Such an action would ultimately lead to changes in the zoning and building regulations and to a gradual reduction of seismic risks. But I am sorry to say that, as of this date, there has been no explicit action taken on seismic safety. It is possible that the opposition was too strong. It is possible that a depressed construction market that struck Memphis in 1974 worked against a seismic policy. It is also possible that we consultants failed to properly perceive the role to be played by an administrative group - a role that was necessary if implementation of our recommendations was to be successful. In fact, if we were to do it again, we would recommend that a special commission be established to develop seismic policies based on technical risk analysis. Such a commission should be composed of a full cross-section of the community, for engineers and scientists, acting alone, can not implement seismic policy.

But I am happy to say that all has not been lost; for although no public policy is currently expressed in law, progress has been made. Numerous industries have adopted policies that require seismic loading be included in the engineering design of the expansion and renovation of their facilities. Many lending institutions are requiring that seismic evaluations be made of the sites of major structures and requiring a specific level of seismic design loading before approving loans. The "rehabing" of a number of structures has pivoted on their being made seismic resistant. The State of Tennessee has established at Memphis State University an Earthquake Information Center which, under the direction of Dr. Archibald C. Johnston, operates a network of seismographs reaching from the Appalachian Mountains to the Mississippi River. The Center provides a credible and widely used flow of information on seismic questions to people throughout the region.

For this progress to continue, it is necessary that a sustained flow of credible information be maintained from scientific and engineering groups to all levels of the community - especially to managers, investors and administrators - and it is necessary that these decisionmakers continue to seriously and responsibly consider the seismic risks. Engineers and scientists must maintain a positive posture on the need for seismic safety, but they must avoid exaggeration that destroys the public's confidence.

CONCLUSION

It has often been said that seismic safety waits on a big earthquake. I do not believe that. Our experience in Memphis proves that there is a better, a simpler, and a safer way. That way requires that a credible estimate of the losses of life and property be made, that those estimates be communicated to the decisionmakers by a recognized and respected group in a credible and acceptable way, and that an on-going flow of sound information be maintained between scientists, engineers, and decisionmakers.

In closing, may I say that it is my hope that our experiences in Memphis, both our achievements and our failures, will contribute substance and encouragement to each of you in this workshop. If you can find a way to adapt to the Central United States those things that we have done correctly and to avoid

those things that we have done incorrectly, you will have made a giant step toward seismic safety in the Central United States.

PLANNING EFFORTS FOR EARTHQUAKES IN THE MISSISSIPPI VALLEY AREA

by

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INTRODUCTION

The earthquake planning effort for the Mississippi Valley area is one of the two largest mitigation and response effort undertaken at the Regional level by the Federal Emergency Management Agency (FEMA); the other one is in California. This paper summarizes the work that has been done, and addresses the research, planning, and action efforts that must be undertaken if we are to have a workable program addressing the crisis created by a catastrophic earthquake on the New Madrid fault. While borrowing from the southern California experience, Mississippi Valley planning must deal with a set of circumstances that differentiate it from the California model. These are: 1) seismic wave attenuation at great distance from the eipcenters, 2) liquefaction, 3) wide diversity of geopolitical divisions and subdivisions, and 4) a lack of earthquake hazard awareness on the part of the public and its leaders. To plan adequately for a major earthquake on the New Madrid fault, these issues must be clearly identified and addressed.

PLANNING

The area potentially affected by a major earthquake on the New Madrid fault encompasses a land mass ranging from Evansville, Indiana, on the east, to Little Rock, Arkansas, on the west. This land mass is covered by the VIII Modified Mercalli intensity zone, as developed by Dr. Otto Nuttli of St. Louis University (see Appendix A). Because of the slow rate of seismic wave attenuation, ground shaking is expected to have an impact on major population centers outside of the VIII and VII zones. Widespread liquefaction, which will occur during a major earthquake, adds another problem to the planning process. Therefore, the Mississippi Valley planning process will encompass a

large area including upwards of 13 million persons. The large geographical area greatly increases the planning that must be accomplished if FEMA is to be prepared for a major earthquake on the New Madrid fault and expands the number of State and local government units with which we must deal. This planning effort places a greater demand than usual on our responsibility to make the public in this overall planning area aware of the potential problem and aware of what is being done to address the problem.

The only way to address a problem of this size and magnitude is through the establishment of an interregional team that could, collectively, commit the manpower and technical resources needed to undertake and accomplish such a broad-based task. FEMA Region VII was given lead responsibility, with assistance from Regions IV, V, and VI. Assistance has been provided in the areas of engineering, administration, and public affairs.

To date, our efforts have been in the problem identification area. A critical facilities inventory process has been undertaken by the four Regions to identify, among other things, major buildings, transportation facilities, and housing in the six cities selected. The analysis will begin this summer to define the scope of the problem to which FEMA must respond.

FUTURE EFFORTS

As our inventory and analysis effort continues, the Regions involved must begin to research and identify strategies in such areas as:

1) Short- and long-term mitigation efforts,

2) Public awareness,

3) Strategies for expanding the inventory-analysis process,

4) Alternate organizational forms for the continuance of this effort at the local, State and regional levels,

5) Prototypical response plans including tests to measure the adequacy of such planning,

6) Guidance and funding for State and local planning efforts,

7) Impacts beyond the immediate earthquake area.

At this time, we are developing a five year work plan that will attempt to chart the specific tasks needed to accomplish the goals of the five year plan, as well as the staff and funding necessary to accomplish the general tasks listed above.

CONCLUSION

The potential for a major earthquake in the New Madrid fault has been established by Dr. Nuttli and confirmed by other scientists in both the public and private sector. FEMA's responsibility, under the laws and executive orders by which it functions, is to attempt to have government, at all levels, the private sector, and the citizens prepared. The five year planning process that has been developed addresses the goal of preparedness at all levels. As we have seen before in emergency situations, the key to successful response is planning. FEMA's charge is to be certain that planning is both accurate and complete so that response to a major earthquake on the New Madrid fault will be adequate.

EARTHQUAKE PREPAREDNESS ALONG THE NEW MADRID FAULT: THE KENTUCKY PERSPECTIVE

by
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and

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INTRODUCTION

July 27, 1980, was one of the busiest days in the history of the Kentucky Division of Disaster and Emergency Services. Major emergency operations were in progress at the site of an Illinois Central Gulf hazardous materials derailment near Muldraugh in Meade County, adjacent to the Fort Knox reservation. While over thirty local, State, and Federal agencies were involved in recovery procedures, a tornado roared through south of the detailment site. Then at 3:00 p.m., it happened. Disaster and emergency workers at Fort Knox detected a slight shaking sensation. Phone lines into the State Emergency Operations Center building at Frankfort were jammed with reports of an earthquake in the northeastern part of the State. Major General Billy G. Wellman, the Adjutant General and Director of Disaster Emergency Services, who was overseeing operations at the derailment, was summoned to the situation room with the word of a quake in the Maysville-Sharpsburg vicinity. State and Federal assessors reported over $1 million in damage. Governor John Y. Brown, Jr., requested and was granted a U.S. Small Business Administration grant for the eleven counties affected by the earthquake, which registered 5.1 on the Richter magnitude scale.

Kentucky has begun planning for earthquakes with completion of the State Natural Disaster Plan and has held an earthquake seminar attended by over 100 people, cosponsored by the Kentucky League of Women Voters. In addition, four emergency management workshops, held throughout the State, featured Dr. Ernst Kastning, Professor of Geoscience, Murray State University, who addressed the technical aspects of earthquake preparedness.

The most significant step in initiating a high level of earthquake preparedness was taken during February 22-26, 1982, when a Federal earthquake hazard vulnerability inventory was coordinated in McCracken County by the Federal Emergency Management Agency (FEMA). Cooperating agencies included the State Disaster and Emergency Services, the local governments of McCracken County and the city of Paducah, and the Kentucky League of Women Voters. The survey was comprehensive and resource information should be valuable for planning for other types of hazards.

The survey will pinpoint problem areas in lifeline facilities and the emergency management system. Six prominent areas of planning, identified below, emerge as significant prerequisites for a sufficient state of earthquake preparedness.

All risk planning - Emergency management plans should not just focus on an individual hazard. Earthquakes will bring complex problems involving fires, hazardous materials, and flooding. Federal Emergency Managency Agency funding should encourage that earthquake planning to be fully integrated into State and local disaster plans.

Mobile command and communications - The failure of emergency radio base stations, commercial television and radio station towers, and fixed warning systems will demand an adequate mobil and portable communications capability. A mobil command post with radio communications should be established in all regions of the State.

Resource stockpile - Food, medicine, and other supplies should be stockpiled in a secure part of the State, not less than four hours from the

nineteen county danger zones. A location near the Kentucky parkway system would be preferable.

Recovery operations - Procedures for earthquake recovery should be streamlined and patterned after California's method of obtaining Federal assistance for recovery from earthquake disaster. Also, FEMA should coordinate State government stockpile mobilization.

Public awareness - The last major earthquake (Richter magnitude 6.0) in the area was in 1895. A training program integrated into school curriculum and public television would enlighten citizens about what to expect and what action to take.

Warning system - Research into an earthquake warning system should be undertaken. Further sophistication of monitoring equipment and even studies on animal behavior might provide the answer to better long- and short-term earthquake prediction.

The Commonwealth of Kentucky will continue to approach the earthquake problem from the viewpoint of a comprehensive effort in preparedness and operational response. It is only through the partnership of all levels of government, community organizations, corporate leaders, and the area's residents that we can establish the stronghold of safety which an earthquake will demand.

ROLE OF THE TENNESSEE EMERGENCY MANAGEMENT AGENCY IN FEMA'S EARTHQUAKE HAZARD VULNERABILITY STUDY

by

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INTRODUCTION

The Tennessee Emergency Management Agency (TEMA) assisted the interregional team of FEMA planners and engineers in conducting the critical facility inventory of the Memphis area to determine the immediate impact of an earthquake on critical facilities and structures in Memphis and Shelby County. The study was conducted from October 5 to 9, 1981.

From the outset, the study team, led by Mr. Eric Jenkins, FEMA, Region VII, recognized the scope and magnitude of the inventory. The objective of the study was to determine the structural composition of several categories of critical facilities and structures in Memphis, including: medical facilities, mortuary services, public structures, communication systems, transportation facilities (rail, airports, highways, bridges), public utilities, natural gas facilities, vital industries and warehousing, housing, and schools. Although an interdisciplinary approach to the survey was used, the expertise that proved to be in most demand was that of structural engineers and architects.

The time and personnel constraints limited the scope of work performed in the Memphis area during the week. It appeared, however, that the most essential information and data was gathered, which is a reflection of the effective deployment of personnel available for the inventory. The following suggestions are offered for subsequent critical facilities surveys:

1) **Greater utilization of local personnel** - Local planners, building officials, and engineers, in particular, can facilitate the inventory process through their familiarity with the city, the structural composition of major buildings and facilities, and the avilability of

primary and secondary sources of data and information pertinent to critical facilities.

2) **Preliminary survey of sources of information** - In metropolitan areas in particular, the FEMA study could perhaps be expedited if one or two FEMA personnel, working closely with local officials, could undertake a preliminary investigation of available sources of information and data, including identification of key officials (i.e., building officials, consultants, planners, etc.) to be contacted and interviewed. Preliminary resource identification would save considerable time for the inventory team as it would allow each member (normally unfamilar with the area) to devote his/her time to gathering relevant information on critical facilities.

3) **Access to survey findings** - Perhaps the most important recommendation advanced by the Tennessee Emergency Management Agency is that FEMA ensure that the findings of the critical facilities inventory be made available, at the earliest possible date, to local and State Emergency Management agencies to give the local and State governments the opportunity to accelerate their earthquake disaster preparedness and response planning program.

The Tennessee Emergency Management Agency will assume a more direct role in the FEMA study during the inventory of critical facilities in the counties in West Tennessee which are located near the New Madrid fault. TEMA staff will coordinate and supervise the inventory of critical facilities in each county, utilizing a methodology similar to that used in the Memphis survey. Certain adjustments in the organizational approach to the study will be made, however, to reflect the economic and demographic characteristics of the counties, the availability of trained personnel to conduct the critical facilities survey, and the amount of time available for the study, particularly with respect to State staff. The experience with the Memphis inventory suggests that a similar inventory of the counties in West Tennessee incorporate, at a minimum, the following tasks prior to the survey itself:

1. Conduct a thorough briefing of local elected officials of the nature and purpose of the critical facilities survey.

2. Contact and recruit State and local personnel to conduct the survey, including local civil defense directors, building inspectors, planners, and engineers.

3. Undertake a preliminary investigation of available sources of information and data on critical facilities to identify information gaps.

The hazard vulnerability study of counties in West Tennessee will afford an opportunity for TEMA staff to explain to key public officials the nature of and the need for the study, the organizational framework necessary to carry out the study, and the relationship of the hazard vulnerability study to the short and long range contingency planning program. In this regard, strong lines of communication between TEMA and local public officials in west Tennessee have been developed in the process of training for the Memphis conglomerate crisis relocation exercise.

STATE ROLE IN IMPLEMENTING EARTHQUAKE PREPAREDNESS AND RESPONSE MEASURES

Earthquake disaster preparedness, response and recovery measures have become a high priority in TEMA's contingency planning efforts. The following discussion highlights the agency's role in implementing earthquake preparedness and response measures in the context of six components essential to a comprehensive earthquake preparedness program. TEMA's role and responsibilities in the earthquake program are subject to modifications as the program develops. It is essential, however, that the State develop a realistic work program with attainable goals.

1) **Hazard awareness and public information** - The Tennessee Emergency Management Agency will play a supportive role in developing a hazard awareness and public information program that will initially focus on the dissemination of information in Memphis and West Tennessee. TEMA will coordinate its activities with FEMA, USGS, Memphis Civil

Defense, and the Tennessee Earthquake Information Center in providing information to the public on earthquake preparedness measures, current scientific developments, and State and local planning efforts. This component will be implemented over a five year period.

2) **Public sector participation** - TEMA will assume a lead role in the education of key public officials, including the Governor, mayors and county executives, on the nature of the earthquake preparedness. The west Tennessee hazard vulnerability study will be the first step in the State's education campaign. This component of the work program will necessarily require a sustained effort over a long period in view of the obstacles to forming seismic safety political constituencies in Tennessee and elsewhere.

3) **Intergovernmental relations and cooperation** - By the very nature of its mission, TEMA will necessarily assume a lead role in developing and promoting intergovernmental relations and cooperation. The agency will be responsible for coordinating and testing Federal, State and local response and recovery plans and will promote and support the establishment of an inter-State seismic safety commission and inter-State mutual aid agreements. To date, TEMA has focused on increasing the awareness of the State's Emergency Services Coordinators concerning the nature and magnitude of the earthquake hazard and the role and responsibilities of the various State agencies in the response and recovery phases of an earthquake disaster.

4) **Earthquake response** - TEMA will develop a comprehensive earthquake response plan which will guide State and quasi-governmental emergency response activities in the event of a damaging earthquake. In terms of the six components of a comprehensive earthquake preparedness program, TEMA staff will devote the bulk of its time and resources to developing, and eventually testing, the earthquake response plan. The first step in the planning process - an inventory of resource capability - has already been started. TEMA staff has generated considerable information and data on resource capability in the

process of preparing crisis relocation plans for Memphis and the counties of West Tennessee. Earthquake response planning efforts will be accelerated upon cmpletion of the FEMA vulnerability study.

5. **Land use** - TEMA will assume a supportive or secondary role relative to land-use regulations in recognition of the fact that zoning and other land-use controls are largely a local function, with policing powers granted by the State to local municipalites. The staff of TEMA will conduct special studies on critical facilities, paticularly dams and levees, that would have a multicounty impact should breach occur. Barkely Dam, Kentucky, is a case in point. TEMA will also support an earthquake hazard mapping program as a basis for preparing seismic land-use regulations at the local level.

6) **Earthquake-resistant design** - TEMA will serve in an advisory capacity in the overall effort to promote the incorporation of seismic provisions in existing building codes. This component of the earthquake program will be included in the public awareness campaign, with emphasis placed on the structural composition of critical facilities.

CONCLUSION

In conclusion, the key to the implementation of a comprehensive program of earthquake preparedness, response and recovery, as viewed by TEMA, is intergovernmental organization and cooperation. The forthcoming crisis relocation exercise in west Tennessee, which will simulate the evacuation of 750,000 people from Memphis, demonstrates that a project of that scope can only be undertaken if there are clear lines of responsibility between Federal, State, and local governments and a commitment at each level to the project.

