UNITED STATES

DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

PROCEEDINGS OF

CONFERENCE XV

A WORKSHOP ON "PREPARING FOR AND RESPONDING TO A DAMAGING EARTHQUAKE IN THE EASTERN UNITED STATES"

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Reston, Virginia

1982

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Editor and Chairman of the Steering Committee

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Reston, Virginia

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by

Walter W. Hays

U.S. Geological Survey

Reston, Virginia

INTRODUCTION

Although most people know that the states along the Pacific Coast are the most vulnerable to damaging earthquakes, they are unaware that other states have experienced moderate (magnitudes of 6-7), large (magnitudes of 7-8), and great (magnitudes of 8 or greater) earthquakes. Several states in the Mississippi Valley area are vulnerable to the occurrence of a potentially damaging earthquake similar to the three great ones that occurred in 1811-1812 near New Madrid, Missouri. Other states in the East are vulnerable to the occurrence of moderate and large earthquakes similar to those that occurred, for example, in 1886 in Charleston, South Carolina; in 1755 off the coast of Massachusetts; and on many occasions since 1650 and as recently as January 9, 1982, in the St. Lawrence River region. Earthquakes such as the New Madrid quakes, should they occur again now or in the near future, would have serious social and economic impacts on the Nation. The severity of these impacts are not completely defined at the present time; nevertheless, the societal impacts can be reduced if an effective seismic safety policy is devised and implemented at all levels of government in the Eastern United States as soon as possible.

The U.S. Geological Survey and the Federal Emergency Management Agency sponsored a workshop on, "Preparing for and Responding to a Damaging Earthquake in the Eastern United States," in Knoxville, Tennessee, on September 16-18, 1981. Seventy individuals representing local, State, and Federal Government, business and industry, and the research community participated in the 3 day workshop. The participants had backgrounds in disaster preparedness, disaster response and recovery, earth science, engineering, social science, political science, law, economics, insurance, architecture, and land-use planning. The diversity of professions and interests was unusual and perhaps unique.

This workshop, one of a continuing series of conferences and workshops designed to improve the application of research results thoughout the Nation, brought together for the first time representatives of the political community and experts of the scientific-technical community to discuss and to suggest specific ways to improve the state-of-earthquake-preparedness in the Eastern United States. The emphasis was on the synthesis and application of the available information in order to achieve a recommended action plan by the end of the workshop.

Bringing together representatives of the political and scientific-technical communities to discuss the earthquake threat in the Eastern United States and to devise practical solutions is a responsibility asssigned to the Geological Survey and the Federal Emergency Management Agency under the provisions of the Earthquake Hazards Reduction Act of 1977 (Public Law 95-124) and its reauthorizations. This Act mandates wide participation in the National program by representatives of State and local governments, business

and industry, the design professions, and the research community. The ultimate goal of the program is to assist communities throughout the Nation to reduce the loss (now estimated to average about $600 million per year) which results from earthquakes of magnitude 5.5 and greater, a small fraction of the several thousand earthquakes that happen each year in the United States. It is well known that the greatest threat is in Alaska, California, and along the Pacific coast where great (magnitudes of 8 and greater) earthquakes happen much more frequently than in the Eastern United States. The greatest cummulative loss, however, is caused by moderate and large earthquakes because they occur more frequently than a great earthquake. For example, a moderate earthquake takes place on the average about once every 3 years in California; whereas, a great one happens only about once every 100-150 years. In the Eastern United States, a great earthquake like the 1811-1812 New Madrid earthquakes happens on the average about once every 600-700 years; whereas, moderate earthquakes happen about once every 20-30 years.

OBJECTIVE

The workshop provided the participants, many of whom had never met before, a stimulating working environment to discuss the earthquake threat in the east and propose solutions for facing it. The goal was to develop and to devise draft 5-year action plans--one each for the Central, Southeastern, and Northeastern United States--to improve the state-of-earthquake-preparedness. Each plan could serve as a guide for public officials, the design professions, and the research community to use in developing future programs to reduce losses from earthquakes and to develop a seismic safety policy in their respective communities. The next step in the process of developing a seismic

safety policy, implementation of the recommendations, was beyond the scope of the workshop.

METHODOLOGY

The group dynamics of the workshop were tailored to meet the needs of the participants, including encouraging persons with varied backgrounds to meet and collaborate on the preparation of action plans for each region of the Eastern United States exposed to the earthquake threat. To maximize the benefits of the workshop, the following strategies were used:

- The workshop was scheduled to follow immediately after the state-of-the-art conference, "Earthquakes and Earthquake Engineering in the Eastern United States." This conference, also held in Knoxville, provided new information and fresh ideas in the context of a comprehensive review of techniques for assessing the earthquake hazards of ground shaking, surface faulting and tectonic deformation, ground failures, and inundation in the Eastern United States. Current techniques for evaluating risk were also reviewed. The proceedings of this conference were available to all the participants of the workshop; many persons attended both the conference and the workshop.

- Participants of the workshop were selected based on their preeminence in the specialized fields of knowledge to be discussed at the workshop or their public decisionmaking responsibility. A secondary consideration was their capability to set goals, to identify problems, and to devise solutions to these problems. Well in advance of the meeting, each

participant was provided with a notebook containing information about earthquake hazards in the Eastern United States and about the proposed discussion process for the workshop.

- Representatives of the public sector (key elected and appointed officials) were drawn from the State governments of the 7 states (Missouri, Illinois, Indiana, Kentucky, Tennessee, Arkansas, and Mississippi), and cities and counties within these states that would be most severely impacted if the 1811-1812 New Madrid earthquakes were to recur. In each case, public officials who would be involved in mitigating the potential impacts or in preparing to respond to such earthquakes were invited to attend or to send a representative responsible for development of seismic policy. Municipalities represented included: St. Louis and Cape Girardeau County, Missouri; Evansville, Indiana; Paducah, Kentucky; Memphis and Shelby County, Tennessee; Little Rock and Crittendon County, Arkansas; and Jackson, Mississippi.

- Experts in earth science, earthquake engineering, and social science, were enlisted to give background papers at the workshop to provide an overview of the earthquake threat from the perspective of these disciplines and to give all participants a common framework of reference.

- "Stimulators" were selected to prepare and deliver papers containing suggestions of general, conceptual approaches for improving earthquake preparedness and response in the Eastern United States. In each stimulator's presentation, important knowledge and experiences

accumulated in other geographic areas were to be identified and proposed for application to the Eastern United States. Each stimulator addressed one or more of the six topics that are considered to represent the essential components of a comprehensive action plan for improving the state-of-earthquake-preparedness; namely:

Topic 1: Hazard Awareness and Public Education

Topic 2: Public Sector Participation

Topic 3: Intergovernmental Relations and Cooperation

Topic 4: Earthquake-Resistant Design

Topic 5: Land-Use Planning

Topic 6: Response to a Damaging Earthquake

- After each stimulator's presentations the participants divided into small groups to react to the suggested approaches and suggest modifications. The reaction groups were guided by the following questions:

  1. Does the suggested approach make sense and capture the special needs of the three geographic areas correctly?

  2. Does the suggested approach suggest other approaches or cost-sharing opportunities?

- Participants were then divided into three panels: (1) Panel 1, representing the Central United States, (2) Panel 2, representing the Southeastern United States, and (3) Panel 3, representing the Northeastern United States. Each panel was asked to review the general

and conceptual approaches suggested by the stimulators, and subsequently discussed in the reaction groups, and to devise a draft 5-year action plan containing specific recommendations. Each area plan was to identify the full range of actions, and their priorities, that might be realistically undertaken in a 5-year period to advance significantly the level of knowledge. Collectively, these three draft 5-year action plans provided a frame of reference for the political and scientific-technical communities to use in preparing current and future plans, projects, and programs for ensuring seismic safety.

To facilitate and to guide the panels' discussion, a model comprehensive 5-year action plan for the Central United States was presented and discussed before the panels began their work.

- Each of the 3 action plans was evaluated critically by the workshop participants in terms of the ultimate goal, the successful implementation of the draft action plans as public policy.

- The last step of the workshop was the publiciation of workshop proceedings to provide a group memory of the group discussions. The proceedings will be issued as a Geological Survey Open-File Report and distributed widely.

The Next Step

This workshop, the first to bring together representatives of the political and scientific-technical communities in the Eastern United States,

is a milestone event. It marks the beginning of a long-term endeavor to strengthen the capability and resolve of the public officials of the Eastern United States to reduce losses from earthquakes. Additional meetings are needed to advance the complex process of improving the state-of-earthquake-preparedness in the Eastern United States. Additional meetings are being planned for 1982.

The draft 5-year action plans prepared by the three regional panels follow. These plans present an assessment of what is needed to improve the state-of-earthquake-preparedness in the Eastern United States. They may appear to be too ambitious; however, they provide a basis for assigning priorities and for selecting strategies to deal with the earthquake threat in each of the three geographic areas. The draft plans should be considered as working documents until they are adopted as public policy.

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

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

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
Dr. Christian Mortgat	Tera Corporation
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.

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

by

G. A. Bollinger

Virginia Polytechnic Institute and State University

Blacksburg, Virginia

FOREWORD

This draft 5-year action plan contains recommendations for improving the state-of-earthquake-preparedness in the Southeastern United States. It was developed in discussions among members of Panel 2 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 sesimic safety policy in the Southeastern United States. The membership of the panel included:

Professor G. A. Bollinger (Chairperson)	Virginia Polytechnic Institute and State University, Blacksburg, Virginia
Professor Joyce B. Bagwell (Rapporteur)	Baptist College at Charleston
Dr. James Beavers	Union Carbide Corporation
Ms. Paula Gori	U.S. Geological Survey
Ms. Marjorie Green	Seattle Research Center
Professor Ajaya K. Gupta	North Carolina State University
Dr. Walter Hays	U. S. Geological Survey
Mr. Dennis Johnson	American Red Cross
Mr. Keith Keister	Peacetime Disaster Preparedness Commonwealth of Virginia
Lt. Col. Charles Lindbergh	The Citadel
Professor Leland T. Long	Georgia Institute of Technology
Mr. Donald P. Moore	Southern Company Services, Inc.
Dr. Donald R. Nichols	U. S. Geological Survey
Mr. Travis Ratcliff	Federal Emergency Management Agency

Professor Blaine Roberts	University of South Carolina
Dr. John B. Scalzi	National Science Foundation
Ms. Hilary Whittaker	National Governors' Association

INTRODUCTION

In considering earthquake preparedness in the Southeastern United States, the panel posed the question, "Is the Southeastern United States prepared for a reoccurrence of the 1886 Charleston, S.C. earthquake?" The August 31, 1886, earthquake (and its aftershocks), the most devastating earthquake in the Southeastern United States, caused an estimated $23 million damage (current dollars), killed 60 persons, and injured many more. Its' ground shaking caused total damage to many buildings in Charleston and damaged buildings as far away as Columbia, South Carolina, and Augusta and Savannah, Georgia. All or part of 30 States and Ontario, Canada, felt the ground shaking (Figure 1).

The panel agreed that the Southeastern United States is not prepared to cope with the social and economic impacts from either a reoccurrence of the 1886 earthquake or from smaller damaging earthquakes. Because a major earthquake similar to the one in 1886 is estimated to happen on the average about once every 1000 years, the panel felt that constructive and prudent steps could be taken now to introduce changes gradually, leading to a seismic safety policy that will improve the state-of-earthquake-preparedness in the Southeastern United States. Such a policy will reduce losses from moderate and large earthquakes which happen more frequently than a major one.

Southeastern United States Seismic Safety Consortium

The most significant accomplishment of the Panel was to establish an Ad Hoc Steering Committee to effect the formation of a Southeastern United States Seismic Safety Consortium (SSC). The cochairpersons of the Ad Hoc committee are Professor Joyce B. Bagwell of the Baptist College at Charleston, South Carolina and Lt. Colonel Charles Lindbergh, Head of the Civil Engineering Department, The Citadel, Charleston, South Carolina. Two other individuals, Dr. Ajaya K. Gupta, Department of Civil Engineering, North Carolina State University, and Dr. Gilbert A. Bollinger, Seismographic

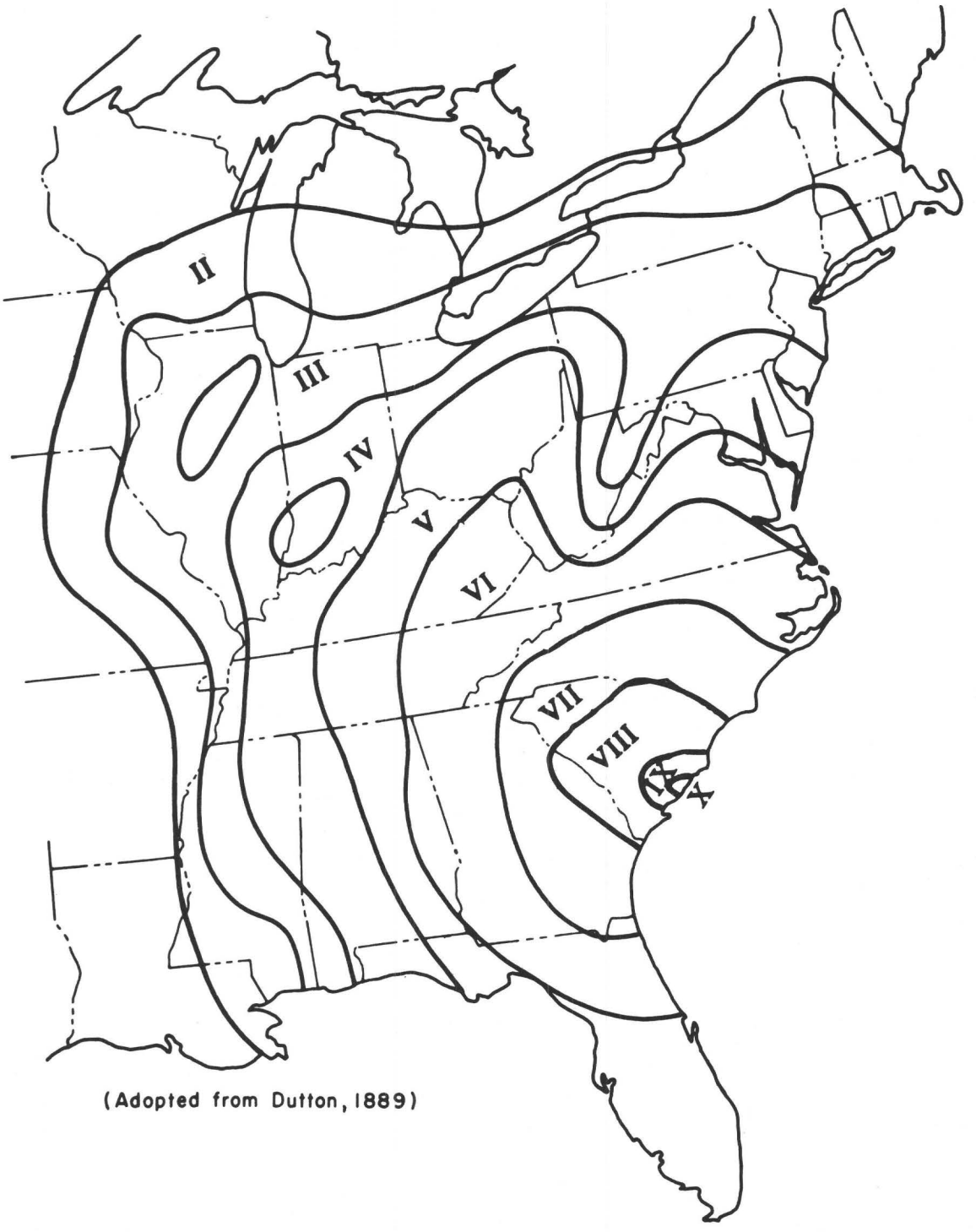

Figure 1.--Isoseismal contours for the 1886 Charleston, South Carolina, Earthquake

Observatory, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, were asked to provide advice and support.

The panel visualized the following preliminary working concepts for SSC:

1) It will be the entity to implement the recommendations of the draft 5-year action plan and to evolve a seismic safety policy for the Southeastern United States.

2) It will consist initially of representatives from South Carolina, Georgia, North Carolina, and Virginia, but other states can participate as desired.

The panel discussed the 6 topical areas and recommended specific actions in each area during a 5-year period to improve earthquake preparedness. These are summarized below and represent the draft 5-year plan.

HAZARD AWARENESS AND PUBLIC INFORMATION

The panel felt that hazard awareness and public information is vitally important and that it should receive priority attention throughout the 5-year period. The recommended actions should begin immediately and include:

1) The Ad Hoc Committee should work to form the SSC (including seeking funding) as soon as possible. In the interim period while SSC is being formed, the Ad Hoc committee can undertake some of the following tasks, utilizing existing resources and institutions to the fullest extent possible; after SSC is formed, it will undertake these tasks:

    a) Collect all available information that defines the earthquake hazards and the risk within the Southeastern United States. Risk should be stated in the context of all hazards to provide relative perspective.

b) Synthesize information into one or more packages that can be released to public officials, the media, business and industry, design professionals, and the research community.

c) Seek advice and information from other groups having relevant information and experience, such as: California Seismic Safety Commission, Utah Seismic Safety Advisory Council, Earthquake Engineering Research Institute, the Federal Emergency Management Agency, the U.S. Geological Survey, and the Geological Surveys of South Carolina, Georgia, Virginia, and North Carolina

PUBLIC SECTOR PARTICIPATION

The panel felt the activities to stimulate public sector participation should begin in earnest as soon as SSC is formed. The tasks should take place mainly in the first few years of the 5-year period. They include:

1) Identify all local, State, and regional institutions and organizations that might have an interest in earthquake preparedness, perhaps in conjunction with an all hazards preparedness program.

2) Form subcommittees to enlist and to involve these institutions and organizations.

3 Provide hazard awareness information through these subcommittees and develop an "outreach" program.

4) Identify and cultivate possible political sponsors; provide specific information to them to increase their hazard awareness and to assist in evaluating the need for legislation.

INTERGOVERNMENTAL RELATIONS AND COOPERATION

The panel felt that the activities to improve intergovernmental relations and cooperation should take place mainly in the last 3-4 years of the 5-year-period and only after SSC has been formed. Recommended activities include:

1) Establish interpersonal communication networks and liaison with governmental organizations who are responsible for setting seismic safety policy.

2) Interact with governmental organizations to build a seismic safety policy; exchange information about earthquake hazards and risk that has been cast into an all hazards perspective.

3) Identify manufacturers and users of hazardous materials (toxic, flammable, etc.) that might be vulnerable to damaging earthquakes; provide information to these groups and encourage them to take preparedness measures consistent with a seismic safety policy.

4) Draft model legislation to address specific issues in earthquake hazards mitigation and response and recovery.

5) Provide precise information to emergency management agencies of local, State, and Federal Government and cooperate with them to develop response plans.

6) Identify the gaps in knowledge that affect seismic safety policy in the Southeastern United States and take steps to eliminate them.

7) Establish cooperative efforts with appropriate agencies of local, State, and Federal Governments, business and industry, design professions, and the research community to improve earthquake hazards reduction and response and recovery planning.

8) Evaluate the organizational structure of SSC at appropriate points in time to determine its effectiveness and the need for change.

LOCAL EARTHQUAKE-RESISTANT DESIGN

The panel generally agreed that the goal of achieving earthquake-resistant design was highly desirable, but that the process to achieve this goal would probably require more than 5-years. The panel felt that SSC, after

it is formed, should contribute strongly and in a sustained way to this process throughout the 5-year period and beyond, as required. Recommended activities include:

1) Work through building code groups, professional organizations, State and local legislative bodies, and others to evolve a seismic safety policy that will lead to the requirement of seismic design provisions in all new buildings of local, State, and Federal Governments located in the Southeastern United States.

2) Provide training for local building officials to increase their competence for enforcing seismic design requirements.

3) Promote continuing education in earthquake-resistant design (perhaps in the context of multiprotection design concepts) through universities, Earthquake Engineering Research Institute, the Federal Emergency Management Agency, and other organizations.

4) Develop a procedure for reviewing the earthquake resistance of existing buildings.

5) Develop a procedure for reviewing the earthquake resistance of existing and planned critical facilities (e.g., nuclear power plants, dams, hospitals), utilizing available information as much as possible.

LAND USE

The panel noted that the Southeastern United States is not yet ready to evolve a seismic safety policy incorporating land-use planning. To develop such a policy will require much more basic earth-science data than presently available. Ten years or more may be required to evaluate the feasibility of land use as a component of seismic safety policy in the Southeastern United States. The panel recommended that:

SSC should seek to promote earth science investigations by appropriate agencies of the Federal and State Governments in order to develop a data base for evaluating the feasibility of land-use planning in the Southeastern United States.

RESPONSE TO A DAMAGING EARTHQUAKE

The panel agreed that response planning is a very essential element of a seismic safety policy for the Southeastern United States and that the SSC, once it is formed, should make response planning a high priority. Recommended activities will require at least 5 years to complete to the point that they can be implemented. They include:

1) Evaluate existing emergency response plans of local, State, and Federal Governments as to their adequacy and relevance to the earthquake threat.

2) Provide the best available information about earthquake hazards in the Southeastern United States to the appropriate emergency preparedness agencies. The information should be synthesized and packaged in a format that is most useful--perhaps in an all hazards perspective, so that existing plans can be updated as required.

3) Coordinate local, State, and Federal Government emergency response plans with respect to seismic safety.

4) Sponsor workshops, conferences, and training sessions to develop and to refine earthquake response plans.

5) Be prepared to take advantage of a damaging earthquake to introduce needed legislation.

SUMMARY

The panel agreed that a great deal can be done with a modest investment of time and money to evolve an effective seismic safety policy in the Southeastern United States. The panel felt that **the Seismic Safety Consortium is the key to progress** and that first priority should be given to making it an official entity. The Ad Hoc committee, which was formed in Knoxville, Tennessee, is already working on this task. Finally, the panel noted that 5 years is a reasonable time frame to begin to introduce change, but that a much longer period of time would probably be required--unless a major earthquake happens in the near future.

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

by

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FOREWARD

This draft 5-year action plan contains recommendations for improving the state-of-earthquake-preparedness in the Northeastern United States. It was developed in discussions among members of Panel 3 of the workshop held at Knoxville, Tennessee. The plan is intended to serve as a guide that individuals in the political and scientific-technical commuities can use to evalaute their current research and preparedness programs, to devise new programs and plans, and, ultimately, to develop a seismic safety policy in the Northeastern United States. The membership of the panel included:

Dr. Paul Pomeroy (Cochairperson)	Rondout Associates, Inc.
Mr. Phil McIntyre (Cochairperson)	Federal Emergency Management Agency
Dr. Walter Anderson (Rapporteur)	Maine Geological Survey
Dr. Goetz Buchbinder	Department of Earth/Mines and Resources of Canada
Dr. Robert C. Bucknam	U.S. Geological Survey
Mr. James Devine	U.S. Geological Survey
Mr. Joseph Fischer	Tera Corporation
Mr. M. Klein	International Business Machines
Mr. Robert Lamont	American Red Cross
Dr. Henry Lambright	Syracuse Research Corporation

Dr. Andrew Murphy — Nuclear Regulatory Commission
Mr. Kenneth Ponte — Civil Defense Agency of Massachusetts
Dr. Clem Shearer — U.S. Geological Survey

INTRODUCTION

The probability of a major earthquake occurring in the Northeastern United States is quite low, but moderate to severe earthquakes have occurred in the region in the past and certainly, will occur in the future. More than in most other parts of the United States, the earthquake hazard problem is compounded by a high population density, many old large buildings, and a high degree of modern industrialization. At present, in the northeast, no specific plans exist for response to a major earthquake other than the general disaster response plans of the Federal Emergency Management Agency (FEMA).

The Northeastern United States is perhaps unique in that many of the governmental units already involved in emergency preparedness and response are interknit in regional councils, interstate cooperative agreements, etc. Thus, the precedent for cooperation on an earthquake preparedness plan is well established.

The most important recommendation of this Panel was that a Northeast Regional Seismic Safety Advisory Council (NERSSAC) be established. The Council, which should be made up of representatives of State and local government, Federal officials and industry and academic representatives, will be responsible for the implementation of most of the tasks outlined below. Action for its establishment should be as soon as possible. Currently a strong emergency preparedness community exists along with a scientific community which has earthquake hazard responsibilities. However, there is a definite need to improve the liaison between these groups in order to improve the state-of-earthquake preparedness in the Northeastern United States.

Because of the relatively small size of the Panel to develop a draft 5-year action plan for improving earthquake preparedness in the Northeast, it was possible for the entire panel to consider and to discuss the proposed

overall program. From these discussions, the Panel recommended activities in five task areas. These are described below.

TASK I: HAZARD AWARENESS AND PUBLIC INFORMATION

The Nuclear Regulatory Commission, the U.S. Geological Survey, and the Federal Emergency Management Agency all have on-going programs that identify earthquake hazards or provide general response capability. The Panel concluded that existing information and data provide a sufficient basis for earthquake hazard reduction planning. Moreover, all members of the Panel felt strongly that earthquake hazard reduction planning should be part of a comprehensive emergency planning effort. It became clear in the discussions that a high level of awareness of the earthquake hazards in this region existed among the scientific community, but the level of knowledge of earthquake hazards among disaster planners and responders is very low.

Particular goals under this task include:

1) Establish a level of interest and identify the level of the hazard.

2) Increase the earthquake awareness of the nonscientific community by:

    a) identifying target populations.
    b) designing a public awareness campaign.
    c) implementing and evaluating the campaign.

The second goal has been criticized as vague, yet we all realize what is needed in such a campaign--the problem is to implement it.

Responsibility for the implementation of these goals should rest entirely with the Northeast Regional Seismic Safety Advisory Council (NERSSAC).

TASK II: INTERGOVERNMENTAL RELATIONS AND COOPERATION

The Panel feels that two goals are particularly vital in this task area; namely:

1) Identify all currently existing relationships at the Federal, regional, State, and local levels of government.

2) Improve liaison and information exchange between the scientific and emergency preparedness communities and among all intergovernmental entities.

Responsibility for the implementation of these goals was also placed with the NERSSAC.

TASK III: LOCAL EARTHQUAKE-RESISTANT DESIGN

The Panel felt that building design problems were particularly acute in the Northeast. Massachusetts is the only State in the region to have specific modern earthquake-resistant design provisions incorporated into its building codes. Although the code in Massachusetts can serve as a model for other parts of New England, differences in adopted codes may be warranted in different parts of the northeast. However, each States and Federal and local governmental unit should require that its own structures and facilities meet specific earthquake-resistant design requirements.

The following six goals were established:

1) Define the level of hazard in quantifiable terms that are usable by the design professions.

2) Inform pubic officials (particularly code writers and enforcers) of the earthquake hazards.

3) Implement a policy that requires public buildings and facilities in appropriate areas of seismic risk to be built to seismic codes appropriate for the level of risk.

4) Define "low-cost" or "cost-effective" solutions to problems associated with earthquake-resistant design.

5) Review design and construction of existing critical facilities such as power facilities, hospitals, schools, fire stations, communication facilities, sewage and water systems in hazardous areas. Make and implement recommendations to reduce the seismic risk associated with these existing facilities, and

6) Review design and construction of existing buildings and devise cost-effective schemes to reduce losses.

Implementation of these goals should be the responsibility of NERSSAC.

TASK IV: LAND USE

Although local zoning laws exist in most areas of the northeast, they do not contain provisions relating to reduction of earthquake hazards. Zoning regulations that are seismically related should be added to the zoning laws particularly in areas of relatively high seismic risk, but the Panel recognizes a natural distaste for any increase in the complexity of zoning in the northeast. Since zoning is a local function, the impetus for adding the proposed seismic regulations must come from the State through incentives to local governing bodies for adoption.

Two specific goals are:

1) The identification of high hazard areas. Identification will be done primarily by means of all-hazard geologic mapping and should be a cooperative program between the private sector and the State and Federal governments. This is an on-going effort which will extend beyond the five year scope of this plan.

2) Define land use. This task should be carried out by the NERSSAC. Maximum use should be made of existing data and the NERSSAC should ensure that new information is rapidly disseminated throughout the scientific and planning communities.

TASK V: RESPONSE TO A DAMAGING EARTHQUAKE

The Panel noted that a number of multihazard emergency preparedness and response plans already exist. These are applicable to the earthquake hazard in the northeast. The responsibility for maintaining and exercising these plans rests with FEMA. It is not clear whether specific earthquake planning in the category of emergency response is necessary in the northeast, and one of the responsibilities assigned below to the NERSSAC is to ascertain that need.

Specific goals include

1) Identification of the existing plans. (Most people are unaware not only of the implementation procedures but even of their existence.) FEMA should take the lead responsibility here and provide the information to the NERSSAC.

2) Exercise the existing plans. This clearly is a joint responsibility of Federal, State, and local authorities.