FEDERAL EMERGENCY MANAGEMENT AGENCYEARTHQUAKE VULNERABILITY STUDY

by

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COMMUNITY PARTICIPATION

The concept for the Memphis Earthquake Study was introduced to the Memphis community at a briefing by City Mayor Wyeth Chandler on September 15, 1981. Representatives were present from the local agencies with the responsibility for providing information and personnel for the study. Both the city and county agencies were represented. This was important for effective cooperation in our area because we have two distinct governments, a city government with a Mayor and thirteen council persons and a county with a Mayor and eleven commissioners. The county Mayor, William Morris, had been involved in preliminary meetings with the Federal Emergency Management Agency (FEMA) personnel. With the support from the city and county, cooperation of various local government diversions was assured.

The quality of the presentation by Eric Jenkins, Coordinator for the study from FEMA Region VII (Kansas City), lead to an informative question and answer session. There was an explanation by city building department representative of the factors which would limit their ability to provide information such as a shortage of detailed maps on local construction built after the early 1960's. This meant that survey members would need to visit more sights than initially intended. The feed-back enabled Mr. Jenkins to get an early estimate of the personnel needed for the on-site visitation team.

Additional suggestions were provided by the fire services, law enforcement agencies, the power company, and the other agencies present. For example, Memphis Fire Services would soon have available knowledge of those industries involved in production, storage, and transportation of hazardous materials. This data and dozens of other bits of background, when pieced

together, would cut through much of the red tape which could have faced the survey team; a group of strangers in a community with an area of 775 square miles with a population of 777,000 people. What ultimately provided the adhesive to connect this diverse collection of information into a unified whole was an offer of help from the Office of Planning and Development. They provided a computer print-out with lists of critical facilities by type and by census tract. A large portion of the information used was generated from Planning and Development data already on hand. With this information printed and ready, all that remained was to provide the expert personnel with this data and make the actural survey.

ON-SITE SURVEY

On October 5, 1981, the team assembled in the Memphis Shelby County Civil Defense Emergency Operations Center for orientation and instructions. But, there was some delay, which could have been avoided had Mr. Jerkins' schedule included additional days in the Memphis area just prior to the survey week. Had this time been available, telephone contact could have been made with each of the individuals in charge of the locations to be surveyed. These calls could have been followed, when necessary, by short personal visits. Our office had made general contact with the organizations having many structures to be surveyed, such as schools and the power company. We were able to provide a basic idea of who would be necessary to assist and what type of information would be required. But often during the survey week, when the team member made contact with an organization, the specific data or the individual needed to provide that data was not available.

The information on the city, county, and private schools proved voluminous. Only about fifty percent of the school facilities had been studied by the end of the week. An additional visit was made this year by several team members to make additional contacts and to assimilate the data. But, the problem with the schools could have only been eliminated with additional survey personnel.

Mr. Jenkins and the members of his team did an excellent job. Our office has already profited from derivative benefits of the study. Community

relations have improved as a result of positive contacts by team members. Statistics from this study have already been plugged into other contingency plans.

COMMENTS

I must finish with the same comment which I made when the study was introduced in September of 1981. In years past a popular quote in Memphis has been, "Plan Your Work, and Work Your Plan."

Much excellent earthquake planning is invisioned for Memphis and its region in the coming years. But, in my opinion, to be effective and to test its validity, this planning will need to be worked, or exercised, with a minimum of simulation.

These are my opinions as a permanent resident of the Memphis area. I realize that more decisive conclusions will be drawn after the tremendous volume of data gathered has been processed and analyzed.

EARTHQUAKE SEMINARS AND WORKSHOPS

by

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INTRODUCTION

This presentation is a brief summary of the workshops and seminars concerning earthquakes which have been conducted over a 3-year period. This presenation is only a partial discussion of the the studies and followup work that has been done in southeast Missouri.

SUMMARY

About 3 1/2 years ago the State of Missouri, through the Disaster Planning and Operations Office, started an Earthquake Mitigation Panel having representatives from different agencies. It was recognized that more information was needed about how other regions handled the earthquake threat.

The University of Denver sponsored a workshop at which several of us were invited to be on the Advisory Council in February 1981. Our initial meeting with the Denver Advisory Council was to help prepare and edit questionnaires to be sent to executive officers and to the general public. This was done to find out how aware individuals were of the earthquake potential in the New Madrid fault. This study was funded by the National Science Foundation (NSF).

The Western States Seismic Safety Council held a meeting and panel discussion at Salt Lake City, Utah, in March 1981. Members of the Missouri Mitigation Panel learned a tremendous amount about earthquakes and ground motion through this workshop which was funded by the Federal Emergency Management Agency (FEMA).

In July 1981 the FEMA Region VII Office in Kansas City chose to include Poplar Bluff, Butler County in the earthquake vulnerability study. This would be their first attempt at this type of survey in the New Madrid fault area. The survey was well accepted by the city and county officials as well as the general public. The results of that survey, together with geotechnical data furnished by USGS are being analyzed at present to draw conclusions as to potential losses that would result from a major earthquake.

In September 1981 members of the Missouri Earthquake Mitigation Panel attended an earthquake seminar in Knoxville, Tennessee, sponsored by USGS and FEMA. This workshop dealt primarily with the New Madrid earthquake fault. Much knowledge was gained from this seminar through the small group discussions.

Before the seminars, however, the Southeast Missouri Civil Defense Association (SEMO-CDA) had conducted a "table top" earthquake exercise. SEMO-CDA consists of 13 counties within the Southeast Missouri Bootheel Region. We found out in this exercise and publicity gained from it that the majority of people in southeast Missouri are very much aware of the New Madrid Fault and what could happen if it should erupt.

In November 1981 another workshop of the Advisory Council was conducted by the University of Colorado, Denver, Colorado. The purpose of this workshop was to review the questionnaires that had been sent out and to analyze statistically the survey results. These results will be distributed to interested parties as soon as they are compiled.

CONCLUSION

In conclusion, the knowledge gained from a series of workshops and seminars during the past three years has been very valuable, not only to SEMO but to the citizens of the 13 counties. From this knowledge, we are trying to write a local earthquake plan that can be used as a prototype by other local emergency preparedness groups. We are trying to write this plan without major assistance from our State Office of Emergency Management due to the urgency of getting these plans ready.

WHAT CAN BE REALISTICALLY ACHIEVED WITH REGARD TO EARTHQUAKE RESISTANT DESIGN OF NEW BUILDINGS AND LIFELINES AND THE RENOVATION OF EXISTING FACILITIES?

by

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INTRODUCTION

There are many actions that can contribute to seismic safety, but only a relatively small number are both effective and within our immediate reach. The task of this workshop is to discuss optional actions and to select those goals that are effective, economical, and attainable.

In order to carry through this workshop mission, we should develop a broad list of goals, estimate their relative costs, and evaluate their public acceptance. The workshop participants should then rank and test the list of goals and finally grade them according to a specific criteria. Those goals with the highest grade will form a list that can become a "road map" toward a realistic seismic safety program for the Central United States.

History has shown that dangers to people from earthquakes occur primarily through damage to structures and systems that men have built. Damage to these systems can pose a threat both during and following an earthquake. The danger from the collapse of a building is immediate and obvious, while the danger from the failure of a water or sewer system is not so immediate and dramatic, but none the less, devastating. In Figure 1, I have listed Goal Areas that include types of structures and systems worthy of attention, where the greatest progress toward earthquake-resistant design is possible.

I suggest that you first decide the minimal level of performance for each goal that is socially acceptable. For example, what is the mimimum level of performance for school buildings that is socially acceptable? The answer might be (1) 100 percent safe and operable, (2) safe but inoperable (not collapsed), or (3) partially collapsed. In this way you may proceed through the list of goals and choose for each a minimum performance level. After the minimum performance level is chosen, it is necessary to rank each goal according to its importance. For this ranking I suggest a numerical system, 1 through 10 with 10 corresponding to those goals that are most important. For example, a hospital is more important than a newspaper building and this can be expressed by using 8 for hospitals and 2 for newspaper buildings.

Finally each goal should be tested to reflect its attainability, effectiveness, compatibility, cost, and acceptability. For this, I suggest an A, B, C, grading. For example, if a goal is technically achievable it should be graded A, but if it is only partly achievable, it should be graded C.

CONCLUSION

The choosing of goals and the ranking and testing concept may at first appear too tedious, but in reality, you will find it a reasonably simple and straightforward process. If your deliberations lead to a goal graded 8 followed by five B's, it will evidently be preferred over a goal showing a grade of 3 and five A's. The system will help you find your way or retrace your steps through an otherwise bewildering maze. It will also provide a means of group communications and refinements of opinions wherein both objectives and subjective information can be meaningfully mixed, and goals can be chosen that are technically realistic and politically acceptable.

Figure 1

Goal Areas	Minimum Performance Level*	Importance Rank**	Test*** 1	2	3	4	5
New Buildings							
1. Commercial							
2. Government							
3. School							
4. Public Service							
5. Hospital							
6. Stadium							
7. Warehouses							
Existing Buildings							
1. Commercial							
2. Government							
3. School							
4. Public Service							
5. Hospital							
6. Stadium							
7. Warehouses							
Utility Systems							
1. Gas							
2. Water							
3. Electricity							
4. Sewer							
Communication							
1. Telephone							
2. Mail							
3. T.V./Radio							
4. Newspaper							
Transportation							
1. Highway							
2. Railway							
3. Air							
4. River							

* Minimum socially acceptable performance level 1 = 100% safe and operable, 2 = safe but inoperable (not collapsed), or 3 = partially collapsed.

** Rank 1 to 10 with 10 corresponding to the most important

*** Test

Criteria for testing of goals:
1. Is goal technically achievable?
2. Is goal effective in reducing loss potential?
3. Is goal compatible with other nonseismic goals such as fire protection, etc.?
4. Is coast of achievement comparable to windstorm or flood protection?
5. Is goal publically acceptable?

**** Answer each question with one grade number using grade numbers A = High, B = Medium, C = Low.

EARTHQUAKE-RESISTANT DESIGN FROM THE PERSPECTIVE OF AN ARCHITECT

Charles Danna of Hellmuth, Obata, and Kassabaum gave an oral presentation entitled, "Building Configuration Issues for Seismic Design." He discussed geometric configuration of the building plan, reentrant corners, setback effect, material cladding of the structural frame, "soft" stories, column transfer, and perimeter strength and stiffness.

A manuscript of the presentation by Mr. Danna was unavailable for publication in this report. Because Mr. Danna's presentation stimulated extensive interest and discussion, some aspects of the theme emphasized in the discussion are given below for completeness.

Earthquake-resistant design is based on a knowledge of the following items: 1) the earthquake hazards at the site, 2) the response of the structure to ground shaking, 3) the stress-strain properties of the materials used in construction, 4) the performance of structural elements under earthquake-type loading, and 5) the desired safety factor or the acceptable level of damage. Once these items are known, the proper size and shape of the structural members must be determined and the connection of the structural members must be described, all in such a way as to achieve the desired performance of the structure. Accomplishing this goal requires close cooperation between the architect, the engineer, and the earth scientist.

In regions of the United States having a low seismic hazard, the structural design seeks primarily to resist the force of gravity (which pulls steadily downward) and secondarily to resist the horizontal pressure of the wind. In regions having a high seismic hazard, the design also seeks to resist the vibratory forces generated by earthquake ground shaking. This last requirement significantly increases the complexity of the design process and requires considerable expertise.

When a building is subjected to earthquake ground shaking, its base tends to move with the ground, and stresses and deformations occur throughout the entire structure. If the building is very stiff, the entire structure moves with the ground, and the dynamic forces induced in the building nearly equal those associated with the ground acceleration. If the building is flexible, differential motions of its supports and floors can induce large dynamic deformations. To survive, earthquake ground shaking, the building must be strong enough to resist the induced forces if it is rigid; if it is flexible, it must be able to accommodate the deformations without collapsing.

The study of structures damaged by earthquakes (for example, Earthquake Engineering Research Institute, 1977) has shown that architecture decisions based on considerations of appearance, function, and other concerns can greatly influence the earthquake resistance of buildings. Earthquake-resistant design, then, is a responsibility shared by the architect and engineer. If the architect gives the engineer a building concept that is fundamentally poor in terms of earthquake resistance, the engineer's task in ensuring a safe building will be more difficult and, possibly, impossible.

The main principle an architect must keep in mind is that **the structural engineer cannot make a poor structure form behave satisfactorily in an earthquake**. Although there is not universal ideal form for a particular structure, architects can follow certain general guidelines to enhance earthquake-resistant design (Dowrick, 1977). In general, the structure should:

1) Be simple.
2) Be symmetrical.
3) Not be elogated in plan or elevation.
4) Have uniform and continuous distribution of strenght.
5) Have its stiffness related to subsoil properties.
6) Have horizontal members which form hinges.

Experience has shown that earthquake ground shaking will find every structural weakness caused by inattention to structural form. The earthquake will create undesirable stress concentrations and torsions in the structure.

The structure will have the maximum chance of surviving the earthquake only if:

1) The load bearing members are uniformly distributed.

2) All columns and walls are continuous and without offsets from roof to foundation.

3) All beams are free of offsets.

4) Columns and beams are coaxial.

5) Reinforced concrete columns and beams are nearly the same width.

6) No principle members suddenly change section.

7) The structure is as continuous (redundant) and monolithic as possible.

We have learned many lessons about building failure during the past two decades which can be integrated into earthquake-resistant design. Based on post-earthquake investigations, the main reasons for building damage are:

1) **Improper choice of seismic-resistant systems for structures** (for example, unreinforced masonry, eccentric shear walls, brittle concrete columns, penetration of columns for utilization of conduits, et cetra).

2) **Improper connections and detailing** (for example, brittle concrete welds, short reinforcing anchorage, lack of hoops and stirrups, lack of reinforcing steel ties from walls to floors and roofs, et cetera).

3) **Ommissions in engineering analysis** (for example, neglect of: torsion effects, overturning effects, static equilibrium of all forces acting on a structure, et cetra).

4) **Ommissions in construction** (for example, improper placing of reinforcing, cutting of holes or openings in structural members, careless welding or bending of reinforcing steel, poorly prepared construction joints in concrete, improper preparation of concrete, et cetra).

5) **Poor materials** (for example, brittle steel, poor concrete, poor masonry mortar and placement, et cetra).

6) **Gross underestimation of the amplitude, frequency composition, and duration of ground shaking** (for example, if the local ground motion predominately has frequencies close to the natural frequency of the building, then the structure will take the maximum punishment).

7) **Gross underestimation of the geotechnical properties of the foundation materials with respect to their potential for liquefaction, differential settlement, and landslides.**

Although many of these lessons involve the engineer more than the architect, the architect can benefit from a knowledge of them.

Recent earthquakes (for example, the 1964 Prince William Sound Alaska; 1971 San Fernando, California; 1972 Managua, Nicaragua; and 1979 Imperial Valley, California) have shown one fact clearly:

When the building starts moving in response to the ground motion, anything that is attached to it, directly or indirectly, will also move and is subject to damage or destruction unless properly designed from both an architectural and structural point of view.

Without proper architectural and structural design it is possible for a building to behave in ways such that nearly all of the architectural components are damaged or destroyed, but the building remains standing. This happened in Anchorage, Alaska, and Managua, Nicaragua, where buildings remained standing after the earthquakes, but the total damage was assessed at up to 76 percent of replacement costs.

The following quotation from AIA Research Corp. (1975) describes the policy that architects should take relative to earthquake-resistant design in the Mississippi Valley area:

> **"The final measure of a well constructed building is the safety and comfort it affords its occupants. If, during the earthquake, they must exit through a shower of falling light fixtures and ceilings, maneuver through shifting and toppling furniture, stumble down dark corridors and stairs, and then be met at the street by falling glass, veneers, or facade elements, then the structure cannot be described as a safe structure."**

References

AIA Research Corporation (1975), Architects and Earthquakes, NSF/RA-770156, U.S. Government Printing Office, Washington, D.C., 94 p.

Dowrick, D. J., 1977, Earthquake Resistant Design - A Manual for Engineers and Architects: John Wiley & Sons, New York 374 p.

Earthquake Enginering Research Institute, 1977, Learning from Earthquakes - Planning Guide, Berkeley, California.

EARTHQUAKE-HAZARDS REDUCTION -- PERSPECTIVE OF A GEOLOGICAL SURVEY

by

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Certainly the subject of gaining the cooperation of public officials for an earthquake hazards reduction program is an important one and one in which State geological surveys should rightfully take an active role. The threat of a catastrophic earthquake is very real. Geologists and geophysicists should perform the scientific studies and make the predictions on which an earthquake hazards reduction program can be based, but it is the function of public officials to organize and implement the preparedness program for local citizenry. Coordination and cooperation are imperative.

The problem of gaining the commitment of the political leadership falls under at least four broad categories: 1) scientific credibility; 2) politics; 3) education; and, 4) financing. All these categories are interrelated to a great degree.

The scientific organization, or in this case the State geological survey, must have established its credibiltiy for conducting sound basic research. This appears to be simple enough, but if the visibility and credibility of your orgainzation is low, you can count on the official response to be low also. If citizens have to ask, "What is a State geological survey and what does it do?", you know you are faced with a major problem. This is an uphill battle that many State surveys are faced with since, for the most part, they have traditionally been low-key organizations focusing on basic geologic research and resource evaluation. While State geological surveys are public service oriented, the clientele has generally been specialized and limited in number.