3) Ascertain the need for creating specific earthquake disaster preparedness and response plans or for modification of existing plans for the northeast.

The last goal is assigned to the NERSSAC.

SUMMARY

Because of a number of factors unique to the northeast, **the appointment of a properly constituted Northeast Regional Seismic Safety Advisory Council (NERSSAC) is critical to the accomplishment of these tasks recommended in the draft five-year plan outlined above.** The Council, once appointed, should have the primary responsibility for the development of a seismic safety policy and the coordination and enactment of the five-year effort. The Council should have the political authority to ensure that its recommendations will be carried out and must have the personnel and financial resources to move forward. Once the Council is in place, specifics in each of the 5 task areas can be addressed.

The northeast is fortunate in that many regional cooperative programs, both political and scientific, are already in place and the precedent for regional cooperation is well established. Moreover, a number of responsible, concerned individuals are already working to enhance awareness of the earthquake risk in this area of low probability of occurrence. The success of any program such as this, requires the active, long-term participation of these and other individuals (as well as corporate entities).

Because of the high degree of industrialization, the large number of older buildings, and the high population density in the region, the occurrence of a major earthquake in the Northeast would result in major loss of life and property. The earthquake preparedness program outlined here would result in a major reduction of these losses.

HIGHLIGHTS OF THE WORKSHOP ON PREPARING FOR AND RESPONDING TO A DAMAGING EARTHQUAKE IN THE EASTERN UNITED STATES

by
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OPENING PLENARY PRESENTATIONS

On September 16, 1981, the U.S. Geological Survey (USGS) and the Federal Emergency Management Agency (FEMA) convened a workshop in Knoxville, Tennessee, for the purpose of devising three 5-year plans for preparedness and response to earthquakes in the Central, Southeastern and Northeastern parts of the United States. The workshop was attended by 70 participants representing a unique mix of backgrounds and perspectives, including: elected officials, decisionmakers and members of the scientific community. The workshop was designed to build upon information, ideas, and motivations generated by an immediately preceding conference in Knoxville on "Earthquakes and Earthquake Engineering in the Eastern United States." Workshop participants were selected for their preeminence in specialized fields of knowledge and for their capability to set goals, to identify problems, and to reach solutions in earthquake preparedness and mitigation.

Eight papers were commissioned to provide background information from within the scientific community and to stimulate discussion. Four of these papers provided an overview of the geologic, engineering, societal, and political aspects of the earthquake preparedness problem. The second set of four papers was commissioned to stimulate discussion based on experiences in other parts of the country. As a whole, the papers were designed to establish goals for each of 6 topics considered to be basic in earthquake preparedness. By using interactive discussions throughout the workshop, the goals were redefined and ultimately served as guidelines for three panels that were convened in the second half of the workshop to develop earthquake preparedness action plans.

This report gives the highlights of the workshop. The reader can refer to the papers that are appended later in this proceedings for details.

The workshop opened with the background information papers which gave brief summaries of geologic, engineering, social science, and political aspects which influence earthquake preparedness and response.

Geologic Aspects (Nuttli)

The effects of major earthquakes in the New Madrid seismic zone and other earthquake zones of the Eastern United States are projected to be devastating. When the next major earthquake occurs in the East it will produce a disaster of unprecedented scale, given the current concentration of population and building wealth. Research based on the series of 1811-1812 New Madrid earthquakes has demonstrated that major earthquakes in the Eastern United States can produce over 5,000 square miles of nearly total destruction and a 100,000 square mile area of structural damage. Throughout all these areas extensive injuries and loss of life can be expected--including damage to high-rise buildings as far away as 300 miles from the epicenter due to the low attenuation of seismic waves, prolonged duration, and nearly pure harmonic character of surface waves at large distances.

Eastern United States earthquakes and their effects are different in a number of ways from those in the West. In the East, faults with little or no surface expression of their seismic potential can produce large magnitude earthquakes. Damage areas are approximately twenty times greater for earthquakes of the same magnitude in the East than in the West. However, the time interval between major earthquakes in the East is much longer than in the West.

Engineering Aspects (Hall)

Population growth and concentration in large metropolitan areas together with a proliferation of man-made structures and facilities have contributed to the increase in earthquake disaster potential in the Eastern United States.

The object of earthquake-resistant design is to enable a structure to resist with slight or no damage the earthquake motions that might reasonably be expected to occur in the lifetime of the structure and to provide a significant measure of resistance to strong ground shaking to prevent collapse or failure. Earthquake-resistant design is not costly when undertaken as part of the original design effort, but retrofitting is generally prohibitively expensive and effectiveness is somewhat uncertain.

All critical facilties throughout the United States and important construction projects, at a miminum should be examined during initial design planning to ensure adequate earthquake resistance. In the East and the Midwest multiple hazard design (wind and earthquake designs) courses should be incorporated into training programs for design professionals. At present only a few States and cities in the Midwest and East have adopted seismic design regulations.

Societal Aspects (Nigg)

Among the many ramifications of a major earthquake on the lives and activities of the populace, four key societal response issues were selected for special examination. They are:

There are four key social response issues:

1) hazard awareness,
2) understanding and assessing earthquake threat,
3) preparedness and hazard mitigation,
4) response to an earthquake event.

Hazard Awareness--Within the East and Midwest, a necessary first step is to determine the present level of vulnerability and the public's awareness. Without awareness by public policymakers preparedness is unlikely to take place. Although the bulk of social science research dealing with awareness has been carried out in California, one study in the Midwest indicated that elected officials are aware of the threat and in some areas press coverage is given to the threat, although the saliency of mitigation action is low. With

the exception of Missouri and Tennessee little public discussion of seismic safety issues or geologic information seems to be taking place.

Understanding the Earthquake Threat--Being aware that a destructive earthquake can and eventually will occur is not sufficient to ensure appropriate action. Many variables affect awareness and response and determine how the threat will be interpreted and how the threat is assessed. Efforts to educate the public rely on raising the level of concern but not so high that fear produces panic and thus freezing all productive activity. Realistic expectations of the earthquake threat must be created.

In the Midwest, where a history of earthquake disasters does not exist, a disaster subculture may nevertheless exist which includes the development of warning systems, mitigation measures, and emergency response planning as well as social relationships which typically prevail during the period of imminent danger. These relationships and familiar behavior patterns may assist people in their ability to respond to earthquakes.

Research carried out in California suggests that ethnicity will have substantial effects on perceptions of earthquake threat. However, precisely what the effects will be is largely unknown.

Preparedness and Mitigation--Investigators in California have made recommendations to improve earthquake preparedness and mitigation actions:

1) Carefully prepared advice should be given widespread and repeated public distribution through the media and other channels.

2) Advice should come from an authoritative government agency endorsed by a well-known, local government official.

3) Each preparedness measure should be presented together with a brief explanation justifying that recommendation and explaining how it can be implemented.

4) A designated responsible State agency should develop a program to promote earthquake safety in households and organizations.

5) Large private sector corporations, as well as public service organizations, should have safety programs for their employees and attention should be paid to disseminating information to small businesses. Existing organizations should be used to disseminate earthquake information to their own members and throughout the community.

Response to an Earthquake Event--Recommendations in this area must take into account behavior learned from other hazards which may or may not be adoptable to earthquakes.

A major question remains--what is the extent to which lessons derived from California can be applied to the Midwest and Eastern United States?

Political Aspects (Atkisson and Petak)

The political environment within which seismic safety polices in the United States are framed is influenced by the following factors:

1) other contemporary problems which appear to be more important and which are given higher priority

2) the absence or presence of earthquake-oriented political constituencies,
3) the absence or presence of inside advocates,
4) debilitating problems of complexity and uncertainty,
5) cost of problem-solving policies,
6) issues of fact and value,
7) inadequate preparation for timely political activity.

Political action is most likely to happen to cope with earthquake effects during the immediate wake of an earthquake event than at any other time. During such periods well-considered earthquake mitigation and policy proposals exhibit the highest probability of enactment. But it is also during these periods that public passions, emotions, and the limitation of time and resources are most likely to deter reason and rational activity.

Recommendations growing out of political studies suggest:

1) Technical issues of fact should be identified and appropriately addressed before problem-solving proposals are submitted to legislative bodies.

2) Model legislation and action programs should be developed before earthquakes occur.

3) Constituent groups should be formed and educated with respect to earthqake problems.

4) Legislators who are potentially interested in earthquake matters should be identified, educated, and assisted to prepared and sponsor appropriate legislation at the opportune time.

Stimulator Papers

In order to stimulate discussion, a second series of four papers was commissioned for presentation to the participants. These papers were based on experiences gained in other parts of the country. These 4 papers covered a topics of six issues basic to earthquake preparedness and response. Each paper suggested approaches designed to clarify issues. The topics were:

1) hazard awareness and public education (Andrews)
2) public sector participation (Andrews)
3) intergovernmental relations and cooperation (Andrews)
4) earthquake-resistant design (Schiff)
5) land use (Nichols)
6) response to a damaging earthquake (Eddy)

Based on experiences in southern California by organizations like the Southern California Earthquake Preparedness Project, the following to **heighten hazard awareness, public sector participation, and intergovernmental relations and cooperation**, strategies were suggested.

To improve **hazard awareness:**

1) Develop detailed scenarios of the threat and the probable loss and damage.

2) Develop an education campaign for public officials, decisionmakers and technical personnel.

3) Make use of existing groups and facilities.

4) Tailor campaigns to specific audiences

5) Make use of media

6) Make use of the public education systems.

To improve **public sector participation:**

1) Take advantage of support from governmental leaders.

2) Tie earthquake preparedness to other desirable social goals such as public safety.

3) Involve all affected parties in the planning process.

4) The Federal Government should support hazard mitigation research and should make seismic safety a condition of Federal funding.

5) State governments should require that public agencies consider strengthening existing structures to resist seismic shaking.

To improve **intergovernmental relations and cooperation:**

1) An interstate seismic safety commission should be established.

2) Federal response plans should be organized which include cooperative arrangements and support with State and local governments.

3) State emergency offices should test their plans frequently.

4) Additional disaster personnel should be hired.

5) A mutual aid program should be developed for postearthquake response.

6) Cooperation should be developed between State agencies, utilities, and other critical services.

7) Private industry should play a role.

Following this presentation, participants were divided into reaction groups and given an opportunity to respond to these suggestions. While recognizing the value of the southern California experience, participants noted that it would be unrealistic to adopt these suggestions without taking into account unique midwestern and eastern needs. In the Central and Eastern United States it will be necessary to treat an earthquake preparedness program as one part of an all-hazards program. Rather than attempting to influence all public officials, a few key officials and media personnel should be identified. Further, in the East it will be necessary to use existing emergency management institutions. Several participants stated that it would be most unwise from the viewpoint of political acceptability to make earthquake hazard mitigation mandatory.

Continuing then to draw on experiences in other parts of the country a presentation was made on improving earthquake-resistant design in regions with low seismic awareness. The following approaches were suggested to improve **earthquake-resistant design:**

1) The State should recognize the existence of earthquake risk and adopt a policy that cost-effective methods be used to mitigate the hazard.

2) States should require its structures to meet seismic requirements.

3) States should adopt model building codes with seismic requirements.

4) Critical facilities should be reviewed.

5) General design practice should be reviewed.

6) Licensing exams for practicing professionals should include material related to earthquake-related design.

7) Emphasis should be placed on measures that can be institutionalized.

Once again the reaction groups refined the recommendations. Not only should states, but cities, counties and the Federal Government, take steps to make their structures seismically resistant. States should be **encouraged** to adopt model seismic standards in their building codes. Participants suggested that the Central and Eastern United States there may be a greater need for the technical community to assist businesses and communities in making these modifications. The efforts should proceed slowly and be accompanied by a long-term public education program to heighten awareness and concern.

Based once again on experiences primarily in California, the third presentation provided suggestions for **improving the state of earthquake preparedness through land use planning.** They included:

1) Each State should establish a seismic hazard mapping program in proportion to the earthquake threat.

2) Existing State statutes that pertain to building code and land use controls of municipalities should include references to earthquake studies.

3) Local governments should be encouraged to inventory current land uses and an assessement should be made of future land use decisions based on "acceptable risk".

4) States should adopt legislation requiring evaluations of seismic risk prior to developing critical facilities and high occupancy structures.

5) Model seismic safety legislation, regulation, and development policies for the Eastern United States should be prepared.

6) Model local seismic safety policies and plan implementation devices should be developed consistent with other hazards faced by each State.

7) Local jurisdictions should be required to prepare post-earthquake reconstruction plans as a condition of receiving State and Federal assistance following a damaging earthquake.

Although supportive of a State seismic hazard mapping programs, a number of participants responded that the proposed 5 year time frame was unrealisticly short. The reaction groups cautioned once again against enactment of **mandatory** land use controls or seismic zoning by the State and suggested that local jurisdictions be **encouraged** to adopt such measures.

The fourth presentation was based on the premise that earthquake contingency planning in the Eastern United States is inadequate to ensure that public officials at all levels of government can respond effectively to a damaging earthquake, a number of approaches were suggested **to improve response:**

1) Conduct vulnerability analyses and earthquake loss studies in all high seismic risk areas.

2) Develop a comprehensive total emergency management plan for each urban area emphasizing mitigation, preparedness response and recovery.

3) Develop intergovernmental emergency response plans and communication linkages between agencies.

4) Define Federal, State, and local government roles for scientific and engineering investigations after an earthquake and define emergency actions.

5) Develop firefighting capability in local communities and take steps to reduce damage to firefighting equipment during and after an earthquake.

6) Assess health care facilities to determine their opertional capability after a disaster.

7) Develop a search and rescue capability with emphasis on special problems created by an earthquake.

8) Develop housing resources to meet the needs of displaced persons.

Having set the suggested approaches or goals for each of the 6 topics, workshop participants turned to the development of action plans using the modified suggsted approaches as guidelines. Participants were divided into three panels representing the Central United States, the Southeastern United States, and the Northeastern United States. Each panel consisted of approximately twenty members having a wide mix of disciplines and varied professional responsibilities. Given the charge to "fine tune" the preliminary goals for their geographic areas, each group prepared a plan reflecting the geologic hazard potential, current level of awareness and public participation, present characteristics of intergovernmental relations, and likelihood of acceptance of local earthquake resistant-design standards and land use requirements in their geographic area.

A "Model" Plan for the Central United States (Thiel and Morelli)

"An approach to seismic safety for the Central United States." The objectives were: (1) to develop vulnerability analyses and identify opportunities for reducing damage, injury, and disruption; (2) to initiate a cooperative planning project among diverse local, State, and Federal jurisdictions to deliver a comprehensive integrated preparedness and mitigation program; (3) to complete specific preparedness plans for critical facilities and interim plans for Federal and State governments; and (4) to improve the knowledge of professionals, public officials, and the general public about earthquake hazard reduction issues.

FIVE-YEAR PANEL REPORTS

Central United States

Hazard Awareness and Public Information--The draft Panel report identifies several principal goals: (1) Materials should be planned and key officials identified, (2) Increasing the hazard awareness of public officials and the general public is necessary. The first goal should be accomplished within 2 years. The latter will require a 5-year effort. Long-term public education is called for to sustain interest. Among the information presentations would be those by the USGS and others on the technical and scientific problems, by FEMA on planning activities, and by local public officials from communities which have taken some action. Seminars on a Statewide basis and later by hazard zones should be held to explain the scope of the threat, liability or consequence of inaction, responsibility for public safety and welfare, and the need for concrete, low-budget suggestions for action. Information packets should be prepared for public officials. Information specialists from the universities in the area should continue to develop materials and to act as contacts.

Public Sector Participation--A most important goal is the education of key public officials. This will require a 5-year effort with the lead to be taken by FEMA and State offices of emergency preparedness. National associations of professionals, national public interest groups (including councils of State and local governments) would be among the leaders.

Intergovernmental Relations and Cooperation--The needs include: (1) to identify hazards within the jurisdiction of each agency, (2) promote earthquake hazard awareness among the appropriate State and local agencies as well as volunteer and private agencies, (3) to develop and coordinate plans for restoration of services, (4) to establish capabilities and responsibilities for each agency in the immediate period after a disaster, (5) to develop interstate mutual aid agreements, (6) to develop and test regional earthquake response plans, and (7) to prepare long-range restoration and redevelopment plans. FEMA should take a role in these activities by providing a vulnerability analysis and making available technical assistance and information.

Earthquake-Resistant Design--Seismic provisions should be incorporated in existing building codes and enforced. These provisions should take into account the characteristics of eastern seismicity.

To facilitate the achievement of this goal an Inter-State Sesimic Code Revision Committee, should be created to draft a seismic code for the Midwest starting with the existing ATC-3 code and applying modifications. Seismic provisions should be balanced with other hazards, economic costs and likely impacts and applicability.

Consideration should be given specifically to critical facilities. The work of the Inter-State Seismic Code Revision Committee would encompass 3 - 4 years and should be supported by a Federal agency. The major points to be considered by the committee are:

(1) hazard level
(2) building use and occupancy
(3) major facilities
(4) good practice and detailing
(5) response spectra
(6) equipment
(7) economic impact

With respect to code adoption and enforcement, a general public awareness program is essential. However State intervention could complicate rather than facilitate local code adoption.

No program of review and upgrading is presently called for. Resulting public opposition and economic impact could jeopardize the entire effort. Minor modifications slowly implemented might be considered. Two categories of structures, however, should be reviewed and potentially upgraded. They are:

1) mitigation structures including fire, police, and hospital facilities,

2) important facilities whose failure would threaten the lives of many e.g., dams, bridges, etc.

Land Use--Currently land use and zoning is a local function with policing powers granted by the State to the local municipality. Seismic land use related regulations should be added to existing zoning procedures, especially for dams and levees.

Zoning regulations should be addressed to downstream development and should not restrict land use because of possible breaks in the levees. Zoning should couple land use with building code requirements for future safety. Flat land zoning should be treated in much the same way with safety being the responsibility of building code officials.

Response to a Damaging Earthquake--State activities should update existing comprehensive plans taking into account private industry capabilities. Responsibilities include: developing local guidance; carrying out inventories of resource capabilities, including life safety and shelter resources; carrying out training exercises, preparing interstate agreements; investigating procedures for rapid declaration of emergency conditions; and develop plans for short-range and long-range recovery.

Local activities should include: updating existing plans, include new seismic sections; preparing inventories similar to those at the State level; carring out training exercises, arranging intercounty and intercommunity mutual aid agreements; preparing response plans and defining lines of responsibility for local, State, and Federal actions; and preparing recovery plans drawing upon local, State, and Federal resources. The development of comprehensive plans and update of existing plans should begin immediately.

In summary, the Central United States Panel recommends that earthquake response preparedness should involve local and State governments as well as educational institutions and voluntary organizations. It will be the responsibility of Federal agencies, inlcuding FEMA and the USGS, to act as prime movers. Education of key officials, along with a program for enhancing public awareness, should form the first step in the plan. Because officials go in and out of office each year, educational efforts will need to continue thoughout the entire 5-year period and beyond.

Southeastern United States

The draft report of the Southeastern United States Panel calls for the establishment of a Southeastern United States Seismic Safety Consortium. An ad hoc steering committee was created and charged with preparing a draft report based on existing information to establish the seismic hazard in each southeastern State. It would be used as a basis for action in establishing the consortium.

Hazard Awareness and Public Information--The next steps include defining the risk to property and life and to classify types of buildings and facilities within each part of the region which merit special consideration. Because of the long recurrence interval of major earthquakes, it will be necessary to incorporate seimic hazard preparedness activities within a multihazard framework. These activities should be initiated during the first 3 years of the 5-year program.

Public Sector Participation--The Consortium should establish contacts with on-going seismic commissions in the Western United States. Efforts should begin immediately to identify interested organizations, to provide awareness information, to identify and recruit political sponsors, and to form a lobby to bring political attention to the seismic hazard potential.

Intergovernmental Relations and Cooperation--The Consortium should establish relations with governmental organizations, exchange information, draft model legislation, and establish cooperative efforts with all levels of government and with industrial and commercial enterprises.

Earthquake-Resistant Design--The Consortium should look into the development of a model building code, encourage education in earthquake-resistant design, and identify existing and planned critical facilities.

Land Use--The Consortium should support all-hazards mapping programs to be carried out by the Federal and State governments to evaluate the feasibility of land use planning.

Response to a Damaging Earthquake--An inventory should be made of existing emergency response plans at the State and local levels. Where necessary, these plans should be revised. Workshops should be held throughout the 5 year period for emergency and recovery planners.

Northeastern United States

The draft report of the northeastern Panel noted that in the Northeastern United States there is currently a high level of awareness among the scientific community of the earthquake hazard, but that level of awareness is extremely low among emergency planners and the general public. Federal agencies, including the Nuclear Regulatory Commission, USGS, and FEMA all have ongoing programs to identify earthquake hazards in the Northeast. Existing information can be provided by these agencies to form the data base for emergency planning. Earthquake planning should be part of a comprehensive emergency preparedness effort.

The first priority in the Northeast should be the creation of a Regional Seismic Commission. There is a need to improve the liaison between groups in the scientific community and those in the emergency preparedness community.

State and local governments should develop or adopt building codes having appropriate seismic provisions for high hazard areas where they do not exist. They should enforce existing codes.

Although there are a number of existing emergency preparedness and response plans in States in the Northeast, it should be determined whether additional planning in the emergency response field is called for. Responsibility for maintaining and exercising these plans rests with FEMA and State governments.

Conclusions

The Workshop concluded with a critical evaluation and suggestions for implementation of draft action plans based on experiences of the Utah Seismic Safety Commission.

Plans and ideas for earthquake hazards reduction are matters of public policy. Nevertheless, in the final analysis, action (or the lack of action) in earthquake preparedness will result from ideas, public acceptance, and commitment.

The ideas for earthquake hazards reduction which were generated in 3 days of workshop activity will greatly exceed the number actually adopted during the next 5 - 10 years. Based on experiences in Utah, it can be concluded that studies do not create public policy. Legislators, other elected officials, and agency administrators create public policy.

Several lessons emerge from the Utah experience which, when taken into account, may facilitate the adoption of a seismic safety policy and programs in the Eastern United States. They are:

1) Earthquake safety policy must compete with many other policy issues and must stand on its own merits as perceived by the policymakers.

2) Earthquake safety, like any other policy issue, requires a constituency. Policy bodies react; they rarely lead.

3) Be vocal. "The squeeky wheel" concept controls much that is done.

4) An advocate within the policymaking body must be found to guide the earthquake safety issue through the political process.

5) Policy issues must be kept simple.

6) The cost of the solution to the problem, whether perceived or real, must not exceed the perceived cost of the risk.

7) Policy issues are often reduced to concepts involving simple "yes" or "no" political decisions. The decisionmaking process for public policy too often is subverted by this kind of attitude.

8) Earthquake safety policies and recommendations must be separated into single, sharply focused issues and actions.

9) Policy promotion efforts should be structured to fit within the working time frame of policymaking bodies.

10) Persons and organizations seeking adoption of earthquake safety policies must learn to be opportunistic in their endeavors. Each small policy that is adopted improves the capability to deal with damaging earthquakes.

POST-WORKSHOP FOLLOWUP OF PUBLIC OFFICIALS

Through a combined mail and telephone survey, each of the public officials who participated in the Knoxville workshop on "Preparing for and Responding to a Damaging Earthquake in the Eastern United States" was contacted. They were asked if participation in the meeting had helped or encouraged them to initiate or to participate in the earthquake preparedness and mitigation activities in their respective communities and States.

Response was positive. Of the public officials who participated, more than one-third took the time to write about activities which grew out of the meeting. Several new programs are underway in Arkansas, Kentucky, Mississippi, Missouri, and Tennessee.

In Arkansas, the emphasis is on improving the awareness of the general public. This approach reflects one of the primary goals developed during the Workshop by the Central United States panel and highlighted in their draft five-year action plan. Recognizing that "people must believe there is risk" before preparedness can take place, the State Emergency Service Office has already begun to provide information to elected officials, including the Governor and his staff, and to the general public through periodic press releases dealing with the New Madrid seismic zones. Representatives have participated in radio talk shows and have begun to provide information to county emergency preparedness coordinators.

The Kentucky experience illustrates that much can be accomplished when one individual becomes involved and takes on an issue, such as preparedness, as a personal cause. A member of the League of Women Voters has taken a lead role in Kentucky and obtained the cooperation and support of the Office of Emergency Services in reaching local and State government officials. Publicity has been provided to members of the State legislature, the executive branch, and State and local elected officials, as well as to the general public though small meetings, workshops, and talks to service and social organizations. These activities have drawn upon scientific expertise available both locally and nationally.

In Mississippi, a new level of awareness has been achieved in the State Emergency Management Agency as a result of participation in the Knoxville workshop. In 1982 plans are underway to carry out a comprehensive review of the hazard/risk analysis for the State. Although all hazards will be considered, a greater emphasis will be placed on earthquake hazards than previously planned, and the review will draw more heavily on the involvement of local officials and those in other State agencies.

In Poplar Bluff, Missouri, materials and information obtained at the Workshop will form the basis for development of a model county earthquake plan. These materials are being used, as well, in preparing presentations which will be made before service clubs and civic organizations.

In Memphis, Tennessee, respondents noted suppport for the ongoing FEMA vulnerability analysis in the Central United States. They pledged their enthusiastic support to ensure the success of this combined Federal/State/local effort.

EVALUATIONS BY WORKSHOP PARTICIPANTS

An evaluation form was distributed to each of the 70 participants of the workshop on, "Preparing for and Responding to a Damaging Earthquake in the Eastern United States." The responses were studied carefully to gain insight into the varied perspectives represented by the workshop participants and to learn how to do a better job of communicating in future workshops and conferences.

A few of the evaluations are presented below to show their thoughtful and constructive nature. They are candidly reflections of what others thought took place. The identity of the person providing the evaluation is not revealed except in terms of their general perspective; the nature of the comment, not who made it, is the important factor.

o Evaluation of a Governor's Representative

"The workshop was not only unique by investigating the earthquake problem in the Eastern United States, but was creative in bring political decisonmakers face-to-face with the professionals who have the knowledge to guide our local, State, and Federal governments into a higher plane of awareness of the consequences of our decision.

Recent emergencies are proof of humanity's vulnerability to our natural environment and to our own carelessness. As those of us in the public policymaking arena observe occurrences such as the Three Mile Island nuclear plant failure, the Mount St. Helens volcanic eruption, the Love Canal chemical dump, the Hyatt Regency structural collapse, and even the California medfly threaten our local communities and neighborhoods, we realize that we must welcome with an attentive ear the scientists, the educators, and the researcher into the arena with us in order to contend with these adversities."

Suggestions for Improving Program Coordination

"The first objective of States in the Mississippi Valley region should be to cooperate with the hazard vulnerability analysis of the Federal Emergency Management Agency. This could be followed by a FEMA-USGS coordinated regional meeting to discuss the New Madrid fault and its specific threat to our respective States. Perhaps, a series of meetings will be required among the States to effect mutual aid agreements and to exchange technical data. An annual workshop could be conducted in the Eastern United States, similar to the Knoxville meeting, to keep program participants informed on the progress of our earthquake preparedness projects."

- **Evaluation of a Governor's Representative**

"Although I had some misgivings about the workshop and the problem of compressing so much in so little time, I am encouraged by the outcome. The level of concern and the intensity of participation by such a diverse group was unusual in itself. The final results of the workshop may not be achieved for some time, but the foundation has been laid and a direction established for the future."

"For our State, it means rethinking the problems presented by the earthquake threat. . . . During this Fiscal Year, the hazard/risk analysis for the State will be subjected to a comprehensive review. The review will focus on all hazards, but unlike the past, greater emphasis will be placed on the earthquake hazard. The review process will also rely more heavily on the involvement of local officials and other State agencies."

- **Evaluation of a Mayor's Representative**

"My view of the recent workshop is that it was a very interesting and worthwhile meeting. Although I have heard of and been aware of the New Madrid Fault Zone for many years, I was not perviously aware of the high probability of an earthquake in this zone during the 20th century."

Suggestions for Improving Program Coordination

"The only suggestion I would make for future meetings of this type insofar as public officials are concerned is to attempt to curtail the amount of technical and scientific information reported and discussed and to keep the dialogue more understandable for a layman who is neither an educator, engineer, or scientist."

- **Evaluation of an Educator**

"A distillation and syntheses of the 3 panels will undoubtedly make a cogent action plan for improving earthquake preparedness in the Eastern United States. However, to my mind, the principal benefit will accrue because of the true diversity of backgrounds, points of view, and vested interests of the participants who . . . not only had to listen to each other but were forced to work together and to deal with each other. Therein lies the benefit to each individual attendee. I must admit I had doubts at the start about the eventual outcome."

. . . "Finally, I sense that some of the younger FEMA representatives also acquired some needed education."