Establishing credibility leads you into the area of politics. A major step is to gain the attention and confidence of your local and State officials. This is not a process which occurs overnight, but must be developed by working with them in all areas where your scientific expertise may be useful. This can include such areas as land-use planning and zoning, flood prediction and prevention, landslide and karst studies, locating suitable areas for landfills, and aiding in locating new water supplies. Obviously, it is a relationship which must be cultivated, and an instant, positive response to a program related to earthquake preparedness cannot be expected. This is especially true in a State such as Kentucky, where major earthquakes occur infrequently.

Once you gain the political backing, you must work toward effective legislation, such as model building codes. You might be able to present a convincing argument that there is a reasonable probability for the occurrence of an earthquake, but it will have little impact on reducing the damages from future earthquakes without the force of specific legislation. It is also important that you convince one or more political officials to adopt earthquake hazards legislation as their personal cause. It is one thing to introduce legislation, but without strong and continuous backing, it will probably never be passed.

Working with your State and local officials can also fall under the category of education. It is imperative to inform the public and to create a sense of awareness of earthquake hazards. Again, this is especially important where earthquakes are not a common everyday occurrence. Education can include such things as talks for civic groups, lectures to students, or articles in newspapers and other media. Some State geological surveys have educational sections which facilitate such programs. In this vein, "alarmist" tactics based on well-documented scientific studies or studies of actual damage to structures in quake areas can often be very useful in gaining the attention of the public and political leaders. One must be careful, however, to avoid overkill and the "chicken little" syndrome.

The final category is financial. Without the funding to conduct basic studies aimed at earthquake prediction and hazards reduction, obviously, it

will be extremely difficult to implement a program of public preparedness. On the other hand, if you have done your homework in the other three categories, you have established the basis for adequate funding.

The Kentucky Geological Survey does not, at the present time, have any programs which focus specifically on earthquake monitoring or earthquake hazards reduction. This does not, however, indicate a lack of interest, but a lack of funding for specific programs in those areas. The Survey is currently engaged in two separate projects funded through the Nuclear Regulatory Commission to attempt to document recent movement along faults in the New Madrid area and in central Kentucky. The Survey has also submitted a proposal to establish a Geologic Hazards Section, one of the major functions of which would be earthquake studies.

In summary, gaining the attention and commitment of political leadership at the State and local level involves commitment on our part to a well organized and persistent approach.

GAINING THE ATTENTION OF STATE AND LOCAL POLITICAL LEADERSHIP: WHAT CAN WE LEARN FROM MISSOURI?

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The title of this plenary session, "How to Gain the Attention and Commitment of the Political Leadership at the State and Local Level," reflects the strongly held belief that seismic issues are of little concern or interest to these officials. The thrust of my remarks this morning is that this long held belief is, at least partially, erroneous.

To the extent that Missouri can be used to generalize to other Mississippi Valley States, I am suggesting that seismic issues are highly salient to local officials to a degree not previously imagined. The salience levels of the officials reported on here are the result of a study recently completed in the States of Washington and Missouri. After first discussing the levels of salience among key actors in Missouri, I will address the question concerning the degree of their comittment to specific policy issues.

In May-July of 1981, a total of 163 key actors were surveyed through the use of mail questionnaires to ascertain the importance of seismic issues to these local key actors. The response rate was 67.4% in Missouri, 110 of the 163 individuals surveyed completed questionnaires. These key actors consisted of mayors, city council members, county executives and judges, directors of building departments, school district supervisors, planners, architects, structural engineers, and emergency service directors. Those actors surveyed all resided in either Uniform Building code seismic risk zone two or three. Although this initial analysis reports on the opinions of all these actors, it is important to note that the opinions of the political actors do not differ from those of other actors.

Two dimensions of salience were thought to be of importance: 1) the risk of a major earthquake causing loss of life and large scale property damage, and 2) concern about the likelihood of such an event. The first question used

to measure the dimension of salience was, "How serious is the earthquake risk in your State?" Close to 57% of the actors reported that they thought the risk was very serious, and another 38% thought it was somewhat serious. This means that over 95% of these local actors believed seismic risk was serious or very serious in Missouri. A second element of salience is the level of concern an individual feels about the possibility of a major earthquake. Just under 92% of the sample indicated that they were either very or somewhat concerned about the occurrence of a major earthquake.

Eighty-three percent of these key actors also indicated that of all of the problems facing their community, seismic problems were either very or somewhat important. In addition, 71.5% of the actors believed that their agencies were very concerned about seismic safety. Finally, earthquakes were ranked behind tornadoes, flooding, and drought as having a high risk of occurrence and causing major damage.

While these views of the local actors about the risk and threat of earthquakes and their concern over earthquakes is interesting, even more interesting are the opinions of these actors which relate to components of seismic policy. The often cited Wright and Rossi study discovered that only 17% of those concerned about seismic hazards supported land-use or building code regulations to help mitigate the effects of an earthquake. However, over 80% of the key actors surveyed for this study who were either somewhat or very concerned about the risk of an earthquake believed the threat sufficient to justify the enactment of land-use or building code regulations designed to mitigate the effects of an earthquake. Part of the difference between the findings of the two studies' may be that the Wright and Rossi study included State actors while this study only surveyed local actors.

Yet, as one might expect given the nature of this meeting, these actors' fears, concerns, and interest were not translated into time on their job which was devoted to mitigation activities. More than 58% of the sample indicated they spent no time on activities related to mitigation, and another 32.4% indicated they spent less than 15% of their time on such issues. In short, the study found high levels of salience but evidence of few, if any, public policies in operation which would have permitted the transference of this

concern to actual work activities designed to mitigate the damaging effcts of earthquakes. Furthermore, only 9% of the actors believed their State's or community's current policies would be effective in the event of a serious earthquake.

Having attempted to demonstrate that to a significant extent the attention of key public officials has been captured, let us now address the question of what can be done. Two findings bear on any answer which might be given to this question. The first comes from a study of Housing & Urban Development's (HUD) efforts to impose seismic building code regulations on all FHA insured projects in St. Louis. The failure of these efforts leads one to conclude that local government must be closely consulted in the development of any mitigation policy. The second finding is that of Federal, State, and local agency activity which has improved the ability of an actor's agency to lessen the effects of an earthquake, local and State activity are valued most highly in Missouri. Fewer than 5% of those surveyed reported a Federal agency as having been helpful. This leads to the conclusion that development of implementation of any seismic mitigation policy needs as a necessary, but not sufficient, condition for success the cooperation and backing of local levels of government. The types of governmental mandates and incentives which will contribute to obtaining this cooperation have been discussed elsewhere. Suffice it to say that local officials are most often concerned with the short term benefits and potential losses and heavily discount long-term benefits.

HOW TO GAIN THE ATTENTION AND COMMITMENT OF BUSINESS AND INDUSTRY

by
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INTRODUCTION

There are a number of actions or events which will help to concentrate the minds of business and industry on preparing for earthquakes. Among the most effective ones are the following:

1) **The actual occurrence of an earthquake**

This is not meant facetiously. Businesses located in earthquake-prone areas of the country are far more sensitive to earthquakes and, undoubtedly, much better prepared for them than are businesses located in areas which rarely experience such phenomena.

If earthquakes do not occur, it may be possible to gain the attention of business and industry by preparing for other kinds of emergencies. Such preparations almost always are a benefit in the event of earthquakes, although they are often inadequate.

2) **Publicity**

If most people are aware that they live in an area where earthquakes are expected to occur, businesses will respond to their perceived needs for planning and preparedness activities. By the same token, if the public is not aware that severe earthquakes may occur, it is unlikely that many businesses will spend the time, efforts, and resources necessary to develop appropriate preparedness plans.

Members of government, particularly at the State level and, in particular, State governors, can exert considerable influence in convincing companies to make adequate preparations. If a State governor is convinced that an earthquake in his State is likely, he can publicize this fact generally and speak to the business community at large or on an individual basis -- and can exert considerable influence on companies to undertake planning and preparedness activities.

3) **Seminars and Conferences**

Seminars and conferences are another form of publicity. They bring together knowledgeable people to discuss the likelihood of earthquakes and earthquake damages. They then publicize the results of their deliberations. Special conferences and programs aimed at business and industry can be put together. However, without supporting government publicity and pressure and without general awareness among the public, such conferences, even if specifically designed for business and industry, are not likely to be well attended.

4) **Credible Earthquake Predictions**

If earthquake predictions are developed for an area and are endorsed by the National Earthquake Prediction Evaluation Council (NEPEC), a flurry of earthquake planning and preparedness activity can be expected. However, the art of earthquake prediction is not sufficiently far advanced to make this a likely prospect.

5) **Private Business and Industry Leadership**

If some companies, particularly leading ones, are seen to be developing their own plans to deal with earthquakes, it is hard for other companies to dismiss these efforts out of hand. By the same token, if some companies are undertaking preparedness activities,

they may be willing to publicize these actions and host seminars and conferences explaining what they are doing and why.

How to Gain the Commitment of Business and Industry

Some achievable actions include:

1) Convince the business community that damaging earthquakes are probable within a reasonable period of time. Unless a company is convinced that a damaging earthquake is likely, it makes no sense for them to expend resources preparing for such an event.

2) Educate companies about earthquake hazards. Demonstrate to companies what kinds of buildings are hazardous during earthquakes and what kinds are considered resistant to earthquakes. Show how building structures and interiors can be strengthened to reduce earthquake damage.

3) Prepare cost/benefit analyses to demonsrate the economic value of being prepared for earthquakes. Show that relatively modest investments of time and money can protect against potentially enormous losses should earthquakes occur. Convince companies that measures taken in anticipation of earthquakes are often very effective in the event of other kinds of emergencies, such as: fires, explosions, and the like. Demonstrate that such preparedness measures do have an economic value to the company.

4) Show how liabilities for injuries and damage can be reduced or contained by adequate preparation for earthquakes. The conventional wisdom in companies is that unless negligence is proved, they are not likely to be held liable for injuries and damage caused by earthquakes; and that if negligence should be proved, their normal liability insurance will cover them. This proposition has not been adequately tested in the courts and so its validity is not certain. At the same time, many companies will find that their liabiltiy

insurance is inadequate in the event of an earthquake, where injuries and damage are extensive and can lead to enormous claims.

5. Establish an emergency planning position in the company. Most companies attach the emergency planning function to some other position. This means it represents one more thing to do for someone who is often already fully occupied if not overburdened. As a result, emergency planning tends to get overshadowed by the person's normal duties.

   If emergency planning is set up as a separate function, it will be the primary responsibiltiy of one or more individuals and will not be submerged by other activities. This will ensure that plans are developed and reported and the appropriate issues are raised, even if some company managers are reluctant to commit their limited resources to such projects.

A critical element in all of the above is that the senior management of the company be convinced of the value of emergency planning and support this activity. Without such support, no efforts by subordinates can bear fruit.

HOW TO GAIN THE ATTENTION AND COMMITMENT OF BUSINESS AND INDUSTRY

by

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INTRODUCTION

To suggest methods that will effectively gain the attention and commitment of business and industry so that they will begin implementing various actions to reduce losses from a major earthquake in the Mississippi Valley area will not be an easy task. The truth of the matter is that the attention and commitment of business and industry will be gained by many actions that occur from a multitude of directions over a long period of time. What I mean by this is that we, as a concerned group, are not going to be successful in gaining the attention and commitment of business and industry by going to them with specific actions and telling them that such actions must be implemented to reduce losses from earthquakes. If we are not careful, business and industry might begin to think of us as doomsayers and zealots. In the long run, the attention and commitment of business and industry will be gained by input from many directions that will culminate into specific actions. This input will come from the voiced concerns of the public about earthquake safety, voiced concern from the employees of business and industry, concern by management and how management perceives the hazards and risks, the manner in which the school systems are having to treat the risks, voiced concerns of the professional groups--engineers, scientists, and others, and code bodies that require specific actions.

Admittedly, if a major earthquake were to occur today in the Mississippi Valley, we would have gained the attention of business and industry, and in the ensuing days after the earthquake, we may even gain commitments. The type of business or industry, and to what extent they were impacted by such an earthquake, will have great bearing on the degree of commitment. However, it

is likely that the commitment will wane as time passes and no further seismic activity occurs. Commitments may wane to the point that business and industry introduce legislation to override seismic legislation based on previous commitments they strongly held immediately following the earthquake.

This introduction is a brief attempt to focus on the problem that will be faced by concerned individuals in the Mississippi Valley area as they try to gain the attention and commitment of business and industry. Although my statements of the problem may sound pessimistic, I believe that there are actions that can be initiated to gain the attention of business and industry and to obtain commitments that will be accepted as reasonable and worthwhile.

REGULATION

Unfortunately, or fortunately, depending upon your viewpoint, one way of gaining the attention and commitment of business and industry is through the regulatory process. The regulatory process is often the route taken when somewhat uniform standards or procedures are deemed necessary throughout business and industry. For example, the Occupational, Health, and Safety Act (OSHA) was passed and signed into law to get the attention of business and industry and to guarantee their continued commitment to their program. The requirement and approval of safety analysis reports concerning the nuclear industry and its respective utilities and the industries that operate Department of Energy facilities is another example of obtaining attention and gaining a continued commitment. Of course, code bodies are another form of the regulatory process that focuses attention and gains continued commitment. It might well be said that it would be best if business and industry adopted uniform commitments on a voluntary basis. Unfortunately, some will make commitments and keep them; whereas, others will make commitments and let them wane, and still others will not make any commitments at all.

EDUCATION

One of the greatest things that can be done to gain the proper attention and commitment of business and industry is to get them to understand the

earthquake hazards and risks that they are exposed to. As O. Clarke Mann stated in his paper at the 1981 Knoxville workshop, **"a successful product must be a good buy . . . to be a good buy . . . it must be cost effective."** If over the long run, and sometimes short run, business and industry see no real benefits, they will not commit.

ACTION PLAN

I wish to express some thoughts concerning various actions a concerned group might take initially to gain the attention of business and industry. They include:

1) Various lead businesses or industries should be identified. High technology companies are prime candidates since they may be facing high seismic hazards in other parts of the country or world and; therefore, have a better understanding. Insurance companies are another prime candidate. Other candidates are businesses and industries that stand to lose considerably if a major earthquake were to occur.

2) Key people having an interest in the seismic hazard problem should be identified within the potentially impacted businesses and industries. Engineers and scientists within such organizations are prime candidates.

3) Professional scientific and engineering groups (many of whose active members are supported by their business or industry) could develop model codes--codes that have been demonstrated as being cost-effective. Adoption of code provisions can occur if the professional organizations, business, and industry are supportive. It is my current belief that the adoption of the proper code provisions will be the most effective way to gain the attention and commitment of business and industry. However, this action puts us back into the regulatory process.

4) Many businesses and industries have current voluntary employee and public safety programs. It is possible that participants of this workshop could work with the managers of such safety programs to assist in educating employees and managers about earthquake hazards and risks.

Regardless of the approach or approaches a concerned body takes to attempt to gain the attention and commitment of business and industry, we should be cautious to avoid appearing as doomsayers or zealots. We must fully understand the hazards and risks, and we must communicate these hazards and risks in a prudent and reasonable manner.

HOW TO GAIN THE ATTENTION AND COMMITMENT OF BUSINESS AND INDUSTRY

by

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INTRODUCTION

To suggest methods that will effectively gain the attention and commitment of business and industry so that they begin activities to reduce losses from a major earthquake in the Mississippi Valley is difficult at best. However, not to suggest methods to gain their attention and commitment will result in society remaining totally unprepared for such an earthquake. Therefore, it is important that workshops such as the one held at St. Louis in May 1982, which this report summarizes and the one held in Knoxville, Tennessee, in September 1981, be conducted to address all of the issues pertaining to public and environmental safety and capital investment. Business and industry run the risk of substantial losses from public safety (employees, customers, etc.), environmental insult (toxic chemical releases, etc.), and capital if a major earthquake should occur. Because of the seismic hazards in the Mississippi Valley area, business and industry should take appropriate actions to reduce their losses from a major earthquake. Currently, very few, if any, have taken steps in this direction. This paper is intended to express some ideas on how concerned individuals and groups might gain the attention and commitment of business and industry.

CAUTION

Any individual or group of individuals should proceed with caution in trying to convince business and industry to take various actions to reduce losses from a seismic event. If the approach is not well thought out and organized, such an exercise can rapidly result in failure. An individual or group of individuals will not be successful by approaching business and industry and telling them that they must comply with certain seismic hazards

reduction measures without business and industry understanding the risks. The approach must be rational and it must be one that business and industry is willing to support. A misguided approach could easily be viewed by business and industry as being led by doomsayers and zealots.