- **Evaluation of a Consulting Engineer**

"It was a pleasure and quite an interesting experience to participate in the workshop. The participants certainly contributed a broad spectrum of ideas and their diversifed fields of specialization provided a balanced view of the problem--a must for approaching such a complex issue."

"The weak points of the workshop were: 1) the schedule was too tight the first afternoon and morning, and 2) it attempted to solve too much."

- **Evaluation of an Engineer (Private Sector)**

"I do think the workshop was extremely valuable. It represents the start of a worthwhile and needed program. I enjoyed talking with the various disciplines represented and, as a result, learned a lot. I especially appreciate the fact that the workshop followed the conference on "Earthquake and Earthquake Engineering."

"I guess it is still not too clear to me how all that we discussed is going to work. It would appear that much is left in the hands of FEMA and USGS, someone who can keep the fire going."

ACKNOWLEDGMENTS

As is the case in every workshop having complex objectives, many people contributed to the success of this workshop. A special note of appreciation is extended to each of the following for their contributions:

- The Steering Committee of Dr. Walter Hays, (USGS), Ugo Morelli (FEMA) Dr. Otto Nuttli (St. Louis University), Dr. Gil Bollinger (Virginia Polytechnic Institute and State University), Dr. Paul Pomeroy (Rondout Associates, Inc.), and Joe Hayes (FEMA) planned and organized the workshop.

- Dr. Charles Thiel, formerly Assistant Associate Director for Natural and Technological Hazards Preparedness (FEMA) who has a deep concern for earthquake hazard mitigation in the United States, was a source of wise counsel and continual encouragement. He and Ugo Morelli authored the model plan used to stimulate development of 5-year action plans.

- Dr. Daniel Barbee and Ms. Claire Rubin of the Academy for Contemporary Problems, Washington, D.C., provided expert advice and guidance to the Steering Committee on the program and the group dynamics process at the workshop. Barbee implemented this advice and guidance as the overall Facilitator of the workshop. Rubin helped in many ways to make the group dynamics work.

- Ms. Susan Tubbesing, Natural Hazards Research and Applications Information Center, University of Colorado, provided expert advice on how to evaluate the effectiveness of the workshop and assisted in obtaining critical evaluations from the participants. She also provided a written summary of the workshop highlights.

- Dr. Otto Nuttli, Dr. William Hall (University of Illinois at Urbana-Champaign), Dr. Joanne Nigg (Arizona State University), and Dr. Arthur Atkisson (University of Wisconsin at Green Bay) and

Dr. William Petak (J. H. Wiggins Co.) prepared written overview papers defining the critical elements of the earthquake threat.

- Dr. Richard Andrews (Southern California Earthquake Preparedness Project), Dr. Anschel Schiff (Purdue University), Dr. Don Nichols (USGS), and Donald Eddy served as Stimulators, giving papers based on their broad experience. These papers contained suggested approaches for improving the state-of-earthquake-preparedness. They successfully directed the attention of the participants to the critical issues in the 6 topical areas selected as the focus of the workshop and proposed plausible solutions.

- Ugo Morelli, Ms. Claire Rubin, Dr. John Stevenson (Structural Mechanics Associates, Inc.), Joe Hayes, and Charles Thiel chaired the discussion sessions prior to panel sessions. These sessions provided essential information and sharpened the group dynamics process.

- Otto Nuttli, Gil Bollinger, Paul Pomeroy and Phil McIntyre (FEMA) chaired the three panels and succeeded in focusing the discussions on the critical issues and the suggested procedures to improve earthquake preparedness in each geographic region.

- Dan Emerson (City of Saint Louis), Dr. Joyce Bagwell (Baptist College at Charleston), and Dr. Walter Anderson (Maine Geological Survey) served as Rapporteurs of the three panels and helped to create the group memory.

- Delbert Ward, (Structural Facilities, Inc.), who had recently completed a 4-year term as Executive Director of the Utah Seismic Safety Advisory Council, served as a resource person to the 3 panels and provided constructive criticism of the proposed 5-year action plan and suggestions for implementing them.

- Dr. Robert Brown (USGS), Dr. Charles Thiel, Ugo Morelli, Dr. William Hall, and Ms. Claire Rubin also served as resource persons to the 3 panels.

- Finally, participants who joined in the discussions, reaction groups, and panel sessions with great interest and enthusiasm were the key to the success of the workshop. Their vigorous and healthy exchange of views made the workshop practical and interesting. They are the key to future implementation of the recommendations and the development of seismic safety policy in th Eastern United States.

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

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EFFECTS OF MAJOR EARTHQUAKES IN THE NEW MADRID FAULT ZONE AND OTHER EARTHQUAKE ZONES OF THE EASTERN UNITED STATES

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When the next major earthquake occurs in the East, it will produce a disaster of unprecedented scale. The 1811-1812 New Madrid earthquakes demonstrated dramatically that major earthquakes in the eastern United States can produce a 13,000 km^2 (5100 mi^2) area of almost total destruction (MM intensity of X to XII), a 250,000 km^2 (98,000 mi^2) area of structural damage (MM intensity of VIII and IX), and an additional 500,000 km^2 (195,000 mi^2) area of minor structural damage and possibly large architectural damage (MM intensity of VII). Throughout all these areas extensive injuries and loss of life can be expected. In fact, injuries and even possible loss of life can be expected in high-rise buildings at least as far as 500 km (300 mi) distance from the epicenter, because of the low attenuation of seismic waves with frequencies of 1 Hz and less and because of the prolonged duration of at least one to two minutes and nearly pure harmonic character of surface waves at large distances.

The 1811-1812 New Madrid earthquakes probably were felt in all of the United States and southern Canada east of the Rocky Mountains. Smaller, more recent earthquakes, have also demonstrated this phenomenon of large area of perceptibility. The 1968 Illinois earthquake (m_b = 5.5) was felt in portions of 23 states and in Ontario. The 1980 Kentucky earthquake (m_b = 5.3) was felt in 15 states and Ontario. The 1886 Charleston, S.C. earthquake (m_b = 6.6) was felt as far west as the Mississippi river, and 1895 Charleston, Missouri, earthquake (m_b = 6.2) was observed along the southeast Atlantic coast, the Gulf coast, in southern Canada and in western Kansas and Nebraska.

Major eastern United States earthquakes differ from their western counterparts in three important ways: stress drop, anelastic attenuation and recurrence rate. The eastern United States earthquakes have higher stress drop, which results in much smaller fault rupture lengths. For example, an M_S = 8.5 eastern earthquake will have a rupture length of only about 55 km (33 mi) whereas a California earthquake of M_S = 8.2 will have a rupture length of about 850 km (510 mi). Thus relatively minor faults can produce large magnitude earthquakes in the East, but not in the West. Anelastic attenuation of ground motion in the range of damaging wave frequencies is much less in the East, resulting in damage areas approximately twenty times greater than for earthquakes in the West of the same magnitude. Counteracting these phenomena, however, is the higher recurrence rate of major earthquakes in the West, about six to seven times that in the East. The long time-interval between major earthquakes in the East results in a general nonawareness or nonappreciation of the severity of the earthquake hazard for that part of the country.

Not enough is known about the character of the presently active fault zones of the eastern United States to be able to assess their maximum possible rupture length and thus their maximum-magnitude earthquake. An exception is the New Madrid fault, consisting of 3 branches of about 100 km (62 mi), 40 km (25 mi) and 75 km (47 mi) length. Each of these branches probably experienced its maximum-magnitude earthquake: the southern branch an M_S = 8.6 event on December 16, 1811, the central branch an M_S = 8.4 event on January 23, 1812, and the northern branch an M_S = 8.7 event on February 7, 1812. The St. Lawrence Valley fault zone of northeastern Canada likely is composed of several discrete segments; at least one was large enough to generate an earthquake of M_S greater than 8 in 1663. The destructive Charleston, South Carolina, earthquake of 1886 may have had a rupture length of only about 25 to 35 km (16 to 22 mi).

It is essential that all the areas capable of generating major earthquakes in the eastern United States be identified, that emergency plans be prepared for disaster relief and recovery for large affected areas, that building codes be established and enforced to protect the general populace,

and that the public be educated to know how to respond to the experience of damaging earthquake ground motion and how to survive until relief can be provided.

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EARTHQUAKE ENGINEERING: GUIDELINES AND SPECIAL CONSIDERATIONS IN THE EASTERN UNITED STATES

by

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The 1971 San Fernando earthquake, the 1970 Lubbock tornado, Gulf Coast hurricanes, midwestern floods, the 1970 Peru earthquake and the 1964 Alaska earthquake with its accompanying massive land and submarine slides, as well as industrial and transportation system incidents and explosions attest to the need for considering the possibility of occurrence, as well as the possible consequences, of such natural and man-made hazards. Merely from the standpoint of increased exposure associated with an expanding population which is concentrated into large metropolitan centers, and with a proliferation of man-made structures and industrial facilities, the number of incidents and consequences of disaster (loss of life, injury, and loss of property or damage) can be expected to increase in the years ahead. Even in geographical areas where seismic risk is assumed to be low as a result of infrequent earthquake activity, as in the eastern United States, the consequences of a large earthquake need careful consideration.

In general the object of earthquake-resistant design is to enable a structure to resist with slight or no damage the earthquake motions that might reasonably be expected to occur during the lifetime of the structure, thus avoiding expensive repairs if a minor earthquake should occur. An even more important purpose is to provide a significant measure of resistance to strong ground shaking, so as to prevent collapse or failure that might lead to loss of life, injury or major property damage in the event of a major earthquake, even if there is only a rare probability of occurrence. Although for the first case a structure may be designed to remain elastic or nearly so, in the latter instance it is not economically reasonable to design solely for elastic behavior unless the structure is of such a character, and of such importance, that it might not be able to fulfill its intended use, even with slight damage, after an earthquake.

Our technologically-based society requires the use of structures and facilities whose destruction, or even damage, by natural or man-induced hazards potentially could be catastrophic, as for example nuclear power plants, large dams, and certain pipelines, lifelines, and industrial facilities. Such facilities, as well as hospitals, emergency service facilities and essential utilities, often are called "critical facilities", in the sense that their damage or loss could seriously affect the public well-being through loss of life, large financial loss, or degradation of the environment if they were to fail functionally. It is generally recognized that some of these facilities should be designed to remain operable immediately after an incident to provide life-support services to the communities affected.

At this point it may be appropriate to note that it is the author's belief that in the near future there should be a comprehensive examination of the design procedures and construction practices for multiple hazards, especially wind and earthquake. In many respects, the structural resistances employed for such hazards are supplementary as well as complementary. This fact should be reflected explicitly in our design codes, standards, and guidelines, and could well be of significant economic importance. However this topic is not the subject of the workshop and is left for another forum.

Based on the historic record of earthquake activity, earthquake risk in the eastern United States is generally rated as relatively low; however, it is moderately high in certain specific areas as reflected in seismic zoning maps. One must not ignore the fact that some of the Nation's largest earthquakes have occurred in the midwest and east, and most assuredly large earthquakes will occur in these areas again in the future. The consequences of such earthquakes most probably will be more serious than in the past since the number of people and sturctures exposed will be greater. It would seem appropriate to note here that the seismic quiescence of an area can be misleading. For example, in Italy seismic activity was reported to be relatively moderate to low for some ten centuries; for nearly the past decade the seismic activity, and loss of life and property, has been high and severe, as illustrated by the November 23, 1980, earthquake near Naples. Similar

occurrences can be expected thoughout the world in seismically quiet areas in the years ahead.

Earthquake-resistant design and construction is not costly generally when undertaken as a part of the original design effort by individuals trained in the field. Retrofitting is generally very expensive, if technically possible at all.

The author recommends that throughout the United States all critical facilities and important construction projects, at the minimum, should be examined during initial design planning for earthquake resistance in the same spirit that they are examined for wind resistance. As for general construction, in addition to specific Federal requirements, a few states and cities in the midwest and east have adopted seismic design regulations relatively recently for specific applications, and especially in the sense of responsiblilty to provide a reasonable level of seismic resistance in buildings financed by public funds.

It is the author's belief that the need in the midwest and east is for a program to develop awareness as to seismic risk and as to the consequences of a severe earthquake, and to train professionals (engineers, architects, contractors, materials manufacturers and suppliers) through institutional instruction, self-study programs, seminars and short courses in earthquake-resistant design. In the light of the slow progress to date in such endeavors the author believes that the process might well be accelerated if training were developed for multiple hazard design (wind and earthquake design especially). Such activity if properly carried out should lead to a general upgrading of the resistance of our structures and facilities over a period of years at a minimum of cost.

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SOCIETAL RESPONSE TO THE EARTHQUAKE THREAT IN THE EASTERN UNITED STATES
SOME ISSUES, PROBLEMS, AND SUGGESTIONS

by
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INTRODUCTION

Recent research endeavors have broadened our knowledge about how individuals and communities assess the earthquake threat and risk, understand forewarnings and predictions, and prepare themselves for future quakes (Haas and Mileti, 1976; Wyner and Mann, 1981; Turner et al., 1980; Olsen and Nilson, 1980). Our knowledge, however, is limited by the choice of California as a primary study area. The magnitude 5.1 Kentucky earthquake felt along the eastern seaboard in July 1980 and Professor Nuttli's high probability scenario of a New Madrid quake before the end of the century (Nuttli, 1980) provide reminders that there are seismically hazardous areas in the United States other than those popularly thought of as "earthquake country."

Since my task at this workshop is to present the societal aspects of the earthquake threat in the eastern United States, I have organized my remarks around four key social response issues:

1. Hazard Awareness
2. Understanding and Assessing Earthquake Threat
3. Preparedness and Hazard Mitigation
4. Response to an Earthquake Event

Because of the need to draw on research and experience with earthquake events from seismically active areas, the underlying question is whether these findings are applicable to the eastern United States. Do individuals and communities in these other areas of the country, with high threat and low seismic activity, assess earthquake risk and respond to it in the same way?

EARTHQUAKE HAZARD AWARENESS

Obviously, before a person can respond to a situation, he or she must know that it exists. In areas of the world where seismic activity is high (e.g., California, Japan, Italy, Guatemala), popular knowledge of earthquake threat is often taken for granted by researchers and planners. People who live in these areas, even for a short time, are likely to have personally felt small magnitude quakes and many may have experienced or heard about the effects of locally destructive quakes. Research findings indicate that a substantial proportion of residents in these areas also believe that a damaging earthquake is likely within the near future (Turner et al., 1980). This awareness of threat, then, can provide a basis from which preparedness actions can be taken.

We must know, however, if easterners are even aware that an earthquake threat exists in these regions. If they are aware, how real does the possibility of a quake within the near future seem to them? Without some awareness, no preparedness--at either the individual or community level--will take place.

If earthquake hazard awareness exists, it probably does so in the Central States area where some community issues have been raised and attention has been directed toward seismic safety issues--including, among others, the meaning and significance of the high probability of a future quake in the New Madrid region, the formation of the Missouri Earthquake Hazard Mitigation Panel, the controversy concerning the use of a seismic element in St. Louis, building code requirements,, and the establishment of the Tennessee Earthquake Information Center in Memphis. In Missouri, Drabek and Mushkatel (1980) found an indication that elected officials are aware of the earthquake threat, although actual mitigation efforts have been few, and that substantial press coverage was given to earthquake threat, especially in the Boot Heel area.

With the exception of Missouri and Tennessee, there appears to be little public discussion of seismic safety policies, issues, or geologic information. Without this public discourse, especially when it becomes "news" for the media, widespread awareness of the earthquake threat is not likely to come about.

UNDERSTANDING AND ASSESSING EARTHQUAKE THREAT

Merely being aware that a destructive magnitude earthquake could occur in one's region of the country is not sufficient to motivate either individuals or communities to take preparedness or mitigation actions. Several variables mediate awareness and response, determining how the earthquake threat will be interpreted. These variables, in part, determine the seriousness and importance which people attribute to the prospect of a local earthquake.

Fear and Concern

Althought the people in the East have not been exposed to scientific predictions or near-predictions to the extent that southern Californians have, those in the Central States at least may have been exposed to the possiblity of earthquake threat and risk during the last few years. Whether this exposure was sufficient to raise their concern over the prospect of a quake is important since the consequences facing them are serious if a large magnitude quake does occur. Feelings of fear and concern over the prospect of a coming quake in southern California were important in predicting the extent to which households had taken preparedness measures. However, the relationship was curvilinear; that is, low and moderate levels of fear produced a more positive response to preparedness, while having either a high or low level of fear was associated with being less well prepared.

Any efforts to educate the public will rely, in part, on reaching some optimum level of concern, raising the level of concern but not to the extent that people feel overwhelmed by the task facing them.

Frameworks of Knowledge About Earthquakes

Before people can interpret novel information and decide how they are going to react to it, that information must be categorized in some way to make it meaningful. Since earthquakes, even damaging ones, are not common events in the lives of easterners, we must look at the frameworks within which this information may be interpreted in order to hypothesize how it will be responded to.

Disaster Lore and Popular Beliefs. What awareness there is may be influenced by earthquake lore and folk beliefs. In California, the popular belief still exists that a major earthquake along the San Andreas fault could result in California's breaking off and falling into the Pacific Ocean. Beliefs that some animals can predict earthquakes and that some psychic premonitions are valid exist alongside understandings of the theory of plate tectonics. In our southern California study when people were asked why earthquakes occur, a small proportion of the sample (about seven percent) mentioned nonphysical causation, attributing earthquake occurrences to a Divine Plan, punishment for the sins of mankind, and the secular theme of interfering with nature (Turner et al., 1979).

Without frequent seismic events which prompt the retelling of such lore and folk beliefs, popular knowledge about the causes of earthquakes and what happens when they occur may be meager in the eastern United States. But some such lore must exist, especially with regard to the 1811 and 1812 New Madrid quakes.

It is important to recover these beliefs and tales of local earthquake lore because they can provide a basis from which one component of a public education program could be developed--the establishment of realistic expectations of earthquake threat. For example, by reviewing the popular lore about the consequences of the 1811-1812 New Madrid quakes--the Mississippi River flowing backwards, whole communities collapsing, rivers changing their course of flow--residents could be reminded of the region's seismic history and a "then-now" comparison could be made. The important point here is to build on the familiar, correcting the glaringly erroneous popular perceptions and extrapolating to the present from the valid recollections of past local events.

Disaster Subcultures. More so than in the West, the three regions in the eastern United States with high seismic risk are frequently threatened by other natural disasters. The New Madrid fault zone is almost entirely overlapped by one of the highest tornado death index areas in the country (Sims and Baumann, 1974). The south Carolina coast and the Boston-New York areas have been threatened by hurricanes, the actual occurrence of these

events has failed to affect the eastern coast in the past several years. Since there have been no recent disasters in these areas, it is unlikely that fully developed disaster subcultures exist. The following discussion, then, will be most applicable to the Central States region where a tornado disaster subculture does exist.

The recurrent, destructive nature of this hazard has led to the development of warning systems, mitigation measures, and emergency response planning. Normal social relationships are replaced during these periods of imminent danger with another set of expected behaviors and organizational responsibilities that last as long as does the disaster threat or its aftermath. These areas, then, have disaster subcultures that aid people in knowing what to expect and how to respond.

Are the adaptive responses associated with a tornado disaster subculture transferable to earthquake threat situations? It is possible that experience with tornado warning systems and taking precautionary actions to protect one's household during watches and warnings may have some carryover effects which sensitize people to the importance of earthquake forewarning and hazard mitigation programs.

It has been claimed that in well-developed disaster subcultures, both individuals and organizations have developed the ability to take precautionary and adaptive measures quickly and successfully. However, the literature on disaster subcultures is somewhat contradictory (Wenger, 1978). Some researchers have found that in areas that are threatened by a frequently recurring type of disaster agent, those organizations responsible for issuing warnings and safeguarding the populace become more competent and better integrated; while the individuals in the area become more lax and personally less well prepared for that disaster (Hannigan and Kueneman, 1978). This paternalistic orientation--characterized by the statement, "let the government do it"--was found to be particularly strong with respect to earthquake hazard mititation and preparedness in southern California.

Research on tornado disaster subcultures has also indicated that there are regional variations in communities' adaptive responses to threat, with the

Central States having lower fatality rates than do southern States (Sims and Baumann, 1974). Since no substantial differences between regions were found in the number, duration or velocity of the tornados, when they hit, the types of residential structures, or the quality of the warning systems, the researchers investigated how the populations of the two regions differed.

Two significant differences were found in the ways people interpreted and coped with threat of disaster. First, Central States residents expressed the belief that they were more in control of their own lives than did southerners who were more likely to identify some force external to themselves. (e.g., luck or God) as a causal agent in their lives. Second, southerners were more likely to rely on their own senses to keep themselves informed about the impending disaster opposed to Central States residents who relied heavily on the media.

Whether local disaster subcultural procedures and behaviors can be adapted to cope with earthquake threat, then, may not be just a question of how much overlap there is between the mitigation and preparedness needs associated with both types of disasters. Regional variation in interpreting and responding to any threatening situation will have to be taken into consideration.

Ethnic Subcultures. These indications of regional differences point to another feature of social life that affects the ways people understand and respond to threat--their ethnic or racial group identification.

In southern California, substantial differences in perception and response were found among Anglos, Blacks, and Mexican-Americans in several areas--the amount of fear and concern they had about a future damaging quake; fatalistic attitudes about the importance of preparedness; differences in knowledge about and attitudes toward science and prediction; trust in government officials; use of the media for information on earthquake threat; extent of informal communication on earthquake-related topics, degree of personal preparedness for a coming quake; awareness of specific endangering conditions; and support for governmental expenditures for mitigation efforts

(Turner et al., 1980, especially Part Six). Even after taking socioeconomic factors into consideration, ethnic subcultural effects remained strong.

It seems reasonable to assume that ethnicity will also have substantial effects on preceptions of earthquake threat in the eastern United States. What those effects will be, however, is largely unknown since there is likely to be a great deal of difference in orientations to earthquake threat between, for example, Black communities in highly urbanized southern California and those in rural South Carolina. Without more information about the frameworks that ethnic groups use to interpret earthquake threat, it will be difficult to develop public education programs that were meaningful to these special populations.

PREPAREDNESS AND HAZARD MITIGATION

Earlier in this paper, I talked about a general awareness of earthquake threat being necessary (but not sufficient) for the development of a general concern about preparedness and hazard mitigation. Let us now turn our attention to the problem of actually getting people to take action.

The problem of motivating people to take preparedness actions is, first of all, an informational problem at both the personal and organizational levels.

Personal or Household Preparedness

Without knowing what the level of awareness is in the East and how that threat has been evaluated, it is difficult to guess at the level of knowledge people have about earthquake preparedness measures; but we can predict that their actual level of preparedness is low.

Even in southern California where there are relatively frequent small magnitude quakes and where there is continuing media attention to earthquake-related topics, people are inadequately prepared to handle the effects of a damaging earthquake. Other than having a working flashlight, a battery-operated radio, and first aid supplies, little has been done (Turner et al.,

1979). Often when preparedness measures have been taken, they were more likely initiated to improve the family's general ability to handle any type of emergency.

Several recommendations for improving public preparedness were made following the southern California study (Turner et al., 1980, Part Ten). I will briefly review those preparedness recommendations that might provide some preliminary ideas for educational efforts in the eastern United States intended to develop a knowledgeable populace. Those four recommendations are:

1. Carefully prepared and selected advice concerning earthquake preparedness for individuals and households should be given widespread and repeated public distribution through the media as well as through other channels.

2. This preparedness advice should come from some authoritative government agency and should be endorsed by well-known local government officials and public personages.

3. Each recommended preparedness measure should be presented in conjunction with a brief but credible explanation justifying that recommendation and suggesting how it can be implemented.

4. Some responsible State agency should develop a program to promote earthquake safety in the household, making use of local government, private agencies, and citizen groups. An especially useful program of this type would be one that conducted household safety inspections.

Although these recommendations may sound obvious or simplistic they are not easy to implement without a commitment from local and State governments to engage in a joint continuing planning effort. To what extent this effort could piggyback on other disaster information systems or could draw on the resources of already existent planning bodies is unknown. But the question gives us a place to begin looking for some structures within which these recommendations could be considered.

Organizational Preparedness

Since people often spend large parts of their days away from home, earthquake preparedness must not be oriented only around the home. Consideration must also be given to the preparedness of schools, hospitals, offices, stores and entertainment facilities.

Preparedness of public sector organizations involves two components which require different approaches. The first component concerns the safety of the physical structures themselves and is often handled by using building codes with seismic design provisions. The second component concerns the policies and procedures that safeguard the people who use those structures. Because building codes will be discussed elsewhere, I will concentrate on organizational concerns with personal safety.

Large, private-sector corporations often has active safety programs for their employees. Seismic safety components can easily and effectively be built into these on-going programs as long as safety officers have access to informational resources (a point to which we will return). Although the focus of these programs usually revolves around the workplace, some research findings indicate that this exposure may be influential in improving household preparedness as well (Nigg, 1979).

Public service organizations--schools, hospitals, utility companies, fire and police departments--are excellent potential users of seismic safety information because of their need to safeguard those entrusted to them and those who are unable to respond fully to an emergency on their own.

Small businesses, usually not having safety officers or safety committees, don't appear to be as actively concerned about emergency preparedness in general. Some thought should be given to how to get preparedness information to those organizations and companies, especially those that use toxic or flammable chemicals or that use manufacturing processes that could become dangerous in an earthquake.

Social and civic groups may disseminate earthquake information to their members, but their interest is often sparked by dramatic events or media attention to prediction and seismic safety issues. Their concern seldom continues over time. Their attention usually takes the form of a one-time only meeting at which an outside "expert" is asked to talk to the group. Unlike the preparedness focus in large companies (for their employees) and in public service agencies (for those being served), social and civic groups often provide information on making one's home safer.

Information Resources

For both types of preparedness discussed above, people should be able to draw on existing information resources to assist them in developing and implementating their plans.

Particularly useful for large organizations and public service agencies would be plans developed in southern California that could be modified to meet the exigencies of local areas. Whether such plans are currently available in a form that would make them useful to planners and safety officers, however, is unknown. Perhaps by scheduling sessions on emergency response planning and hazard mitigation at annual meetings of professional organizations or at regional planning meetings, this information could be distributed, finding its way into the eastern communities that are just now starting their own earthquake planning endeavors. There should be no need for these communites to "start from scratch" when other areas of the country, southern California in particular, has been giving seismic safety planning a great deal of attention during the past ten years.

Concerning the availability of information for the general public, a major problem was identified in the southern California study--"resource scarcity."

Once public awareness begins to increase and people start to ask what they can do to reduce the hazardousness of their immediate environment, they engage in information-seeking activities. They turn to the media, to public service agencies (e.g., fire and police departments), to emergency

preparedness agencies and organizations (e.g., Civil Defense offices, State offices of emergency services, the Red Cross), to local government officials, and to scientific organizations and universities that are engaged in earthquake research for clarification of the threat and for suggestions about what to do to prepare themselves.

The effect of this information-seeking activity (especially if it occurs in response to the announcement of an earthquake warning or prediction) is to overwhelm these agencies with requests for written materials or speakers. For all of these organizations, the dissemination of earthquake preparedness information is a very small part of their overall functioning. In many cases, agencies refer information seekers to other agencies that they assume have better information or more resources available; an assumption that is often unfounded. When agencies do have some information available, it is frequently of a very general nature that could be used in any type of emergency or its suggestions are superficial.

Even when organizations have speakers available to talk on earthquake threat and preparedness, their time and resources are frequently voluntary. The use of volunteers as an information resource has two effects--(1) it detracts from speakers' ongoing normal duties (which in southern California were related to either earthquake prediction or community-wide preparedness for disastrous event), and (2) it frequently produced a "lag" time of several weeks to several months between the time the request was made and when the volunteer could fit the request into his/her schedule. Any momentum that had motivated the group to seek out preparedness information may have been lost by the time a meeting could actually be held.

Resource scarcity is a major informational problem related to the public's ability to prepare itself. How this problem can best be solved may involve creative collaboration between the private and public sectors, both of whom will benefit from the dissemination to timely and specific information.

RESPONSE TO AN EARTHQUAKE EVENT

While it is important to inform people about hazard mitigation and preparedness measures, it is equally important for people to know what to do during and immediately following a damaging earthquake. Southern Californians were quite knowledgeable of adaptive behaviors that could be taken during a quake (e.g., standing in a doorway or staying away from windows) and of prescribed behaviors to avoid after a quake (e.g., not tying up the telephone for personal calls).

In an area like the Central States where a disaster subculture exists, it will be important to determine whether any adaptive behavior taken during or immediately following a tornado may be dangerous or beneficial if employed following an earthquake event. In the areas where no other disasters are common, the problem will be to introduce the appropriate behavioral responses in a meaningful way to populations that have no disaster frameworks within which the information can be categorized.