AN EARTHQUAKE EVENT

If a major earthquake were to occur today in the Mississippi Valley, the attention of business and industry would be gained. This appeal would obviously be the "brute force" method. In the ensuing days after such an earthquake, business and industry would also make commitments. The type and degree of commitment would be heavily dependent upon the extent of the impact of the earthquake on the various businesses and industries--the greater the impact, the greater the commitment. However, regardless of the commitment given, it is most likely to wane as time passses and no further seismic activity occurs. Commitment could eventually wane to the point where new legislation might be introduced by business and industry to counter legislation they had previously introduced to provide public and environmental safety and protection of capital investment. Therefore, when business' and industry's attention and commitment have been gained by a major earthquake or for whatever reason, it is extremely important that concerned individuals and groups continue to work toward maintaining high levels of attention and commitment.

REGULATION

One way of gaining the attention and commitment of business and industry is through the regulatory process. The regulatory process is often the route taken when somewhat uniform standards or procedures are deemed necessary in business and industry. Two major examples are the Occupational, Safety and Health Act and the Environmental Protection Act. The requirement and approval of safety analysis reports in the nuclear industry and its respective utilites is another form of the regualtory process at work. Each of these regulations and others are preceived to be in place to protect the environment, the public, and employees. I hope that the attention and commitment of business and can be gained through a natural process rather than a forced regulatory process.

CODES AND STANDARDS

Building codes and standards have been developed by engineering and engineering-reglated organizations as guides for designing facilities to be earthquake resistant, thus, effectively reducing potential losses. In many cases, this may appear as the institution of the regulatory process and it is, to some extent. Codes and standards are necessary in today's society to assure equitable protection of the public. From the business and industry viewpoint, codes and standards drive costs up. Thus, if codes and standards are to be developed, it is imperative that engineers develop them to optimize public safety while minimizing cost.

To date, only a few States, municipalites, and counties have adopted existing seismic design provisions as part of their current codes and standards requirements. Some cites, such as Los Angeles, have not only adopted seismic design provisions but have also adopted retrofit requirements. Adoption of such regulation by cities is viewed by business and industry as very prudent because of the continuous reminder of the earthquake threat by noticeable earthquake occurences and recent large historical events. To adopt similar building code or standard provisions in a city such as Memphis, Tennessee, would be much more difficult because of the perceived low seismic threat and the perceived high costs of such provisions.

VOLUNTARY PROGRAM

Basically, there are only two ways that the attention and commitment of business and industry can be gained without the occurrence of a major earthquake. The first would be the forced regulatory process discussed above and the second would be on a voluntary basis. It seemed to be the consensus of the participants in the St. Louis and Knoxville workshops that the voluntary process is the approach that should be taken. Two general reasons might be attributed to this consensus: 1) To regulate seismic mitigation procedures such as building codes, employee-and public-awareness and education, evacuation procedures, earthquake prediction. litigation limits, etc., would be an extremely formidable process and, when applied in actural cases may not be effective, 2) Business and

industry, and even the public, have experienced a continued growth of the regulatory process during the past fifteen years and now seriously question the cost-effectiveness of any new regulation. Thus, in terms of earthquake regulation, tremendous resistance would likely be encountered.

The voluntary program is more acceptable to all. However, the task of gaining the attention of business and industry, and even the public, on a voluntary basis will require a major effort. Obviously, the activities discussed in other papers contained in this volume and the continued actions of the U.S. Geological Survey (USGS) and the Federal Emergency Management Agency (FEMA) is a beginning. All avenues of educating business and industry on the seismic threat must be taken. These avenues include educational programs directed at the public and more specifically, at the leaders of business and industry. Business and industry must understand what the risks are. The educational process can take place through new releases to the news media (papers, radio, and television), speakers bureaus set up for professional, civic, and fraternal organizations (Rotary Clubs, Lions Clubs, engineering associations, etc.), invitations to leaders of business and industry to attend conferences and workshops held in major metropolitan areas where a seismic threat exists, renewed or continued emphasis by city, county, or State emergency preparedness groups (assuming such groups already recognize the hazards and risks), formation of a seismic hazard/risk commission, and other similar activities.

PUBLIC PERCEPTION

The attention and commitment of business and industry can be gained if the public understands the earthquake threat and how to institute mitigating procedures. This will occur basically for two reasons: 1) there will be a considerable amount of pressure from the public, subtly or directly, for business and industry to institute mitigation activities if there is a real threat and 2) the leaders of business and industry are members of the public and, therefore, will understand the threat to their businesses and industries and voluntarily take mitigation actions.

SUMMARY

To gain the attention and continued commitment of business and industry will be no different from gaining the attention and continued commitment of the public. Before any mitigation activities can become effective, the public, business, and industry will all have to understand the seismic threat and the risks.

Some ideas were discussed above concerning alternative ways of gaining the attention and commitment of business and industry. The following could be identified as an action plan:

1) Lead business or industries should be identified as candidates for a seismic hazards reduction program. High technology companies are prime candidates because they may be facing high seismic hazards in other parts of the country or world and, therefore, may have a better understanding. Insurance companies are another prime candiate. Other candidates are businesses and industries that stand to lose considerably if a major earthquake were to occur;

2) Key individuals should be identifed within these businesses or industries that have an interest in the seismic hazard problem. Engineers or scientists within such organizations are prime candidates. They are likely to be more easily convinced of the seriousness of the problem and usually have direct contact with management;

3) Professional scientific and engineering groups (many of whose active members are supported by their business or industry) could develop model codes --codes that have been demonstrated as being cost effective. Adoption of code provisions can occur if the professional organizations, business, and industry are supportive. In the near term, it is my current belief that the adoption of the proper code provisions will be the most effecive way to gain the attention and commitment of business and industry even though it is thought of more as a regulatory process;

4) Businesses and industries have current voluntary employee and public safety programs. The managers of such safety programs should be contacted to assist in educating employees and managers of the hazards and risks.

In the final analysis gaining the attention and commitment of business and industry will require the use of these and other ideas disucssed by in this document. Two other papers also focus specifically on business and industry and contain excellent suggestions.

Gaining the attention and commitment of business and industry surrounding the New Madrid area (areas such as St. Louis, Memphis and Paducah, and Kentucky) and other areas subject to seismic threat in the Eastern United States will not be an easy task. It will take a dedicated effort by a groups of individuals, such as has been put together by the USGS and FEMA within the framework of the Knoxville and St. Louis workshops, and it will not occur overnight.

Progress has been made and will continue to be made as more people become aware of the earthquake threat, the risks involved, and actions that they can take to mitigate the consequences of a major earthquake.

THE MOST APPROPRIATE ROLE FOR VOLUNTARY AGENCIES

by

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INTRODUCTION

Voluntary agencies have a continuing and important role in earthquake response planning and public awareness efforts and can be active supporters of citizen action aimed at earthquake loss reduction.

From the Red Cross perspective, this kind of effort is not new, for the organization has been involved in planning for all kinds of hazards for many years. Planning for a major Mississipi Valley earthquake is now being added to the preparedness planning carried out by local chapters and regional offices in the seven-State areas that could be heavily impacted by a repeat of the New Madrid earthquakes.

Red Cross Disaster preparedness planning is linked closely to the planning of Federal, State and local emergency services agencies, with the Red Cross assuming specific responsibilities related to its congressional charter as a voluntary disaster relief agency. In developing response plans, the Red Cross works with other voluntary agencies and private sector groups ranging from organized labor to the Salvation Army to the Civil Air Patrol, many of whom now work together in the National Voluntary Organizations Active in Disaster. For example, the Red Cross is actively involved with the Federal Emergency Management Agency (FEMA), the California Office of Emergency Services, and various county and municipal agencies in planning for earthquake loss reduction in both southern and northern California. The southern California plan, for example, calls for the Red Cross to operate 1,000 shelters for emergency evacuees.

In California, the Red Cross has also joined forces with public officials and private industry to encourage plant-by-plant planning and awareness and to educate the public in self-protection. Information has been developed for the public in several languages; special materials have been developed for use in schools and by private industry. Included are specially developed slide-tape series keyed to the local areas with multi-lingual sound tracks and a nationally-produced five minute earthquake safety film for television and other use.

POSSIBLE ACTIONS

Insofar as citizen action is concerned, the Red Cross and other voluntary agencies are actively concerned about hazards mitigation as well as disaster planning, and they represent a tremendous potential constituency because they include most of the major religious groups. They can be catalysts for arousing community support for earthquake mitigaiton and outlets for public education on such matters. They can team up---and have done so---with groups such as the League of Women Voters and the environmentalists for this purpose.

The activities in California can be utilized as the basis for planning and public awareness education in the Mississippi Valley. However, there are problem factors that need to be considered. If the potential Mississippi Valley earthquake disaster is as great as predicted, there may be such a competition for resources that the smaller, more isolated communities in the epicentral area and elsewhere may have to be prepared to go it alone for a period of days, if not longer. This means stockpiling some kinds of supplies, intensified first aid training, plans for airdrops, etc. Also, general awareness and public education campaigns will need to be tailored to a large number of states and communities so that they have specific meaning for each population at risk. This is a lot of work, and it must involve the volunteer agencies in every risk area. They can supply a lot of resources and manpower.

Secondly and equally important, all of the planning and much of the public education must be based on a reliable forecast of what may happen. In California, everyone is working from the early seismic risk analyses done by the Federal Government (i.e., the NOAA/USGS report prepared for Federal Disaster Assistance Administration for the San Francisco, Los Angeles, Pudget Sound and

Salt Lake City areas). These are quite specific in terms of what is likely to happen, or at least specific enough for planners to know that they will need 1000 shelters in the Los Angeles area and where those shelters will need to be. From that figure they can postulate, fairly accurately, supply and manpower need. However, in the Mississippi Valley, there have been only a handful of prototype vulnerability studies, and, up until the time of this meeting, we have had no idea of what they showed. In flood and hurricane preparedness, planners and awareness campaigners have a host of flood-plain maps and other information sources available to them. Although voluntary agencies are quite willing to work with government agencies in preparedness, awareness campaigns, and mitigation efforts, they can be much more effective if they can relate to specific risk information for a given area. This problem is heightened by the fact that when the Mississippi Valley earthquake planning effort was initiated, it was related in the public and organizational minds to projections of a major earthquake likely to happen by the year 2,000. Now that projection has been countered by another scientific statement putting the repeat of the New Madrid earthquakes off for 150-250 years or more. The sense of urgency becomes diffused at a time when there are many more pressing social and econmoic priorities.

Thirdly, and this relates to a very special and important role that can be played by voluntary agencies, the Red Cross and the religious groups construct and operate a host of physical facilities---churches, schools, hospitals, recreation centers, etc. Such facilities would be primary locations for emergency relief centers and shelters, along with municipal auditoriums, fire houses, and public schools. If the groups operating them were to begin a program of retrofitting old buildings and designing new buildings for seismic resistance, and do so with attendant publicity, this could have a bellwether impact on the efforts of local, county and State governments to push for earthquake mitigation through improved construction standards. Suppose, for example, the Catholic Church in Memphis and St. Louis announced a program of retrofitting its parochial schools for seismic safety, wouldn't that bring pressure on the public school systems to do likewise? Again, such a movement would require fairly specific predictions of what would happen to such buildings in a major earthquake. In potential epicentral areas around New Madrid, Tiptonville, Poplar Bluff, and Blytheville, most public buildings slated for relief purposes are of brick and masonry construction that may fall apart in an earthquake. The emphasis could be

placed on the need for retrofitting these facilities for community protection and recovery, especially in view of the fact that these locations might be self-help areas for quite awhile.

CONCLUSION

The voluntary agencies can play many roles in earthquake loss reduction. The foregoing represents the major ones as seen from the perspective of an agency that has been involved in this kind of effort for many years. If government agencies leading the earthquake hazard mitigation effort involve the voluntary sector from the very beginning, many more such roles may well emerge.

THE ROLE OF THE ENGINEERING PROFESSION IN EARTHQUAKE MITIGATION

by

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INTRODUCTION

The engineering profession performs numerous tasks which contribute to an acceptable earthquake response, a few of which are listed below.

1) Engineers design and supervise the construction of most structures, facilities, and equipment which are important to a modern industrialized society.

2) Engineering education provides the training which enables engineers to build earthquake-resistant structures.

3) The vast majority of earthquake engineering research has been carried out by the engineering departments within the major universities of the country.

4) Engineers play a vital role in the formulation of model building codes.

5) Engineers, through their professional organizations and the National Academy of Engineering, conduct post-earthquake site visits so that the earthquake performance of structures and equipment can be evaluated. This is probably the single most important source of information for the upgrading of seismic elements of building codes.

6) In large part, it was through the engineering profession that the Federal government recognized the significance of the earthquake hazard and mandated funding in 1977 to address various aspects of the problem.

SUGGESTED ACTIVITIES

While this session addresses the question of how to gain the commitment of the professional societies, this would appear to be inappropriate for most engineering societies, as various segments of the engineering profession have been leading efforts at getting decisionmakers to consider the earthquake hazard. My own experience is that engineers and the engineering profession are willing participants in matters relating to the improvements of the earthquake response of the things which engineers build. This is not to say that the profession can not make significant contributions to the situation as it currently exists in the New Madrid earthquake impact area.

Some areas where the engineering profession can make contributions towards improving earthquake response in the Midwest are listed below:

1) The emergency planning community is, in part, geared to respond to all types of disasters. All disasters have many things in common so that a general response plan can have broad applicability. While each disaster has its unique features, a large earthquake has a particularly severe impact on the physical parts of the infrastructure which are so crucial to emergency operations. Of note are the effects on communication and transportation systems as well as other lifelines. The emergency preparedness community could use technical assistance so that they will have a better idea of the types of response that can be expected of these facilities and how their response might be improved.

2) There is a need to establish appropriate guides, standards, and codes that apply to critical facilities. These should be applied beyond structural design and should include performance standards for equipment.

3) While the engineering community does not have sole responsibility for model building codes, there should be an effort to ensure that the various model codes have consistent measures of seismic hazard for any given region of the country.

HOW TO GAIN THE ATTENTION AND COMMITMENT OF PUBLIC SERVICE ORGANIZATIONS, VOLUNTEER AGENCIES, AND PROFESSIONAL SOCIETIES

by

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CREDIBILITY

We must be credible to gain the attention and respect of organizations we are attempting to influence. I have used official technical materials in presentations to citizen groups, State political conventions, interest groups, and on local television programs.

The materials that have proven to be invaluable include:

1) Dr. Otto Nuttli's unpublished report and recommendations to FEMA, Region VII, 1981.

2) Dr. Charles Thiel's statements at the September 1981 conference, Earthquakes and Earthquake Engineering: The Eastern United States, and workshop, "Preparing for and Responding to a Damaging Earthquake in the Eastern United States," in Knoxville, Tennessee.

(3) The proceedings of the 1981 Conference, Earthquakes and Earthquake Engineering: The Eastern United States, Knoxville, Tennessee, (Beavers, 1981).

(4) The proceedings of the 1981 Workshop on "Preparing for and Responding to a Damaging Earthquake in the Eastern United States," in Knoxville, Tennessee (Hays, 1982).

I have personally given copies of these publications to key people in selected organizations including State and local elected officials, interest groups, scout leaders, teachers, and citizen groups.

Enlarged maps of the New Madrid seismic zone and slides showing phenomena such as Reelfoot Lake, land waves, and sand blows have also been helpful. We have much visible evidence of the effects of the New Madrid earthquakes; this evidence enhances the credibility of a presentation and should be utilized fully.

"Those who cannot remember the past are condemned to repeat it" is a helpful reminder. Fortunately we have eyewitness and historical materials describing the events during the New Madrid earthquakes in 1811-12. Family stories and Indian legends have been handed down. There is testimony from Congressional hearings as well as detailed writings by scientists who happened to be in the New Madrid area. These are a part of the necessary tools to establish credibility. I also emphasize the fact that as long as this old planet is alive and well, we will continue to experience earthquakes.

It is a challenge to deal with the "denial syndrome" that exists in every group. To respond to statements such as "the 1811-12 earthquakes were freaks of nature and have happened only once," I refer not only to recent geological studies but also to studies of ancient civilizations in the Mississippi and Ohio River valleys who totally abandoned their villages and the area on a cyclical basis. Dr. Dragoo in, Adena People, asks the intriguing question, "Why would groups of the Adena people want or find it necessary to leave the Ohio Valley, which had been their home for at least 500 years." Periods of decadence could take over in the Ohio and Mississippi Valleys on a cyclical basis.

INFLUENCING ORGANIZATIONS

In our efforts to influence organizations, we recognize that within all organizations people tend to behave in a predictable pattern mode. This is true whether the organization is a business, a religious organization, a volunteer organization, or even a military or political organization. We need to always be people watchers. There are frustrations, ambitions, and conflicts. There

are personal needs that must be satisfied. There is a need for security and for a sense of accomplishment and recognition. Decide what you want from the organization you are concentrating on and your priorities.

KNOW WHAT YOU WANT

Do you want:

1) A lobby group at the Congressional level for funding FEMA and USGS?

2) Studies at your local levels?

3) A lobby to influence State government? Dam safety legislation? Enhanced seismic codes?

4) To use the organization as a vehicle for public awareness? Distribution of safety materials? Development of safety earthquake programs within our schools?

We must always remember the individual needs and the organization needs. Human personality and ego needs are the number one problem, no matter what organization you are dealing with. We must always communicate, give praise, reward, and show appreciation.

I have tried it both ways in talking to groups about the New Madrid seismic threat. I am convinced that a policy of telling it like it is - STRAIGHT - no sugar coating is the most productive. Given the facts, people have the common sense to understand and react to a devastating threat in a positive manner. People are always eager to receive materials to take home and study. We must always remember:

1) Organizations will not work unless they have something useful to accomplish (in the eyes of their constituents).

2) Know yourself and your supporters. Amazing skills reside in the mind and heart of every person.

3) Delegate. Do not do all of the work yourself. People like to be a part of the authority and responsibility.

4) **SHOW** appreciation.

SELECTED REFERENCES

Mississippi Valley

Beavers, James E., (ed. 1981), Earthquakes and Earthquake Engineering: The Eastern United States, Ann Arbor Science, 2 Vols.

Clifton, Juanita W., 1980, Reelfoot and the New Madrid Quake, Asheville, N.C.: Victor Publishing Company, 84 p.

Fuller, Myron Leslie, 1912, The New Madrid Earthquake, Washington, D.C.: Government Printing Office, 119 p.

Hays, W. W., (ed., 1982), A Workshop on "Preparing and Responding to a Damaging Earthquake in the Eastern United States", Knoxville, Tennessee, September 1981, Proceedings of Conference XV, U.S. Geological Survey Open-File Report 82-220, 197 p.

Kentucky Messenger, December 27, 1969, "The Birth of Reelfoot Lake, Legend of Kalopin," Mayfield, Kentucky.

Merrill, Boynton, 1976, Jefferson's Nephews: A Frontier Tragedy, Princeton: Princeton University Press, 462 p.

Nelson, Weber A., "Reelfoot - An Earthquake Lake," in National Geographic Magazine, January 1924, Washington, D.C., pp. 94-114.

Nuttli, O. W., 1973, A Mississippi Valley Earthquake of 1811-1812, Intensities, Groundmotion, and Magnitudes, Seismological Society of American Bulletin, v. 63, p. 227-248.

Penick, James L., 1981, The New Madrid Earthquakes, Columbia Missouri: University of Missouri Press, 176 p.

Thiel, Charles C., and Morelli, U., 1981, Enhancing Seismic Safety in the Central United States, in Hays, W. W., ed., A Workshop on "Preparing for and Responding to A Damaging Earthquake in the Eastern United States," Knoxville, Tennessee, September 1981, Proceedings of Confrence XV, U.S. Geological Survey Open-File Report 82-220, p. 151-174.

Ancient Civilizations

Carnegie Museum, Annals of the Carnegie Museum, vol. 37, Pittsburgh: Carnegie Institute.

Dragoo, Don W., 1963, Mounds for the Dead: An Analysis of the Adena Culture, Pittsburgh: Carnegie Museum, 315 p.

Webb, William Snyder and Snow, Charles E., 1945, The Adena People, Lexington: University of Kentucky.

Organizational Theory

Burns, James MacGregor, 1978, Leadership, New York: Harper & Row, 530 p.

Fischer, Dalmar, 1981, Communication in Organizations, St. Paul, Minnesota: West Publishing Company, 418 p.

Grusky, Oscar and Miller, George A., The Sociology of Organizations: Basic Studies, New York: Free Press, 565 p.

Hall, Calvin Springer and Gardner, Lindzey, 1978, Theories of Personality, New York: Wiley, 725 p.

Hollander, Edwin Paul, 1978, Leadership Dynamics: A Practical Guide to Effective Relations, New York: Free Press, 212 p.

Klopf, Donald William, 1981, Interacting in Groups: Theory and Practice, Denver: Morton Publishing Company, 185 p.

A TARGETED PLANNING APPROACH FOR PUBLIC EDUCATION PROGRAMS

by

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INTRODUCTION

Since one of the major goals of this workshop is to develop strategies to educate the public about earthquake threat and what can be done about it, we must first resolve a basic question--**education about what, for whom, provided by whom**. If our approach is to be "targeted," we are not talking about one program. Our research in earthquake hazards has demonstrated that awareness of threat, knowledge of preparedness measures, and the attitudes toward mitigation are distributed differentially throughout the population. To plan any educational program without taking this variability into account might cause us to implement a program that has limited efficacy.

I would like to suggest a planning strategy that begins by breaking down the basic issue into its three components -- target groups, program objectives, and resources available to develop and implement these programs.

TARGET GROUPS

The first decision one must make is to whom is the educational program to be directed. Who do we want to educate? Several target groups exist including:

1) The general public,
2) Private enterprise,
3) Government agencies,
4) Earthquake-endangered groups (e.g., the aged, the handicapped),
5) The hard-to-reach (e.g., certain ethnic groups, non-English-speaking groups),

6. Institutionalized populations (e.g., the hospitalized, prisoners, students),
7. Utility and life line companies.

Local government and agency officials might be a good source of information when identifying and prioritizing target groups since they should be most familiar with the demographic profile of their communities. Then, in conjunction with emergency preparedness personnel, educational objectives could be formulated for specific target groups identified. Certainly, different educational programs and strategies may need to be developed depending on what objectives are selected for specific target groups.

PROGRAM OBJECTIVES

Second, it must be determined what these people should know and do about earthquake threat. There are at least six broad areas which could be used as objectives, either separately or jointly, for program planning:

1) To heighten awareness of the earthquake threat,
2) To inform about possible, pre-quake preparedness measures,
3) To inform about adaptive behaviors during a quake,
4) To inform about adaptive post-quake behaviors,
5) To encourage the implementation of personal or organizational preparedness plans and actions.

To heighten support for community hazard reduction actions these broad objectives could then be prioritized and specfic objectives within each category developed.

The identification of specific objectives, however, needs to be made with reference to specific target groups. For example, it may be that the general public's awareness of the earthquake threat needs to be raised but that this is an insufficient educational objective for utility companies.

Table 1 presents a format which could be used to begin the process of identifying and prioritizing target groups and the kinds of earthquake information that needs to be communicated to them.

The number of objectives and target groups for any such educational program will determine the type and extent of resources that will be necessary.

RESOURCES AND STRATEGIES

Once educational objectives for specific target groups have been defined, it must be determined how to communicate that information most effectively. Representative questions include:

1) What networks and organizations would be most efficient?

2) What kind of communication skills or media channels would be most effective?

3) What kinds of materials would be most instructive or motivating?

4) What resources (personnel, time, materials, in-kind contributions, etc.) are available for this effort?

By identifying target groups, it may be possible to encourge already-existing groups and organizations to involve themselves in this educational effort, particularly if the program objectives are seen as beneficial to members and if the objectives can be included in already existing activities of the organization. For example, programs to inform the elderly about precautions that can be taken before an earthquake might be included as part of senior nutritional programs through presentations by speakers or the distribution and discussion of literature at mealtime.

Using this approach, emergency planners and managers may devise area-specific educational programs well suited to their local populations. This design also allows for an incremental approach to public education by

stressing the prioritization of objectives and target groups. Once awareness has been raised for a particular group, the reformulation of objectives in terms of more specific actions to be encouraged or the identification of a new target group can be undertaken.

TABLE 1

A MODEL FOR IDENTIFYING TARGET GROUPS AND EDUCATIONAL OBJECTIVES FOR EARTHQUAKE PLANNERS AND MANAGERS

	EDUCATIONAL OBJECTIVES					
TARGET GROUPS	1. Threat Awareness	2. Preparedness Measures	3. During-Quake Actions	4. Post-Quake Actions	5. Taking Preparedness Measures	6. Taking Hazard Reduction Measures
1. General Public						
A.	A.	A.	A.	A.	A.	A.
B.	B.	B.	B.	B.	B.	B.
C.	C.	C.	C.	C.	C.	C.
D.	D.	D.	D.	D.	D.	D.
2. Private Enterprise						
A.	A.	A.	A.	A.	A.	A.
B.	B.	B.	B.	B.	B.	B.
C.	C.	C.	C.	C.	C.	C.
D.	D.	D.	D.	D.	D.	D.
3. Government Agencies						
A.	A.	A.	A.	A.	A.	A.
B.	B.	B.	B.	B.	B.	B.
C.	C.	C.	C.	C.	C.	C.
D.	D.	D.	D.	D.	D.	D.
4. Endangered Groups						
A.	A.	A.	A.	A.	A.	A.
B.	B.	B.	B.	B.	B.	B.
C.	C.	C.	C.	C.	C.	C.
D.	D.	D.	D.	D.	D.	D.
5. Hard-to-Reach Groups						
A.	A.	A.	A.	A.	A.	A.
B.	B.	B.	B.	B.	B.	B.
C.	C.	C.	C.	C.	C.	C.
D.	D.	D.	D.	D.	D.	D.
6. Institutionalized Populations						
A.	A.	A.	A.	A.	A.	A.
B.	B.	B.	B.	B.	B.	B.
C.	C.	C.	C.	C.	C.	C.
D.	D.	D.	D.	D.	D.	D.

REFERENCES

Nigg, Joanne M., 1982, Societal Response to the Earthquake Threat in the Eastern United States: Some Issues, Problems and Suggestions; Proceedings of Conference XV, U.S. Geological Survey Open-File Report 82-220, 77-91.

Gates, George O., 1982, Safety and Survival in an Earthquake, U.S. Department of the Interior/Geological Survey, U.S. Gov't Printing Office 361-618-1551/128.

Federal Emergency Mgmt. Agency, 1980, Earthquakes: Safety Tips for Earthquakes, U.S. Gov't Printing Office 330-454.

A TARGETED PROGRAM OF PUBLIC EDUCATION: A PSYCHOLOGICAL PERSPECTVE

by

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INTRODUCTION

A psychological perspective on public education addresses the question, "How to behave regarding an earthquake." Behavior can be subdivided into actions, feelings, and beliefs so that the education efforts can be focused more sharply and thus have a higher probability of influencing behavior.

As educators of the public, we are concerned about either promoting or preventing different types of behavior before an earthquake occurs, during the earthquake itself, and after it has happened. Actions, feelings, and beliefs, can be analyzed for these three time periods, pre-, trans-, and post-disaster. Figure 1 suggests some of the major behavior patterns of concern to the individual in the specific environment of an earthquake. Reference to these patterns provides a basis for recommending specific public education programs to either promote or reduce the behaviors noted.

PRE-EARTHQUAKE PUBLIC EDUCATION

Attempts to orient the general public toward appropriate actions, feelings, and beliefs about an earthquake should be divided into efforts that take place before an earthquake has occurred and those that occur after the initial major earthquake. The "psychology" of the recipient is likely to be qualitatively different at these two times, in the sense of receptivity to being influenced, need for information, and the emotional tone with which messages are received and interpreted. In the pre-earthquake phase there is a natural tendency toward the use of palliative defenses such as denial and avoidance. Public education needs to overcome two rather strongly held

	BEHAVIORS		
	Actions	**Feelings**	**Beliefs**
Pre-earthquake	Preparedness of self, family, home	(Low arousal levels and vague feelings)	Overcome "denial"
	Rehersal of protective behavior		Promote realistic expectations for different levels earthquake damage
	Planning for family communications		Promote belief that individual actions are important
Trans-Earthquake	Promote instrumental behavior optimal for survial and injury avoidance	Direct feelings to appropriate action	Reduce helplessness
		Promote controlled catharsis and sharing of feelings	Promote belief in utility of action
Post-Earthquake	Promote cooperation with authorities and rganize social responses	Accept dysphoric and anxious feelings as normal	Promote belief in long-term ability for successful coping
	Promote individual initiative and responsibility	Promote sharing of feelings with others and eliciting feelings from others	
		Promote help-seeking as appropriate for persistence of dysphoria	

Figure 1. Target behaviors of concern to a public education program regarding a midwest earthquake.

beliefs. One is that an earthquake will not happen, especially in the midwest, and the second is that individual actions are ineffective even if an earthquake should occur. (Logically inconsistent beliefs such as these are often held concurrently by people.) The attitude of expected helplessness can be reduced in several ways. A primary method for reducing anticipated helplessness is rehersal of protective actions to be taken during an earthquake. These not only increase the chances of survival and injury reduction, but promote a positive belief in individual efforts during an earthquake. A public education program might also convey an expectation of positive support by telling recipients the kinds of aid and information they will be receiving should an earthquake occur.

POST-EARTHQUAKE PUBLIC EDUCATION

Disasters arouse a variety of dysphoric and anxious feelings, some of which persist for many months following the disaster. These adverse psychological reactions are especially prominent in very severe and unexpected disasters, although they are transient for most survivors of most disasters in this country. An important focus of a public education program post-earthquake is the message that unpleasant feelings and sub-clinical symptoms, such as sleeplessness, irritability, and fatigue, are normal reactions to extreme events.

Actions to be promoted post-earthquake include both the taking of individual initiative and responsibility and cooperation with social rehabilitation efforts. There is usually no difficulty in promoting these as they seem to be natural reactions to most disasters in this country. Likewise, there is usually a strong belief in the long-term ability for successful coping with a disaster event both individually and socially, and a program for public education should enhance this belief.

WHO IS RESPONSIBLE FOR A PUBLIC EDUCATION PROGRAM?

The behaviors to be influenced regarding an earthquake fall under the domain of many different agencies, organizations, and channels of communication. For example, protective actions to be taken trans-earthquake

are a concern of civil defense, Red Cross, and other security organizations, while emotional responses following an earthquake would be of major concerns to mental health and crisis intervention services. A program of public education would be most efficient if it were to concentrate its efforts on the credible organizations that already exist and that relate to the behaviors that are desired before, during, and after an earthquake. It would seem important to increase the involvement of these opinion molders as a major part of public education program, rather than trying to focus exclusively on messages to the general public.

It is important from a psychological perspective to separate actions from beliefs regarding an earthquake. Appropriate, protective actions can be rehersed, learned, and carried out in spite of the fact that an individual may not accept a scientific explanation of the earthquake itself. Informational messages should concentrate less on convincing others about why earthquakes occur than on the expectations for damage at various levels of intensity, actions that should be taken with regard to protection and reduction of injury, and how to promote individual and social healing and rehabilitation in the aftermath of an earthquake.

SOME SUGGESTIONS FOR BEGINNING A TARGETED PROGRAM FOR PUBLIC EDUCATION

by
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INTRODUCTION

The problem of reducing losses from earthquakes in the Mississippi Valley area is broad in scope and will require the interaction of many different groups. Addressing only one aspect of this problem, that of public education, is a multi-faceted task. Other members of this panel have discussed the need for assessing the public's earthquake hazard awareness and for devising the best methods for reaching the various segments of the public (see papers by Nigg, Hartsough, and Palm). I would like to suggest a few steps that can be implemented to educate the public in the near future with a moderate amount of effort and expense.

SUGGESTED ACTIONS

The task of bringing the general public to an optimum level of earthquake hazard awareness necessarily includes educating individuals about what to do before, during, and after a quake. In our eagerness to convince the public that the hazard is real, we must be careful not to paint such a bleak picture that they feel the situation is hopeless and that any effort on their part is futile. Nigg (1982) points out that moderate levels of fear produce a more positive response to preparedness measures than do low or high levels.

Now, how do we go about this massive education campaign? First of all, some excellent materials on earthquake preparedness already exist. As I read through several pamphlets, I was struck by the simplicity of some of the safety measures they suggested. I might never have thought to take them if I had not read about them before being caught in a damaging earthquake. Many people know better than to run outside and stand next to the chimney during an earthquake, but do they know how to turn off the gas at their homes or where

they work? This one bit of knowledge, if widely known, could prevent a large proportaion of the property damage and loss of life that accompanies a major earthquake. Some of these brochures are gems of brevity and clarity and could easily be included with other material being mailed to large segments of the population. They would be more effective, however, as a follow-up to a talk, film, or slide show about earthquakes. Personnel at the Tennessee Earthquake Information Center frequently give talks to civic groups and school science classes, so we already have an excellent opportunity to begin educating the public. This rather random approach could be greatly improved if we enlist the teachers in the process, perhaps through seminars at State or regional teachers' meetings. If a prepared program were available for use in each area, perhaps through the civil defense offices or public libraries, training seminars could be held for volunteers willing to present it to civic and church groups, senior citizens' organizations, etc.

The role of the mass media will be addressed by the next panel, but let me comment that television may undoubtedly be the most effective single way to reach the largest number of people with the least effort. An excellent presentation on what to do during a tornado was shown on one of the Memphis TV stations recently. Presented in a question and answer format, it ran as part of both the 5 o'clock and 10 o'clock news programs for several evenings. A similar presentation on surviving large earthquakes could be instrumental in reducing casualties.