SUMMARY

These are some of the major problems and issues that must be addressed when societal response to the earthquake threat in the Eastern United States is considered. Clearly, a major question that still remains unanswered is the applicability of lessons learned from southern California to the Eastern United States. Without information on the level of community awareness of earthquake threat, the evaluation of earthquake risk, and knowledge about preparedness and response measures, our planning efforts during this workshop must be seen as preliminary. The focus of these efforts, however, should be directed toward the assessment of current disaster information, preparedness, and response systems and the adaptation of those systems for public education in the area of earthquake preparedness and hazard mitigation.

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THE POLITICS OF COMMUNITY SEISMIC SAFETY

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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]

In short, it is "squeaking wheels" which "get the grease" in the American

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

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) The absence of "inside" advocates:

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 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

2 John F. Kennedy, Profiles in Courage.

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 be. 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.

LESSONS FROM SEISMIC SAFETY PLANNING IN CALIFORNIA

by

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INTRODUCTION

California has experiences in seismic safety planning that are potentially relevant to the eastern United States. This paper summarizes some of those lessons in three areas: Hazard Awareness and Public Information, Public Sector Participation, and Intergovernmental Relations and Cooperation, and suggests general and conceptual approaches for improving the state-of-earthquake preparedness in the Eastern United States. The paper draws upon recent work by practitioners and researchers in California as well as the activities of the Southern California Earthquake Preparedness Project (SCEPP) during the past year. SCEPP's goal is to stimulate preparedness for a predicted or unpredicted catastrophic earthquake in Southern California through development of a model planning process and a limited number or prototype response plans for selected jurisdictions within the region. These response plans are to be transferable within the State and to other high risk metropolitan regions throughout the Nation.

Hazard Awareness and Public Education

To raise hazard awareness and improve public education in the central United States, it is helpful to examine what is currently being done and recommended in California. Popular awareness and education require special attention in the eastern United States because people are unaccustomed to thinking that their land is subject to earthquakes. It is important to distinguish between hazard awareness and public education, for they are not necessarily the same. Since 1932, the Southern California region has experienced an average of 3.6 earthquakes per year having a magnitude of 5 or greater on the Richter scale. The public sector in Southern California is very aware that they live with an earthquake hazard; they know California is

earthquake country. To some extent, that very hazard awareness may be a barrier to public education. In effect, the public is innured to efforts to persuade them that knowledge about what to do before, during and after an earthquake will make a difference, so we must not automatically assume that hazard awareness leads to education. Nevertheless, they are connected. It is not too simplistic, I believe, to argue that a sense of personal risk is a prerequisite to any successful public education campaign.

The infrequent and uncertain nature of the earthquake hazard makes it very difficult to initiate and maintain the informational-educational aspects of a preparedness program. Public information programs are very important, however, because other hazard mitigation measures, community involvement, governmental cooperation and budget allocations may depend on hazard awareness. California State expenditures on earthquake information have risen dramatically in the last few years, but they still comprise only 4.1% of the funds allocated to seismic safety programs. The importance of hazard awareness ought to receive greater official support everywhere, even though current efforts by voluntary organizations, such as Red Cross, are effective.

One important strategy should be an education campaign aimed at decision-makers within the public and private sectors and technical personnel involved in public safety. Public agencies must be kept aware of recent developments in the rapidly evolving fields of earthquake prediction, structual engineering, and seismic safety planning. Emphasis ought to be placed on utilizing generalists in the field of earthquake hazard mitigation. Scientists and technicians have a crucial role to play, but they should not dominate policy. The issue has too many social, political, and economic facets to be dealt with by any one specialty. A campaign could consist of briefings for associations of emergency managers, public administrations, planners, architects, educators, business and civil leaders, and other interested parties. Presentations should always stress the advantages of action rather than the disadvantages of inaction, and include clear guidelines and attainable goals. Other tactics might involve extension courses through local, universities, worksite seminars, and an emphasis on earthquake safety in professional publications and organizations.

Community awareness may be stimulated by a dedicated individual, a local catalyst, but research shows that a larger spectrum of the population can be reached more consistently by working through existing institutions and organizations. Currently meetings are frequently organized by employers or school officials who have an established moral and legal responsibility for the well being of their personnel. In the future, homeowners associations, neighborhood watch groups, and civic service groups such as the Retired Seniors Volunteer Programs or VISTA should be cultivated. Dr. Ralph Turner, a UCLA sociologist who has completed a massive 10-volume study assessing public attitudes in Southern California toward the earthquake threat, found that by using existing organizational structures and memberships, earthquake and seismic safety information can be disseminated to a wider variety of people. This is especially important in reaching people with special needs such as the elderly, the handicapped, the non-English speaking, or the poor. Often they respond more positively to suggestions made from within their "community" than to proposals from Government outsiders. Government should allocate a portion of its educational funds to reach these groups through established local networks as well as other programs, for often they are more at risk than the general population.

Classroom instruction for children in the public school system is a good means of reaching a relatively large portion of the population. In addition to geologic facts about eathquakes, curricula should stress the application of seismic safety measures in the home such as assembling emergency supplies and developing family response plans. Parents may not formally consult with school children about earthquakes, but an inspired child can set a good example, and earthquake hazard awareness may persist throughtout adulthood. Earthquake awareness should be integrated into other courses where applicable. Science, health, home economics, shop, and social studies could all include a unit on seismic safety.

The need for coordinated curriculum development and information dissemination is recognized. In California, five governmental task forces have suggested that a network of Earthquake Preparedness Information Centers be created. The legislature has not funded these projects to date. The centers would seek to promote communication among the media, the public, the

scientific community, and officials. Resources of the centers would include libraries, emergency hotlines, media centers, referral centers, and information on speakers bureaus.

In 1978, a subcommittee on earthquake education was created by the California Seismic Safety Commission. Currently they are working on the passage of a bill that would fund research by Berkeley's Lawrence Hall of Science in the development of instructional materials. The Southern California Earthquake Preparedness Project (SCEPP) has an education/information component. It is currently inventorying the educational resources dealing with earthquake that already exist in the region, and development prototypical curricula for grades K-12. It is hoped that these materials and plans will be transferable to other seismically active areas such as Northern California and the central United States.

Public Sector Participation

Public sector participation can be increased by heightened public interest in the subject of earthquakes and greater Government support for legislative and budgetary actions. The central United States has less history of public sector involvement in earthquake preparedness than the West primarily because of the lower perception of risk felt by both officials and the public. Education campaigns focused on both sectors are important. Because earthquakes are high-risk/low probability events, public sector attention may be diverted to more pressing and visible projects unless the electorate actively endorses the preparation of earthquake hazard mitigation plans. If there is widespread public support for seismic safety planning, officials will attend to it. Politicians thrive on recognition; public information campaigns should stress positive actions of Government officials to convince them to continue those actions.

Political obstacles must be considered when viewing seismic safety policy. For example, a problem can occur where the original supporters of a safety program lose interest, but its opposition remains very attentive In such a climate, rigorous implementation may be more politically injurious than passive non-application of the safety measures. This trend is seen in the

inconsistent enforcement of land use regulations in many California communities. Another political problem in implementing seismic safety programs is that individual officials are reluctant to admit that their jurisdiction is unprepared or especially vulnerable. They may suppress the collection and dissemination of risk information for fear of affecting property values or other socio-economic variables. Fear of incurring legal liability for not acting in the face of a know hazard or response to a prediction may also hinder involvement of Government officials. SCEPP will be making recommendations for statutory changes needed to clarify legal immunity and local government authority.

The importance of mitigation strategies should be stressed to officials and the public. One public information tactic would to be to ally the proposals with other desirable social goals such as urban redevelopment, growth control, neighborhood organization, and even national security as well as linking earthquake preparedness with on-going natural hazard measures for tornados, floods or hurricanes. Encouragement of cooperative planning may dispel some of the politicians fears. Citizens, officials, planners, and other interested parties should work together to develop viable plans tailored to their needs within broad State and Federal guidelines. One of SCEPP's guiding principles is that the planning process must begin at the local level, and address the needs to both public and private entities. We believe plans are more effective when they are developed by those who will actually be called upon to use them. No one should feel that regulations and restrictions have been arbitrarily imposed by some outside body.

The trend in the national earthquake hazard mitigation programs has been toward decentralization of power and responsibility from the Federal to the local level. The creation of the Federal Emergency Management Agency (FEMA) in 1979 consolidated Federal responsibilities. One of FEMA's highest priorities is to assist State and local governments in the preparation of their plans. FEMA recognizes the need for cooperative planning on the local level; its allocation of $800,000 to SCEPP is an indication of this commitment. Other responsibilities of FEMA are to set national guidelines, to coordinate policy, and to help offset the cost of seismic safety compliance for local jurisdictions. Currently, the Federal Government plays more of an

advisory and supervisory role in disaster preparedness and response than it did in the past. Continuing expressions of concern and encouragement from high levels of Government can do much to raise hazard awareness and motivate local officials and communities.

Creation of the California Seismic Safety Commission has been the most significant factor in fostering continued State legislative support for seismic safety initiatives. The commission's primary task is to develop, implement, and evaluate State seismic safety policy. Its membership includes representatives from a broad range of scientific and public policy fields. The State Office of Emergency Services maintains and updates the California Emergency Plan and associated readiness plans for critical services and facilities. Many other agencies such as the Department of Water Resources, the Department of Transportation, and the Department of Health Services, are responsible for seismic safety and disaster mitigation measures as well. Commitment varies widely and so, therefore, does the quality and effectiveness of agency planning.

Earthquakes strike at the local or regional level. Local officials and agencies carry primarily responsibility for earthquake response because isolation and disorganization resulting from a catastrophic earthquake may preclude outside assistance for many hours. This is another reason that SCEPP is emphazing the needs for those who will be using plans on the local level. Local government is responsible for much of the planning required to meet the public's immediate post-disaster needs. In addition, they have an ongoing duty to consider potential seismic hazards when authorizing construction on zoning land for development within their jurisdictions.

Following the 1971 San Fernando, California, earthquake, the State amended its Planning Law to mandate that all local jurisdictions include Seismic Safety Elements (SSE) in their general plans. The Alquist-Priolo Special Studies Zones Act and the Hospital Seismic Safety Act were also passed during this active period. A pattern of earthquake legislation following major seismic events in the State can be traced. After the 1933 Long Beach earthquake the State Legislature passed the Field Act decreeing that public school buildings be constructed to withstand earthquake stress. The lull in

major legislation until 1971-72 is understandable. Seismic events serve as catalysts to generate needed support and legislation. It is difficult to maintain interest in the absence of actual events.

Legislation must have official support to be effective. The Seismic Safety Elements are a good example. Some jurisdictions, such as the City of Los Angeles, have made significant progress; others have responded with less enthusiasm. Seismic Safety Elements have been drafted for most California jurisdictions in order to comply with law. Implementation and integration of the elements into other phases of planning, however, are left to the discretion of each jurisdiction. Research indicates that as a consequence of this independence, consideration of such vital factors as changes in organizational structure and altered agency responsibilities following a catastrophic earthquake have often not been addressed.

To reinterate, earthquake preparedness plans must be designed by those who will be using them. A paper "compliance" plan drawn up by an outsider and dusted off irregularly for a drill is not an effective tool. Recognizing this problem, SCEPP developed the planning partner arrangement. The participants are guided through the inventory and evaluation of their own needs and capabilities: SCEPP provides technical assistance and a mechanism to integrate locally developed plans into a regional response capability. This approach promises to produce a plan that is more tailored to local needs and is also less politically threatening.

Public sector participation is often hampered by financial pressures. This is an especially important consideration in light of recent Governmental budget cuts. Since the Federal Government still has relatively more money to invest in research and development, it should be primarily responsible for financing improvement in prediction and engineering technology. The Federal Government should also require that Federal grants or loan guarantees to facilitate planning the building improvement programs meet minimum seismic safety standards nationwide. Amending tax and insurance laws could also encourage property improvements in the interest of seismic safety.

In California the SSC has adopted a number of policies for financing seismic safety. Included are suggested amendments to existing lending, tax and insurance laws to help offset the costs of complying with seismic safety regulations, and requirements for public agencies to include provisions for seismic safety compliance in their budgets. The Commission endorses legislative appropriations to help retrofit unsafe structures, housing, fire and police stations, emergency operating centers, communication facilities, and prisons. Implementation of these measures remains problematic. To lessen the dependency of local jurisdictions on Federal money and priorities, the SSC proposes the initiation of matching fund programs on a 75% - 25% basis between State and local governments.

Local governments still bear a heavy cost in retrofitting older buildings, overseeing current construction, and planning and organizing emergency operations. As in all levels of Government, seismic safety must be made a priority item to receive the funding needed. Compliance with State and Federal regulations and codes should not be preceived by local agencies and governments as impediments to the performance of their primary functions. Once again education and hazard awareness programs are the best recourse against political apathy and inertia. Officials and their constituents must see seismic safety as a valuable, attainable goal. Reduction of paperwork involved in meeting seismic safety standards would help too. To help face the opposition of contractors, builders, and other affected parties of seismic safety regulations and codes, local officials should press for State and Federal revisons in lending, insurance, and tax legislation.

Intergovernmental Relations and Cooperation

All levels of Government having seismic safety responsibilities face organizational as well as political and fiscal constraints. Problems are compounded in the Central United States because the seismic risk is shared among many States and multiple Federal jurisdictions. Every department, agency and bureau has its own motives, limitations, and requirements to consider when composing its preparedness, response, and recovery plans. Southern California is very familiar with the problems of coordinating the rival interests of multiple jurisdictions; within SCEPP's five-county planning

region, there are approximately 500 distinct political jurisdictions. Coordination is difficult even under the best of circumstances. One successful example of coordination is the Firescope program. (Firefighters of Southern California Organization for Potential Emergencies). Firescope includes a regional resouces management network and a command center for coordinating response by the various agencies charged with combating the yearly brushfires that devastate areas of Southern California. It has taken over three years to develop coordination among firefighting agencies. SCEPP hopes to expand on their model in organizing the many agencies involved in earthquake response.

Intergovernmental organization is a crucial and much-discussed concern. Most plans call for both horizontal and vertical integration with other plans. Agencies and planners agree that cooperation is necessary, but it is rarely fully achieved. This is partly because responsiblity for programs is fragmented among a number of agencies, departments, bureaus, and commissions. Funding also comes from diverse Federal, State and local sources each with its own stipulated purposes and requirements.

In summary, interagency coordination is a desired goal, not a concrete reality. It is generally conceded that while current response and preparedness plans measures in California may be adequate for moderate earthquakes, preparations are insufficient to cope with the damage and casualties from a catastrophic earthquake. The disruptions in communications, social fabric, and governmental structure that will follow may be too much for public and private officials to manage. Decisionmakers must come to appreciate the magnitude of difference in impacts between a moderate and a severe earthquake before they can create adequate plans. The key issue is to help local officals make decisions about which aspects of the earthquake threat can be managed through public and private planning.