Probably the most difficult aspect of our job will be to maintain, during the long periods between earthquakes, whatever measure of awareness we manage to raise and to remind the public periodically of the correct course of action. During National Fire Prevention Week, school children take home a check list and are asked to inspect their homes for fire hazards. Perhaps an annual "Earthquake Preparedness Day" could coincide with the anniversary of one of the great New Madrid quakes and serve as a reminder to review safety measures and survival procedures.

These suggesions are meant only as a starting point until adequate information is available to launch a comprehensive and efficient program of public education.

REFERENCES

Nigg, Joanne M., 1982, Societal Response to the Earthquake Threat in the Eastern United States: Some Issues, Problems and Suggestions; Proceedings of Conference XV, US Geological Survey Open-File Report 82-220, p. 77-91.

Gates, George O., 1982, Safety and Survival in an Earthquake, US Department of the Interior/Geological Survey, US Gov't Printing Office 361-618-1551/128.

Federal Emergency Mgmt. Agency, 1980, Earthquakes: Safety Tips for Earthquakes, US Gov't Printing Office 330-454.

A TARGETED PROGRAM OF PUBLIC EDUCATION

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INTRODUCTION

In previous discussions of public education for earthquake hazard mitigation, it was pointed out that merely increasing the general awareness of earthquake hazards is insufficient in itself to engender the adoption of preparedness and mitigation measures (Nigg, 1982). I would like to extend these arguments to suggest that policymakers might go beyond a consideration of factors affecting motivation to the analysis of measures which might encourage the adoption of mitigation strategies without accompanying attitude change.

It should be noted first that policymakers must agree on what kinds of action they wish individuals or organizations to take as a result of any program of public education. If what is sought is storage of food and water by households, or the availability of flashlights, battery radios, and the like, then the type of strategy to be adopted is quite different than if support is sought for the rezoning of residential land into public parks. It is, therefore, important that those engaged in public education campaigns specify in advance the actions they intend the general public to adopt as a result of their program of public education. I would like to outline some of the factors affecting decisionmaking based on an outline devised by Cook and Berrenberg (1981).

AFFECTING INDIVIDUAL BEHAVIOR

Individual behavior may be affected (1) by promoting attitudes favoring a response to earthquake hazards, (2) by evoking attitute consistent behavior on the part of those already aware of the hazard, (3) by inducing hazard mitigation behavior with external incentives, (4) by making mitigation

behavior more feasible, and (5) by providing feedback when mitigation measures are adopted. Although each of these alternatives has not been used in inducing hazard mitigation behavior, this set provides an outline for further exploration of alternatives in public policy. Let us use as our example of individual mitigation behavior the storage of food and water.

Promoting attitude change

The study of attitude change is probably the area about which social scientists know most vis-a-vis hazard response. The approach involves persuasive communication--the encouragement of mitigation behavior based on the premise that if people believe there is a need for mitigation behavior, they are more likely to adopt mitigation practices. Involved in public education campaigns would be the provision of information about the hazard, predictions about negative consequences associated with the hazard (destruction to property or loss of life, for example), and recommendations concerning actions to mitigate the consequences of the hazard.

Persuasive communication is affected by source credibility (Hovland, Janis and Kelley, 1953) (Is the information source objective? Is this source an expert in the field?), the nature of recommended change, the level of fear appeal included in the message, the feasibility of the recommended action, the specificity of the recommended action, and the context of communication.

A few of these points may need further elaboration. With respect to the recommended changes, these are more likely to be adopted if they do not deviate much from existing beliefs, if they are easy to adopt, and if they have been specified in some detail (Weigel, 1979). For example, if a person is already preparing for earthquake hazards through the pruchase of earthquake insurance, he will be far more likely to adopt the storage of food and water as well; or if he is storing food and water because of religious beliefs, the transfer of such activity as a response to earthquake threat is also more likely. The impacts of fear appeal are apparently complex, with contradictory research results - but it is generally accepted that the higher the level of fear arousal, the greater the persuasion (Higbee, 1969; Levanthal, 1970; Cook and Berrenberg, 1981).

The context of the communication refers to the existence of other evidence concerning the reality and importance of the hazard (Cook and Berrenberg, 1981). For example, if a hazard awareness campaign were coincident with publicity about the damages associated with a major earthquake elsewhere, it would be more likely to elicit a response than in a more neutral context.

Finally, the influence of a hazard information campaign is mediated by attitudes of individuals: For example, the extent to which individuals are confident that institutions will come to their rescue in any case ("the government will bail us out"), or the extent to which individuals believe that actions are beyond their control ("when your number is up there is nothing you can do about it"), (McGuire, 1968; Baumann, 1980).

Evoking attitude consistent behavior

It has been noted that even when individuals have attitudes which are consistent with the adoption of mitigation measures, they may still fail to adopt these measures. A second set of strategies aims at encouraging attitude-consistent behavior. This involves directing the attention of individuals already predisposed to adoption of mitigation measures to adopt appropriate behavior (Delprata, 1977) - in other words, in our case, a suggestion that food and water should be stored, with reminders at the point of action (accompanying water bills, or at grocery or supply stores), and at a time appropriate for action.

External incentives

It is also possible to encourage mitigation regardless of the attitudes of individuals to earthquake hazards by providing external incentives. Material incentives have been found to be effective in encouraging conservation behavior (McClelland and Cook, 1980). It is therefore possible that tax incentives for purchases of food to be stored (in our example) would encourage such mitigation behavior even in those not convinced that an earthquake is an actual personal threat; similarly, if homeowners were

convinced that through the storage of food they could save considerable sums of money, they might engage in this activity regardless of their attitudes towards hazards.

The influence of material incentives may partially account for the observation that many California residents do not currently adopt mitigation measures. Their nonresponse may be linked with the absence of material incentives - although it might be "wise" for California residents to pay for structural reinforcements to strengthen housing against earthquakes or to purchase earthquake insurance, such investments cannot be recouped in subsequent house sales and are therefore seen as material DISINCENTIVES.

Social incentives might also be invoked. Social rewards include publicity for the household which adopts mitigation strategies or the provision of models of mitigation behavior in prominent people who endorse the storage of food and water (Katz and Lazarsfeld, 1955).

Making mitigation more feasible

Even if positive attitudes towards mitigation exist, or external incentives for such behavior are in place, there may still be further barriers. It is necessary that knowledge about appropriate practice be provided, and that alternatives become widely available without excessive expenditures of time or money (Winett and Neal, 1979; Reichel and Geller, 1981). Similarly, mitigation measures are more likely to be accepted if they are not accompanied by unusual costs or discomfort.

Feedback

Finally, individuals are more likely to continue with hazard mitigation behavior if there is feedback provided to them - when their relative comfort is noticeably higher than households which had not adopted mitigation measures or when they are reminded of the cost-savings of a hazard mitigation measure (Bilodeau and Bilodeau, 1961).

I should note that the lack of impact of the Alquist-Priolo special studies zones disclosure legislation on California homebuyers was at least partly a function of several of the above conditions not being met (Palm, 1981a, 1981b). Real estate agents making the disclosure were not a highly credible source of hazards information; there was little fear introduced in the message conveyed; no recommended action accompanied the disclosure; and the disclosure took place within a context which minimized its probable impact-amidst the signing of large volumes of paper in drawing up the purchase contract. External incentives to ignore the disclosure abounded. There was no obvious gain to homebuyers avoiding special studies zones for other neighborhoods in terms of appreciation in house values, nor from the purchase of earthquake insurance or other costly hazard mitigation measures including structural reinforcement of existing dwellings.

BEYOND INDIVIDUAL BEHAVIOR

Individual behavior is affected by the actions of many institutions - for example, the impacts of safety campaigns by schools and employers have already been discussed (Nigg, 1982). Governmental regulation (such as anti-discrimination laws) can coerce individual behavior, or government agency incentives (such as tax credits) can induce behavior change.

One institution that profoundly affects the household location decision, and could have a far more important role in affecting the occupancy of geologically hazardous areas, is the home mortgage lender. In setting the requirements for the mortgage loan, the lender can inform a prospective buyer about geologic characteristics which may threaten safety and reduce future property values. Lenders may simultaneously inform buyers about geologic hazards and protect their own investments in property by setting relatively more stringent requirements on property located in hazardous zones: among such requirements would be larger downpayments, higher points or loan chargers, or mandatory earthquake insurance.

A survey of twelve of the largest home mortgage originators in the state of California with portfolios containing a combined total of $72 billion in residential loans was undertaken in the summer of 1981. It was found that

there is a wide variety in the response of lenders to earthquake hazards - from refusing all loans on property underlain by surface fault traces, to requiring earthquake insurance on certain classes of dwellings, to no response whatsoever (Palm, 1981c).

The complexity of factors entering into this highly varied set of responses to earthquake hazards can be expressed as a combination of:

1) General portfolio analysis - the standard economic assessment of assets, liabilities, extent of liquidity, prevailing interest rates and relative returns from various types of investments given regulations governing particular types of lending institutions,

2) Corporate assessment of earthquake hazards - the resolution of individual judgements within the corporate structure,

3) Individual judgements - not independent of corporate structure and conceptualized as as:

    a) General information concerning the location and probability of damage at particular sites,

    b) The effects of heuristics (the use of particularly memorable events as a basis for judgment of miscalculations of low probabilities to minimize uncertainty) (Slovic et al, 1980),

    c) Desires of corporate officers to appear to be aggressive and risk-takers or conservative and risk-avoiders, as they perceive this to affect their professional advancement.

This complex of factors affecting corporate decisionmaking indicates that simple media campaigns or even directed workshops may not have the impacts intended by those charged with public information provision. More detailed knowledge of organizational communication patterns, particularly insofar as they affect responses to natural hazards, is clearly called for as a predecessor to targeted public education campaigns.

SUMMARY

A program of public education should consider not only those factors which affect the attitudes of individuals, but also those actions which motivate individuals to adopt behaviors regardless of attitude, and those factors affecting the behavior of institutions such as government or private industry. It may be that focussing attention on certain institutions that constrain individual choices--such as real estate agencies and home mortgage lenders--may be the most efficient way of achieving the presumed goals of public education - the adoption of preparedness and mitigation measures by large numbers of households.

REFERENCES

Baumann, D. (1980). Notifying Floodplain Residents: An Assessment of the Literature. Chicago: Illinois Department of Transportation.

Bilodeau, E. A., and Bliodeau, I. (1961). "Motor-skills learning." Annual Review of Psychology, Vol. 12, pp. 243-80.

Cook, S. W., and Berrenberg, J. L. (1981). "Approaches to encouraging conservation behavior: a review and conceptual framework, Journal of Social Issues, Vol. 37, pp. 73-107.

Delprata, D. J. (1977). "Prompting electrical conservation in commercial users," Environment and Behavior, Vol 9, pp. 433-40.

Higbee, K. (1969). "Fifteen years of fear arousal: Research on threat appeals, 1953-68." Psychological Bulletin, Vol. 72, pp. 426-44.

Hovland, C. I., Janis, I. L., and Kelley, H. H. (1953). Communication and Persuasion: Psychological Studies of Opinion Change. New Haven: Yale University Press.

Katz, E. and Lazarsfeld, P. F. (1955). Personal Influence. New York: Free Press.

Kunreuther, H., with Ginsberg, L., Sagi, P., Slovic, P., Bordin, B., and Katz, N. (1978). Disaster Insurance Protection: Public Policy Lessons. New York: John Wiley and Sons.

Leventhal, H. (1970). "Findings and theory in the study of fear communications.: In L. Berkowitz (Ed.), Advances in Experimental Social Psychology, Vol. V. New York: Academic Press.

McGuire, W. J. (1968). "Personality and Susceptibility to Social Influence." In E. F. Borgatta and Lambert, W. W. (eds.) Handbood of Personality Theory and Research. Chicago: Rand McNally.

Nigg, J. (1982). "Societal response to earthquake threat in the Eastern United States: Some issues, problems, and suggestions," in Proceedings of Conference XV, A Workshop on "Preparing for and Responding to a Damaging Earthquake in the Eastern United States," USGS Open File Report 82-220, pp. 77-91.

Palm, R. (1981a). "Public response to earthquake hazard information," Annals, Association of American Geographers, Vol. 71, pp. 389-99.

Palm, R. (1981b). Real Estate Agents and Special Studies Zones Disclosure: The Response of California Home Buyers to Earthquake Hazards Information. Boulder: University of Colorado, Institute of Behavioral Science Monograph #32, 147 pp.

Palm, R. (1981c). "Special Studies Zones and Home Mortgage Lending Policies," Paper presented at the meeting of the American Real Estate and Urban Economics Association, Washington, D.C., December, 1981.

Reichel, D. A. and Geller, S., (1981). "Applications of behavioral analysis for conserving transportation energy. In A. Baum and J. E. Singer (Eds.) Advances in Environmental Psychology, Vol. III. Hillsdale, N.J.: Erlbaum Associates.

Saarinen, T. F. (1979). "The Relation of Hazard Awareness to Adoption of Approved Mitigation Measures," University of Colorado, Natural Hazards Research and Applications Center Paper, Mimeo.

Slovic, Paul, Fischoff, Baruch, and Lichtenstein, Sara (1980). "Facts and fears: understanding perceived risk" in Richard Schwing and Walter Albers (Eds.) Societal Risk Assessment: How safe is safe enough? New York-London: Plenum Press, pp. 181-214.

Slovic, p., Fischoff, B., Lichtenstein, S., Corrigan, B., and Combs, B., (1977). "Preference for Insuring Against Probable Small Losses: Insurance Implications." Journal of Risk and Insurance, Vol. 44, pp. 237-58.

Weigel, R. H. (1979). "The Behavioral Implications of Knowledge: Lessons from the Attitude-Behavior controversy." Unpublished paper prepared for the National Institute of Education.

Winett, R. A. and Neale, M. S. (1979). "Psychological framework for energy conservation in buildings" Energy and Building, Vol. 2, 101-116.

ROLE OF NEWS MEDIA AND THE EARTHQUAKE PROBLEM IN THE CENTRAL MISSISSIPPI VALLEY

by
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INTRODUCTION

News media are a critical element in getting information to the public on the earthquake problem in the Central Mississippi Valley, both before and after a major earthquake occurs. Government agencies, universities, and other organizations involved in earthquake research, planning, and disaster response and recovery operations need to cooperate with news media so that vital information can reach the public. In turn, news media need to be aware of sources of earthquake and disaster information available from government agencies, universities, and other organizations and need to develop contingency plans for covering and coping with earthquakes.

This paper is based on a discussion by a panel composed of the author; Jim Adams, assistant city editor of the St. Louis Post-Dispatch; Al Wiman, a reporter for KMOX-TV in St. Louis; Eric Newhouse, St. Louis bureau chief of Associated Press; and Frank Begley of Kansas City, Mo., Deputy Division Chief for Region 7 of the Federal Emergency Management Agency (FEMA) and formerly a public affairs officer for FEMA.

ROLE OF NEWS MEDIA

Government agencies, universities, and other organizations involved in earthquake studies or in disaster operations, for the most part, do not reach the public directly with earthquake information. Instead they rely on news media for dissemination of information. This is accomplished mainly through news releases and other material released by public affairs offices of the organizations or through other formal or informal release of information.

For example, the U.S. Geological Survey, St. Louis and Purdue Universities, the Tennessee Earthquake Information Center at Memphis State University, and various State geological surveys have done considerable research in recent years on past earthquakes and the potential for future earthquakes in the Central Mississippi Valley from St. Louis to Memphis. The work of these agencies has been reported to news media by public affairs offices of the organizations, and the stories have received considerable coverage in news media in the region. But the serious, potential earthquake hazards in the area are a continuing story that needs to be told and retold, especially when research adds new information or perspectives on the potential for loss.

News media in the region need to be aware of the USGS, the universities, the State surveys, and other sources of research and information on the earthquake problem in the Mississippi Valley area. In turn, the organizations involved in the earthquake problem need to continue and, if necessary, improve their efforts to get information and data to the public via news media. This is necessary if the public is to understand the potential earthquake hazards in the region, what can be done to prepare for earthquakes, and what should be done during and after a quake occurs.

ROLE OF FEMA AND OTHER GOVERNMENT AGENCIES

If a devastating earthquake occurs, much of the news emphasis will shift away from research and scientific agencies to other government agencies, such as FEMA; State offices of emergency services; Federal and State disaster-relief agencies; and State and local agencies involved in rescue operations, fire fighting, law enforcement, and road and bridge clearing and repair.

Presumably, the President would issue a disaster-area declaration after a major earthquake in the region. This would authorize FEMA to move in to coordinate disaster relief and other disaster operations. Among its many activities, FEMA normally sets up a disaster information and news center in or near a disaster area. All government agencies involved with the disaster are asked to help staff the center with representatives from their public affairs

or news offices or other appropriate personnel, with the overall operations of the center coordinated by FEMA.

FEMA provides support services, such as recorded telephone-message updates, printed news updates, and arrangements for news conferences. Thus, news media can contact one place and have access to information from any or all of the government agencies involved in the disaster, rather than having to contact each government agency separately. Also, news conferences arranged by FEMA can include representatives from various government agencies.

FEMA, as the Federal coordinating agency, needs to have contingency plans, as detailed as feasible, for setting up such a news and information center in case of a major earthquake in the Mississippi Valley and also have contingency plans for dealing with news media. For example, since most newspapers and radio and television stations may be out of operation, FEMA should have plans ready to provide communications support to news media, such as receivers for wire-service transmissions and emergency transmitters for radio stations whose own transmitters may be out of operation.

Based on experiences in the Mount St. Helens eruption of 1980, a FEMA news and information center cannot satisfy all needs and requests of news media for information from government agencies. Often, reporters want field-site stories that require cooperation of agency public affairs representatives. Thus, government agencies need to plan not only how to staff the FEMA information center, but also how they can respond to news media requests for such things as interviews with agency staff members working in the field or for simple access to the disaster area. For example, FEMA may need to provide assistance in obtaining transportation, such as helicopters, for news media as helicopters may be the only practical way to get reporters into the zone of devastation and to get news out again. Without such communications assistance to news media, there may be no effective way to get news to the public.

NEWS MEDIA MUST REMAIN INDEPENDENT

News media, while cooperating with government agencies during an earthquake disaster, must be careful to retain their arms-length, often adversary relationship with government. As one editor put it, news media must maintain their independence and not become arms of the Federal or a State government.

NEWS MEDIA SHOULD PLAN TO COPE WITH EARTHQUAKES

News media should consider what effects a major earthquake could have on their own news operations and how they can plan to take care of any disruptions to their operations. For example, electric power and telephones may be out; highways may be blocked; bridges may be down; buildings that house news media operations may be destroyed or damaged; news media staff members and correspondents may be among the casualties or otherwise unable to get to work; newspaper press may be damaged or in buildings unsafe to enter; and radio and television transmitters may be knocked out. In other words, local news media may not be able to operate for some time after a major earthquake occurs. The more planning they do in advance, the more likely they will be able to continue operating or to get back in operation sooner. For example, many television stations use helicopters for news crews. Following an earthquake, however, they probably would need many more than their normal one or two helicopters, because roads and bridges may not be passable. It is clear, however, that helicopters will be in demand to serve many purposes following an earthquake. Reserving additional helicopters for use after an earthquake would enable them to do a better job of covering the disaster.

Newspapers could arrange beforehand to have their editions printed at other plants if their own presses are inoperable after an earthquake. Radio stations could arrange for alternate transmission towers. Mutual cooperation between normally competing news media may be one way to continue getting news to the public after a major earthquake. For example, if a daily newspaper cannot publish because of inoperable presses, it might agree with a still-operating radio station to help the station gather and broadcast news. Since newspapers normally have much larger reporting and editing staffs than radio

broadcast news. Since newspapers normally have much larger reporting and editing staffs than radio stations, this would greatly increase the news-reporting capacity of the radio station.

Immediately after a major earthquake, radio stations and news wire services Associated Press (AP) and United Press International (UPI) could be the most effective disseminators of news. If electric power is out, radio stations with emergency-power sources could still get news out to people who have battery-powered radios. Because news wire services have bureaus in numerous cities in the nation, they may be able to get news out of the disaster zone to bureaus in other areas by telephone, radio, or other means, even if their local bureaus are unable to transmit news reports to newspapers and broadcast stations. AP and UPI could get this news back into operating news media in the earthquake zone, even if land transmission lines are knocked out.

Professional news organizations, such as State press or broadcast associations, should consider conducting studies, making surveys, holding seminars, or otherwise looking into the problem of whether news media in the Central Mississippi Valley need to be better prepared for major earthquakes. Such concern by these organizations might encourage individual news media to look at their own situations and make better preparations for earthquakes.

SUMMARY

Government agencies and news media have critical roles in getting earthquake information to the public in the Central Mississippi Valley, both before and after a quake occurs. This information could be vital to public safety and welfare. Government agencies and news media should have operations and contingency plans designd to make this transfer of information to the public as efficient as possible.

FORMS AND FUNCTIONS OF SEISMIC SAFETY ORGANIZATIONS

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INTRODUCTION

Many States in the Mississippi Valley and in other seismically active areas recognize the need for a seismic safety organization to implement the action plans developed at this workshop and an earlier workshop held in Knoxville, Tennessee. This paper addresses the possible functions seismic safety organizations can perform and the orgnizational forms they can take. As an example, the Utah Seismic Safety Advisory Council's form and functions will be explored.

Most membership service organizations perform one or more of these types of functions:

Information Services

1) Collect and share information (e.g., secretariat) including:

   a) Specialized library of books, roster of names,

   b) Inquiry and research (e.g., reference service).

2) Prepare information pieces including:

   a) Specialized newsletter,

b) Research briefs, maps, and analyses,

c) Monographs, and professional papers.

3) Perform or manage research (seek State and Federal grants).

Educational, Training, and Assistance Services

1) Offer courses, other training.

2) Take lead role in bring new information to attention of members

3) Provide indirect (direct) technical assistance to localities.

Advocacy Activities--pushing for advances in earthquake plans preparedness.

1) Advocate State actions including:

a) inclusion of seismic resistant element in local general plans,

b) inclusion of seismic element in State building codes.

2) Advocate local actions (e.g., land use controls).

Review and Regulatory Activities

1) Review on a State-by-State basis seismic safety code revisions in order to draft provisions applicable to the region.

2) Review designs and construction standards for public buildings.

3) Set standards for public buildings as example for private sector.

Regional and National Representation

1) Advocacy functions may be pursued at a multi-State level or national level.

2) The organization may serve as a focal point or present a presence, for national attention, publicity, inquiries, etc.

A graphic description of these categories of functions, which may be achieved incrementally, follows.

POSSIBLE FUNCTIONS FOR A SEISMIC ORGANIZATION

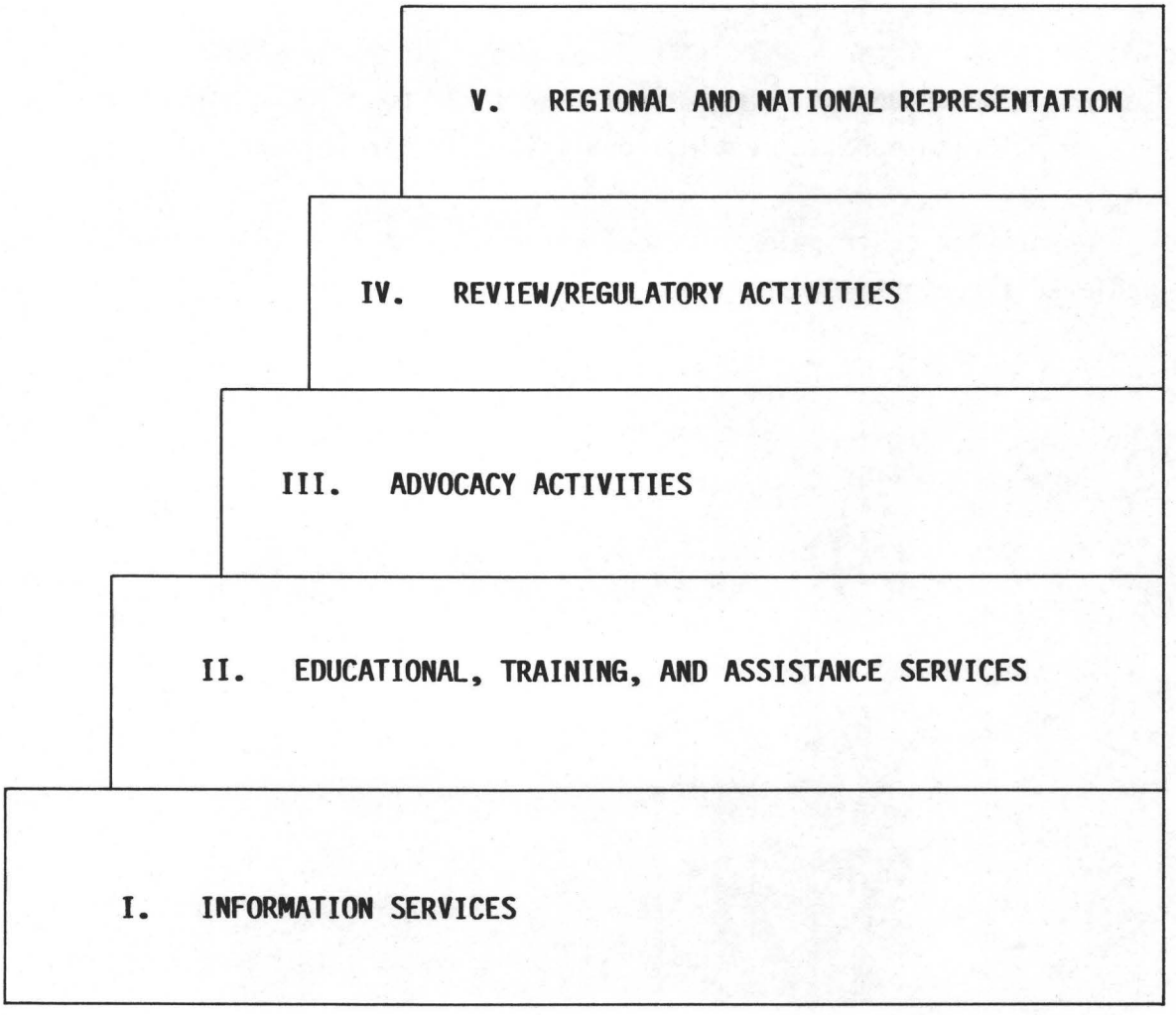

Figure 1.--Functions of an organization represented as steps with information services as the first step and regional and national representation as the fifth step.

THE UTAH SEISMIC SAFETY ADVISORY COUNCIL

The Utah Legislature created the Utah Seismic Safety Advisory Council in 1977 to develop public policy recommendations and programs leading to earthquake hazard reduction activities. The council, which finished its work in 1981, was charged with providing many of the functions identified earlier. Below is a categorization of the services the council provided:

1) Educational, training, and assistance services

a) Educate the public and private sectors on earthquake safety.

b) Recommend training for specialized enforcement and technical personnel which may have responsibilities relating to earthquake hazards.

2) Advocacy Activities

a) Recommend a consistent policy framework for seismic safety in Utah.

b) Suggest goals and priorities for earthquake hazard reduction.

c) Recommend Statewide and local programs to reduce earthquake hazards.

d) Request that State agencies devise criteria to provide seismic safety.

3) Review and Regulatory Activities

a) Review proposed earthquake-related legislation and propose needed legislation.

b) Advise the Governor and Utah Legislature on matters relating to seismic safety.

c) Recommend the addition, deletion, or changing of State and Federal standards as deemed desirable to promote seismic safety.

d) Recommend methods for:

- improving building standards and construction compliance with the standards.

- siting and designing of critical facilities, hospitals, and schools.

- delineating fault zones which require special investigation, regulation, and reporting procedures.

The Utah Seismic Safety Advisory Council performed many advocacy and regulatory functions due to its establishment by the State Legislature to "advise the governor, legislature, State, and local governments, and the private sector on possible ways of reducing earthquake hazards." Other seismic safety organizations may emphasize different functions, depending on nature of the seismic hazards and risk in their State or region, the task that the organization is set up to perform, and the experience and interests of the membership of the organization. Over time, organizations may also change, expand, or reduce the services they provide.

APPENDIX A

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APPENDIX B

PREPARING FOR AND RESPONDING TO DAMAGING EARTHQUAKES IN THE CENTRAL UNITED STATES: DRAFT OF A 5-YEAR PLAN FOR IMPROVING EARTHQUAKE PREPAREDNESS

by
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FOREWORD

This draft 5-year action plan contains recommendations for improving the state-of-earthquake-preparedness in the Central United States. It was developed in discussions among members of Panel 1 of the workshop held at Knoxville, Tennessee. The plan is intended to serve as a guide that individuals in the political and scientific-technical communities can use to evaluate their current research and preparedness programs, to devise new programs and plans, and, ultimately to develop a seismic safety policy in the Central United States. The membership of the panel included:

Professor Otto Nuttli (Chairperson)	Saint Louis University
Professor Arthur Atkisson	University of Wisconsin at Green Bay
Mr. William Beaty	Missouri Disaster Planning and Operations Office
Professor James M. Brown	George Washington University
Mr. James Cripwell	Emergency Planning Canada
Mr. Don Dallenbach	Tennessee Emergency Management Agency
Mr. Dan Emerson (Rapporteur)	Disaster Operations Office, St. Louis, Missouri
Associate Judge J. Ronald Fischer	Cape Giradeau County, Missouri
Mr. John R. Groves	State Farm Insurance Companies
Mr. James R. Gurley	Civil Defense and Emergency Management, Memphis, Tennessee
Professor William J. Hall	University of Illinois at Urbana--Champaign
Dr. Robert M. Hamilton	U.S. Geological Survey

Mr. Warner Howe	Gardner and Howe
Mr. Eric Jenkins	Federal Emergency Management Agency
Dr. Arch Johnston	Tennessee Earthquake Information Center
Mr. E. Erie Jones,	Illinois Emergency Services and Disaster Agency
Mr. William J. Kockelman	U.S. Geological Survey
Mr. James E. Maher	Mississsippi Emergency Management Agency
Mr. O. Clarke Mann	Consulting Engineer
Ms. Marilyn MacCabe	Federal Emergency Management Agency
Mr. Norman J. Mansfield	Kentucky Department of Military Affairs
Mr. Leon McGoogan	Arkansas Office of Emergency Services
Mr. Phil McIntyre	Federal Emergency Management Agency
Rev. Lloyd Miler	Civil Defense, Poplar Bluff, Missouri
Ms. June Miller	American Red Cross
Ms. Jean Millin	Federal Emergency Management Agency
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Professor Joanne M. Nigg	Arizona State University
Mayor John Penrod,	Paducah, Kentucky
Mr. Leon Perry	City of East St. Louis, Illinois (now with the National Aeronautics and Space Administration)
Mr. Kenneth C. Ponte	Civil Defense Agency, Commonwealth of Massachussetts
Mr. Roy Popkin	American Red Cross
Ms. Brenda Prichard	Better Business Bureau Knoxville, Tennessee
Mr. Christ Sanidas	Shelby County, Tennessee
Mr. Buddy Smith	Paducah, Kentucky
Ms. Shirley M. Smith	Purdue University
Dr. John D. Stevenson,	Structural Mechanics Associates, Inc.
Ms. Susan Tubbesing	Natural Hazards Research and Applications Information Center (University of Colorado)
Mr. Delbert Ward	Structural Facilities, Inc.
Mrs. Corrine Whitehead	League of Women Voters of Kentucky

INTRODUCTION

A unique feature of the earthquake hazard in the Eastern United States is the low probability of occurrence of structurally damaging earthquakes at any particular place in the lifetime of an individual or an ordinary building. Yet, damaging earthquakes have occurred and will again occur, as will the great earthquakes, such as the New Madrid series in the winter of 1811 and 1812. Because of the high population density in the East, the concentration of industrial and commercial activity, and the large damage areas of the major or great earthquakes, the earthquake hazard problem becomes one of low-probability/and high-risk. For such a longshot, the questions become "how much effort should be expended in earthquake preparedness? "what can be expected if mitigation efforts are carried out?" and "what would be the consequences of inaction when a great earthquake happens again?" These and related problems were considered by six task groups of the panel considering earthquake preparedness in the Central United States. Each task group had a rapporteur and moderator.

TASK GROUP 1: HAZARD AWARENESS AND PUBLIC INFORMATION

The first task group addressed the problems of hazard awareness and public information. It operated on the assumptions that the geoscientific community agrees that there is an earthquake threat, and that hazard awareness must be coupled with information on what can be accomplished. Three principal goals were identified:

1) materials planning and identification of key public officials,

2) increasing hazard awareness of public officials, and

3) increasing hazard awareness of general public.

The first two goals should be attained within two years, whereas the third will require a five-year effort. For all goals, however, continuing effort and reinforcement will be required, because there is only a low probability that a damaging earthquake will occur in the five-year time period. The

public officials to be educated include decisionmakers and emergency services directors at the local, county and State levels. The Federal Emergency Management Agency (FEMA) and the U.S. Geological Survey (USGS) will be the lead agencies, providing both the information and the encouragement for such activities. For the general public the largest groups are opinion leaders (churches, volunteer groups, etc.), youth, the media and other special local public. The lead for these activities might be provided by a group or individual that is given a training grant to develop efficiently the necessary materials and to begin the dissemination procedure.

The task group felt that the activities for increasing hazard awareness of public officials is vital and should include:

1) presentations by the USGS on the technical and scientific problems, by FEMA on planning activities, and by local government representatives of communities which have taken some action on the earthquake threat.

2) seminars, to be organized first on a State-wide basis and later by hazard zones, which explain:

    a) the scope of the threat (deemphasize long recurrence intervals)
    b) the liability, or consequences, of inaction
    c) the responsibility for public safety and welfare
    d) the need for concrete suggestions for action, preferably those that are low cost and simple.

3) preparation of information packets for public officials and a follow-up to see if this material has any impact.

4) availability of educational/information specialists from Saint Louis University and the Tennessee Earthquake Information Center to continue development of material and to be the contact people for public officials.

The task groups felt that activities for increasing hazard awareness of the general public should include:

1) development of information packages which are ready to go when the next earthquake occurs.

2) keeping visibility of threat before general public by providing information on current scientific developments, government planning and preparedness.

Dissemination of the information is vital. Government agencies that can assist in this task should be identified. The media should be enlightened and encouraged to contact people at the Tennessee Earthquake Information Center and Saint Louis University for scientific information and at Purdue University for preparedness information. A telephone book "survival guide" for natural disasters should include earthquake information. Traveling exhibits for schools, community centers, etc., might be prepared. Finally, speakers might be provided for existing groups, although the number of groups requesting this service will likely be much greater than the number of available speakers.

TASK GROUP 2: PUBLIC SECTOR PARTICIPATION

The second task group was concerned with public sector participation. They concluded that the single, most important goal is to educate the key officials, namely governors, mayors and county executives, on the nature of the earthquake hazard and the necessity of initiating or improving earthquake preparedness. The panel believed this would require at least a five-year effort, with the lead to be taken by FEMA and the State offices of Emergency Preparedness. Also to become involved are the National Governors Association, the U.S. Conference of Mayors, the National League of Cities, and the Council of State Governments.

The panel emphasized that this would have to be an ongoing program with official involvement, as well as participation by professional, civic, academic, fraternal, and community-based organizations.

TASK GROUP 3: INTERGOVERNMENTAL RELATIONS AND COOPERATION

The third task group discussed intergovernmental relations and cooperation. As the primary goals, the task group recommended:

1) identification of hazards within the jurisdiction of each agency.

2) promotion of earthquake hazard awareness among the appropriate State and local agencies, as well as volunteer and private agencies.

3) development and coordination of plans for restoration of services after an earthquake.

4) establishment of the capabilities and responsibilities of each agency in the period immediately after a disaster.

5) development of interstate mutual aid agreements.

6) carrying out regional tests and exercises of earthquake response plans.

7) preparation of long-range restoration and redevelopment plans.

8) development of a regional Seismic Safety Commission, for the States of Arkansas, Illinois, Kentucky, Missouri and Tennessee.

TASKS GROUP 4: EARTHQUAKE-RESISTANT DESIGN

The fourth task group addressed the subject of local earthquake-resistant design. It noted that most cities and counties in the Central United States have adopted one of the three model codes: Standard Building Code, BOCA, or UBC. However, the seismic provisions of these codes have either been deleted or are not enforced. The opinion of the panel is that seismic provisions should be either added to the codes or enforced, but it appears that no seismic provisions have yet been drafted specifically for the Central United States. The existing codes are heavily biased by California and the Western

States, where the rate of earthquake activity is very high compared to the rest of the country. Hence, their recommendations cannot be applied directly to the Central and Eastern United States without appearing unacceptable to the professional community.

New Structures

The first recommendation of the panel is to create an interstate Seismic Code Revision Committee (maybe covering the whole central and eastern United States), whose task will be to draft Seismic Code Provisions applicable to this part of the country. They should start from an existing document known as ATC-3 and modify it, concentrating principally on the elements described below. The Committee will be made up of a broad spectrum of construction-related professionals--owners, builders, designers, etc.--in order to provide a balanced product, in view of the great impact such a document will have and the new ideas it will introduce.

In developing their recommendations, the Committee will need to remember that the desired level of seismic protection should be balanced with other hazards, economic impact, applicability, etc. Too high a level of protection, rather than being beneficial, would doom the whole effort due to economic constraints and negative public response. Since building codes are a compilation of the minimum legal requirements for health and safety in the design of buildings, consideration should be given to whether provisions for operability of certain essential facilities needed in time of emergency should be included in the building code, or otherwise covered by public policies.

The work of the Committee would require a three-to-four-year period of time and would need the support of a Federal agency. The major points to be considered by the Committee are as follows:

1) Hazard Level

Consider a zone-dependent design level based on the variable seismic threat in different regions of the Central and Eastern United States.

2) **Building Use and Occupancy**

For the same region, consider variable design levels as a function of building use and occupancy. In the codes heavily influenced by the Western United States, such considerations aren't explicitly addressed because it is assumed that any building will have to sustain at least one earthquake during its lifetime, and therefore should be provided adequate protection. In the area east of the Rocky Mountains where earthquakes are much less frequent (although the risk of a catastrophic event cannot be excluded), the level of desired protection should be a function of the building use and occupancy (risk).

a) Highest protection provided to the high density occupancy buildings, especially high-rise structures which are, moreover, particularly vulnerable to distant earthquakes.

b) Lower protection to intermediate occupancy buildings depending upon probable density of occupancy.

c) No specific requirements for one and two family detached residences, although good seismic practice and detailing seismic practice should be enforced.

3) **Major Facilities**

Make separate recommendations for facilities whose operation is critical or whose failure would be extremely hazardous to large sections of the population, i.e., chemical plants, public utilities, communication networks, disaster response facilities, dams, major bridges, etc.

4) **Good Practice and Detailing**

Provide a list of recommendations of good practice and detailing enhancing building response to earthquakes, and a list of common

mistakes to be avoided, such as soft story, irregular plan, variable stiffness, etc. It is felt that the greatest amount of good can be done at this level with the smallest economic impact on the professions, by this "think seismic" approach.

5) **Response Spectrum**

Study the frequency content of the recommended response spectrum. Combine available data, potentially augmented by data from other parts of the world, with the theoretical models to determine a response spectrum applicable to the Central and Eastern United States.

6) **Equipment**

Expand the code section on mechanical and electrical equipment and distribution systems. This section of the codes is particularly lacking in seismic requirements, which might lead to extensive nonstructural damage even if the structural damage is limited.

7) **Economic Impact**

Evaluate the economic impact of the proposed seismic requirements before finalizing them.

Code Adoption and Enforcement

The adoption and enforcement of the Seismic Code Provisions should be done by local governments following the existing procedures for code adoption and enforcement. It is felt that if the provisions are "reasonable", are not considered as final, but as a step in the right direction, and are backed up by a general public awareness program, that they will eventually be adopted, even though it might require several years. State implementation, due to involved bureaucracy, would probably complicate the problem rather than solve it.

Existing Structures

The panel feels that a general program of review and upgrading should not be implemented for existing structures. The public opposition and economic impact would be sufficient to jeopardize the whole effort. Minor modifications implemented slowly, such as the "parapet requirement", might be feasible. Two categories of structures should, however, be reviewed and potentially upgraded. They are:

1) response structures, i.e., fire department, police buildings, hospitals, etc.

2) important facilities whose failure would threaten the lives of many or create major disruptions, i.e., dams, major bridges, etc.

TASK GROUP 5: LAND USE

Land use was the topic of concern to task group five. The group noted that almost all cities presently have zoning laws, reflecting population density and life quality, that control land use. Currently, zoning of land use is a local function with policing powers granted by the State.

Land use regulations that are seismic related can and should be added on to existing zoning procedures. The task group identified three specific problem areas: namely dams, levees and flat lands.

For existing dams the zoning regulations should be addressed to down-stream development. Breach analyses should be made in order to rate the dams in terms of earthquake intensity and to determine the depth and width of flood flow. New dams should be designed for a given earthquake intensity, or set of ground motion parameters. If the technical analysis is beyond the capabilities of the local level, it should be provided by the State, but administration should reside at the local level.

Although levees may break and release floodwaters, zoning should not restrict land use because of possible breaks in the levees. Rather zoning

should couple land use with building code requirements that assure safety. Flat land zoning should be treated in the same way as levees, with safety the responsibility of building officials who have adequately prepared geotechnical reports to guide them.

The task group recommeded that maximum use should be made of existing data on geology, seismology, magnetic and gravity anomalies, topography and flooding. New data can be developed through research and soil borings at specific sites. Zoning bodies should systematically accumulate and disseminate information about new developments.

TASK GROUP 6: RESPONSE

Task group 6 was concerned with response to a damaging earthquake. Specifically it addressed State and local plans, which would be prepared after the FEMA-USGS vulnerability study in the Central United States had been completed. State activities should include:

1) updating the existing comprehensive plans, including private industry capability and assigning specific responsibilities,

2) developing local response guidance,

3) inventoring resource capabilities, including life safety and food and shelter resources,

4) carring out training exercises,

5) preparing inter-State agreeements,

6) investigating procedures for rapid declaration of emergency conditions, and

7) developing plans for immediate or short range and long range recovery.

Local activies should include:

1) updating of existing plans in inclusion of new section,

2) preparing response plans with lines of responsibility going from local to State to Federal and

3) preparing recovery plans, drawing upon local State and Federal funds.

The panel task group noted that some response plans already exist. Although much of the planning activity will depend upon the vulnerability analysis, the task of preparing inventories and comprehensive plan update can be started immediately.

SUMMARY

All six task groups seem to agree that earthquake response preparedness should heavily involve local and State governments, as well as educational institutions and organizations such as the American Red Cross, but that it will be the responsibility of the Federal agencies, namely FEMA and the USGS, to be the prime movers. Generally speaking, these agencies plus a few more Federal agencies, such as the Corps of Engineers and the Nuclear Regulatory Commission, are the only ones that appreciate the nature of the earthquake hazard in the Central United States. Thus, education of key officials, along with a program for increasing public awareness of the problem, must be the first steps in the comprehensive five-year plan. Furthermore, because elected and appointed officials go in and out of office every year, these efforts will have to continue throughout the entire five years and beyond.

APPENDIX C

MODIFIED MERCALLI INTENSITY SCALE

Intensity. A numerical index describing the effects of an earthquake on the Earth's surface, on man, and on structures built by him. The scale in common use in the United States today is the Modified Mercalli scale of 1931 with intensity values indicated by Roman numerals from I to XII. The narrative descriptions of each intensity value are summarized below.

I. Not felt--or, except rarely under especially favorable circumstances. Under certain conditions, at and outside the boundary of the area in which a great shock is felt: sometimes, birds, animals, reported uneasy or disturbed; sometimes dizziness or nausea experienced; sometime trees, structures, liquids, bodies of water, may sway--doors may swing, very slowly.

II. Felt indoors by few, especially on upper floors, or by sensitive, or nervous persons. Also, as in grade I, but often more noticeably: sometimes hanging objects may swing, especially when delicately suspended; sometimes trees, structures, liquids, bodies of water, may sway, doors may swing, very slowly; sometimes birds, animals, reported uneasy or disturbed; sometimes dizziness or nausea experienced.

III. Felt indoors by several, motion usually rapid vibration. Sometimes not recognized to be an earthquake at first. Duration estimated in some cases. Vibration like that due to passing of light, or lightly loaded trucks, or heavy trucks some distance away. Hanging objects may swing slightly. Movements may be appreciable on upper levels of tall structures. Rocked standing motor cars slightly.

IV. Felt indoors by many, outdoors by few. Awakened few, especially light sleepers. Frightened no one, unless apprehensive from previous experience. Vibration like that due to passing of heavy or heavily loaded trucks. Sensation like heavy body striking building or falling of heavy objects inside. Rattling of dishes, windows, doors;

glassware and crockery clink and clash. Creaking of walls, frame, especially in the upper range of this grade. Hanging objects swung, in numerous instances. Disturbed liquids in open vessels slightly. Rocked standing motor cars noticeably.

V. Felt indoors by practically all, outdoors by many or most; outdoors direction estimated. Awakened many, or most. Frightened few--slight excitement, a few ran outdoors. Buildings trembled throughout. Broke dishes, glassware, to some extent. Cracked windows--in some cases, but not generally. Overturned vases, small or unstable objects, in many instances, with occasional fall. Hanging objects, doors, swing generally or considerably. Knocked pictures against walls, or swung them out of place. Opened, or closed, doors, shutters, abruptly. Pendulum clocks stopped, started or ran fast, or slow. Moved small objects, furnishings, the latter to slight extent. Spilled liquids in small amounts from well-filled open containers. Trees, brushes, shaken slightly.

VI. Felt by all, indoors and outdoors. Frightened many, excitement general, some alarm, many ran outdoors. Awakened all. Persons made to move unsteadily. Trees, brushes, shaken slightly to moderately. Liquid set in strong motion. Small bells rang--church, chapel, school, etc. Damage slight in poorly built buildings. Fall of plaster in small amount. Cracked plaster somewhat, especially fine cracks chimneys in some instances. Broke dishes, glassware, in considerable quantity, also some windows. Fall of knick-knacks, books, pictures. Overturned furniture in many instances. Moved furnishings of moderately heavy kind.

VII. Frightened all--general alarm, all ran outdoors. Some, or many, found it difficult to stand. Noticed by persons driving motor cars. Trees and bushes shaken moderately to strongly. Waves on ponds, lakes, and running water. Water turbid from mud stirred up. Incaving to some extent of sand or gravel stream banks. Rang large church bells, etc. Suspended objects made to quiver. Damage negligible in buildings of good design and construction, slight to moderate in well-

built ordinary building, considerable in poorly built or badly designed buildings, adobe houses, old walls (especially where laid up without mortar), spires, etc. Cracked chimneys to considerable extent, walls to some extent. Fall of plaster in considerable to large amount, also some stucco. Broke numerous windows, furniture to some extent. Shook down loosened brickwork and titles. Broke weak chimneys at the roof-line (sometimes damaging roofs). Fall of cornices from towers and high buildings. Dislodged bricks and stones. Overturned heavy furniture, with damage from breaking. Damage considerable to concrete irrigation ditches.

VIII. Fright general--alarm approaches panic. Disturbed persons driving motor cars. Trees shaken strongly--branches, trunks, broken off, especially palm trees. Ejected sand and mud in small amounts. Changes: temporary, permanent; in flow of springs and wells; dry wells renewed flow; in temperature of spring and well waters. Damage slight in structures (brick) built especially to withstand earthquakes. Considerable in ordinary substantial buildings, partical collapse: racked, tumbled down, wooden houses in some cases; threw out panel walls in frame structures, broke off decayed piling. Fall of walls. Cracked, broke, solid stone walls seriously. Wet ground to some extent, also ground on steep slopes. Twisting, fall, of chimneys, columns, monuments, also factory stacks, towners. Moved conspicuously, overturned, very heavy furniture.

IX. Panic general. Cracked ground conspicuously. Damaged considerable in (masonry) structures built expecially to withstand earthquakes: Threw out of plumb some wood-frame houses build especially to withstand earthquakes; great in substantial (masonry) buildings, some collapse in large part; or wholly shifted frame buildings off foundations, racked frames; serious to reservoirs; underground pipes sometimes broken.

X. Cracked ground, especially when loose and wet, up to widths of several inches; fissures up to a yard in width ran parallel to canal and stream banks. Landslides considerable from river banks and steep

coasts. Shifted sand and mud horizontally on beaches and flat land. Changed level of water in wells. Threw water on banks of canals, lakes, rivers, etc. Damage serious to dams, dikes, embankments. Severe to well-built wooden structures and bridges, some destroyed. Developed dangerous cracks in excellent brick walls. Destroyed most masonry and frame structures, also their foundations. Bent railroad rails slightly. Tore apart, or crushed endwise, pipe lines buried in earth. Open cracks and broad wavy folds in cement pavements and asphalt road surfaces.

XI. Disturbances in ground many and widespread, varying with ground material. Broad fissures, earth slumps, and land slips in soft, wet ground. Ejected water in large amounts charged with sand and mud. Caused sea-waves ("tidal" waves) of significant magnitude. Damage severe to wood-frame structures, especially near shock centers. Great to dams, dikes, embankments often for long distances. Few, if any (masonry) structures remained standing. Destroyed large well-build bridges by the wrecking of supporting piers, or pillars. Affected yielding wooden bridges less. Bent railroad rails greatly, and thrust them endwise. Put pipe lines buried in earth completely out of service.

XII. Damage total--practically all works of construction damaged greatly or destroyed. Disturbances in ground great and varied, numerous shearing cracks. Landslides, falls of rock of significant character, slumping of river banks, etc., numerous and extensive. Wrenched loose, tore off, large rock masses. Fault slips in firm rock, with notable horizontal and vertical offset displacements. Water channels, surface and underground, disturbed and modified greatly. Dammed lakes, produced waterfalls, deflected rivers, etc. Waves seen on ground surfaces (actually seen, probably, in some cases). Distorted lines of sight and level. Threw objects upward into the air.