At the State level seismic policy is organized by the California Seismic Safety Commissison (CSSC). The Commission is responsible for setting uniform standards, goals and priorities. They coordinate earthquake safety activities of government at all levels, and regularly review earthquake-related programs and legislation. An essential first step for the Eastern United States should

be the establishment of an Interstate Seismic Safety Commission. Its role would be similar to that of the CSSC, but focused on the problems on interstate coordination.

The California State Office of Emergency Services (OES) is responsible for insuring emergency lifelines, organizing mutual aid and disaster assistance areas (DSA), and conducting disaster drills. They are also a liaison between Federal and local OES offices. The OES offices perceive the need for intensified earthquake response drills involving all levels of organization from the Federal Government to community groups and private industries. Various scenarios should be tested. Responsibilities of people and organizations after a catastrophic event should be clarified and codified. This is especially important for organizations whose everyday functions are very different from the roles they are expected to play after an event. The CSSC has also suggested that procedures for hiring disaster assistance personnel be simplified.

Locally, all jurisdictions have been required for the past 30 years to join the California Mutual Aid program in order to be eligible for outside assistance in the event of a disaster. While voluntary, participation is almost universal. The program works well for localized disasters such as fires, but considering the widespread impact of a devastating earthquake, the program needs to be reviewed from the fiscal viewpoint of costs and reimbursement so that operating procedures and sources of funds after an event are clearly stated. Expansion of the concept is needed as a basis for mobilizing other critical resources such as building inspectors, coroners, public works personnel, and others.

In California there exists a wide variety of earthquake information sources. They need to be pulled together, organized, and distributed among local jurisdictions. For example, the Public Utilities Commission has suggested that seismic research on utility systems be circulated throughout the industry because small utility companies do not have the funds to engage in research themselves. Technology sharing would be of use to them. More of these cooperative efforts should be encouraged.

SCEPP and the Governor's Task Force on Earthquake Preparedness both stress the need to involve private industry in earthquake hazard mitigation. Private industry has a special role. Despite the overwhelming belief that Government is responsible for earthquake preparedness, response and recovery, communities and industries need to concern themselves because most of the property affected by an earthquake is privately owned. In California the interest and response of private industry has in the past, been sporadic. Recently, however, major corporations have initiated promising efforts. Top level executives at IBM, Levi-Strauss, Atlantic Richfield, Fluor Corporation, and Security Pacific Bank have promoted employee education programs, workplace hazard evaluations, and the development of elaborate disaster response plans that even include corporate communication systems for employees to contact and reassure their familites after an event. San Francisco has convened a business and industry earthquake forum that meets regularly to coordinate and promote preparedness activities in the workplace. A similar program is being organized in the Los Angeles county area. Private industry will provide leadership and define priorities; SCEPP will provide technical assistance and staff support.

SUMMARY

In conclusion, coordination of seismic safety efforts are still incomplete. Support seems to be growing for localized cooperative approaches such as SCEPP. The importance of raising public awareness of the seismic hazards of an area is also receiving stronger official and public support. The political problems will always exist, but legislative and budgetary actions can lessen their impact. Preparations for damaging earthquakes are essential in all seismically active areas of the United States. The rewards are not immediately apparent but the future pay-off is an incalculable reduction in pain and damage.

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SUGGESTED APPROACHES FOR IMPROVING THE STATE OF EARTHQUAKE PREPAREDNESS THROUGH HAZARD AWARENESS AND PUBLIC EDUCATION

Issue: Awareness of earthquake hazards is low among both the public and officials in the central United States. This hampers efforts to prepare for the consequences of a damaging earthquake and to respond to it adequately.

Suggested Approaches

A. Raising hazard awareness requires development of as precise risk and hazard scenarios as available knowledge allows. Geoscientists and engineers should assume the leadership in informing decisionmakers within the public and private sectors of what is known about the earthquake hazards in each region.

B. To raise hazard awareness among public officials, decisonmakers and technical personnel, an education campaign should be directed specifically toward them. This campaign could use professional seminars, extension courses and attention to seismic safety in professional puiblications and organizations.

C. Take advantage of established institutions and facilities when organizing community involvement. Groups such as homeowners associations, neighborhood watch groups, and civic services groups should be encouraged to make seismic safety awareness one of their goals.

D. Campaigns should be addressed to specific audiences within the region; special groups such as the elderly, the poor, the handicapped and the non-English speaking should receive particular attention. Contact with them can often best be established through networks of familiar local authorities.

Issue: The media has a fundamental role in relating earthquake information. Their effectiveness in dealing with the sporadic interest in seismic events could be improved by better planning.

Suggested Approaches

A. Earthquake news should be clear, concise, specific, well-documented, and presented by recognized experts.

B. To sustain interest in the absence of local earthquakes, complete media coverage should be made of earthquakes happening elsewhere; clear presentations should be made of the geologic/structural hazards of the local area, and specific instructions should be given on how to decrease personal risk.

C. Standarization of prediction terminology, formalization of official routes of communication, and advance preparation of earthquake programs will help the media to capitalize on the increased interest in eathquakes following a prediction, or a publicized event elsewhere.

Issue: Schools can be an effective means of educating large numbers of people about the risks of damaging earthquakes.

Suggested Approaches

A. Curriculum on earthquake safety should be added to other natural hazards educational efforts.

B. Curriculum should stress the application of seismic safety measures in the home and community.

C. A unit on earthquake awareness should be integrated into other courses such as health, social studies, and science courses.

D. Establish an Earthquake Education Committee responsible for curriculum development. Use them, or another designated organization, as a clearinghouse on earthquake information for the community.

SUGGESTED APPROACHES FOR IMPROVING THE STATE OF EARTHQUAKE PREPAREDNESS THROUGH PUBLIC SECTOR PARTICIPATION

Issue: Political considerations often block involvement by public agencies, departments and bureaus in seismic safety planning. Attention is easily diverted to more pressing, visible projects. Even when legislation exists, the commitment to implementation often varies. Commitment also varies with the level of public interest in the subject, as evidenced by the pattern of legislation following major seismic events in California.

Suggested Approaches

A. Raise hazard awareness in both the public and private sectors. Support and cooperation from high-level Government leaders as well as popular support can foster more attention to seismic matters by officials.

B. Ally earthquake preparedness proposals with other desirable social goals such as urban development, growth control, neighborhood organization, and national security.

C. Involve affected parties as active participants in the planning process. The process should begin at the local level and should address the needs of both public and private sectors.

D. Provide technical assistance to local and State governments as needed; for example: mutual aid program for building inspection, technical advisory for local governments and media, etc.

Issue: Public sector participation is often restrained by financial pressures. Implementation of higher safety standards often involves costs for which there is no immediate benefit. Public agencies may see compliance with State and Federal regulations as a "cost" in its ability to perform its primary functions.

Suggested Approaches

A. The Federal Government should invest in hazard mitigation research and development, put seismic safety stipulations on Federal grants or loan guarantees for planning and building improvement programs, and amend tax laws to encourage property improvements in the interest of seismic safety.

B. The State should decree that public agencies include provisions for strengthening existing structures to meet seismic safety requirements and adequate funds and design criteria to ensure reasonable earthquake resistance of new structures in their capital expenditure programs. Legislative appropriations to help strengthen unsafe critical facilities should be authorized. Greater reliance on State matching funds will reduce local governments dependence on Federal funds and priorities. Revised lending, insurance, and tax regulations should help lessen opposition to stricter codes, zoning, and regulations.

SUGGESTED APPROACHES FOR IMPROVING THE STATE OF EARTHQUAKE PREPAREDNESS THOUGH INTERGOVERNMENTAL RELATIONS AND COOPERATION

Issue: The problems of intergovernmental coordination are multiplied in the central United States because the seismic risk is shared among many States and multiple Federal jurisdictions. Responsibility is fragmented and funding originates from many sources. Each participant develops plans using his own motives, limitations and requirements. Interjurisdictional rivalries and personality conflicts can compound the situtation even further. Coordinated plans are adequate for small earthquakes, but insufficient to cope with the damage from a moderate to catastrophic earthquake.

Suggested Approaches

A. An Interstate Seismic Safety Commission should be established in the Central United States with responsiblity and coordinating powers similar to those of the California Seismic Safety Commission.

B. More Federal response plans such as the one made for San Francisco should be organized. Coordination of these plans with State and local responses is essential. Repeated drills are necessary to familiarize people with emergency tasks and to work out resource conflicts.

C. State OES offices should run more frequent disaster drills. Scenarios of responses made by skeleton staffs should be developed; existing functions should be utilized as much as possible, but altered responsiblities should be clarified and codified.

D. State and local procedures for hiring disaster assistance personnel should be simplified in an effort to accelerate response to an event.

E. The State mutual aid programs should be evaluated from a fiscal viewpoint so that the sources of funds and procedures after an event are clearly stated. The ability to mobilize other critical resources such as building inspectors, coroners, and public works personnel should be added to the programs' disaster plans.

F. Cooperative efforts among State agencies, utility systems, and critical services should be encouraged.

G. Private industry should recognize its role in seismic hazard mitigation. Employer coordination of community response efforts as well as worksite safety should be encouraged.

IMPROVING EARTHQUAKE-RESISTANT DESIGN IN REGIONS WITH LOW SEISMIC AWARENESS

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STATEMENT OF THE ISSUE

For the vast majority of construction, design practice is closely related to building code requirements. Thus, the seismic performance for most structures will be determined by the quality of building codes and their enforcement. Responsibility for building codes and other regulations for construction are retained by the States or delegated to municipalities. Even for federal projects where federal requirements can apply, local codes are ususally used. Critical facilites may have special provisions associated with them. For example, the construction of nuclear facilities is federally regulated and federal agencies are involved in the construction of large dams. In California some industries have adopted seismic design criteria which are more severe than those imposed by State regulations.

The time required for new seismic requirements in the building code to bring about improved seismic response of a community's structures is measured in tens of years since it is related to the life of existing structures. Retrofitting structures to improve their seismic performance is always expensive and may be limited in its effectiveness. Earthquake prediction, which has not been seriously considered for the Eastern U.S., will do little to mitigate the effect of inadequate seismic design on structural response. For these reasons earthquake code provisions which are cost effective should be adopted as soon as possible.

The adoption of seismic codes will have associated with them both economic and noneconomic costs. Owners of buildings will not only experience higher construction costs but if a neighboring community is not subjected to the same requirements the owner will suffer a competitive disadvantage. These

costs will be immediately apparent and may create political pressures which are not balanced by the perceived risk to public safety. The cost of earthquake protection is incurred at the time of construction while the benefits only accure after the next earthquake which might be some time in the future, possible the distant future. Earthquake resistance must compete for available resources with other needs which will often yield benefits sooner. In addition, the introduction of seismic code requirements imposes on the design professional the need to change existing procedures to more complicated methods and can also require the use of more professional judgements which increases the exposure to liability.

Current building codes are effective in reducing casualties and damage. Strategies to get seismic codes adopted must take into account the political realities of adopting these measures in the Eastern United States so that they aid rather than hinder the process. Thus, gradual adoption of codes by certain classes of structures within a State may be beneficial. For example, initially requiring State buildings to use seismic codes would provide an opportunity for the local professional community to become familiar with the new requirements and demonstrate that the added cost of implementation is not as large as is usually perceived by those unfamiliar with seismic design. It may be counter productive to try to get too much. For example, the total relaxation of the requirement to upgrade existing structures may quell many objections to seimsic codes. Another example would be to avoid the mention of land use planning for earthquake hazards. While the implementation of such plans would reduce seismic risk, attempting to pass it may mobilize real estate interests, one of the most effective lobbies at the State and local level, against all earthquake mitigation measures.

Given the many factors working against the adoption of earthquake building codes, what can be done to improve the earthquake-resistant design of structures and facilities? Listed on the next page are measures which the author feels are appropriate to improve earthquake-resistant design in regions like the Eastern United States. Some measures at the beginning are meant as initial steps and would be included as part of suggestions contained later in the list.

Suggested Measures to Improve Earthquake-Resistant Design

A. States should formally recognize the existence of earthquake risk and adopt a policy stipulating that cost-effective methods should be used to mitigate the earthquake hazard.

B. States should require that its structures and facilities meet seismic requirements.

C. An attempt should be made to have States adopt model building codes with seismic requirements.

D. Seismic requirements for critical facilities should be reviewed and strengthened as needed. Lifelines, such as power, communication, and water systems can, should they be interrupted for an extended period of time, cause disruption and hinder the recovery operation. Many system practices, once changed, can significantly improve seismic performance at little or no cost on new construction.

E. General design practice should be modified as needed to attain earthquake performance. Many practices, particularly those associated with securing equipment, can improve earthquake performance at nominal cost.

F. Licensing exams for the appropriate professions should include material related to good earthquake practices.

H. In general, emphasis should be placed on measures that can be institutionalized so that they do not require maintenence beyond that normally associated with the activity.

Reducing Earthquake Damage Through Land-Use Planning

by
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STATEMENT OF THE ISSUE

Planning decisions involving the use of land have significant long-term implications for earthquake safety in the Eastern United States. Such decisions can only reduce losses where earthquake hazards, such as ground shaking, ground failure, surface fault rupture, and flooding are known, mapped, and used in development decisions by the private sector and in land-use plans and decisions by the public sector. Because planning is a power granted by the State to local governments, each State can influence the degree to which the planning authority allows, encourages, or requires local application of earthquake safety practices.

INTRODUCTION

Earthquake-hazard reduction can be achieved through two principal measures--avoidance of the hazards and the design and engineering of building sites and structures. Both measures generally are implemented through the planning process which entails: (1) the identification of problems and the definition of goals and objectives to resolve them; (2) the collection and interpretation of data; (3) plan formulation; (4) evaluation of impacts; (5) review and adoption of plans; and (6) plan implementation (Blair and Spangle, 1979). Although the planning process is carried out at all levels of government and the private sector, responsibility and authority for land-use planning resides largely at the local governmental level, usually with cities and counties. As practiced in most parts of the United States, land-use planning is part of the political process. Elected public officials make the final decisions on adoption and implementation of proposed plans, which, perhaps more than most other governmental decisions, usually are developed

with citizen involvement. As a consequence, earthquake-hazard reduction through land-use planning requires broad community support.

A variety of factors constrain the planning process in achieving earthquake-hazard reduction, particularly in the Eastern United States. These factors include:

1. Generally poor knowledge of the type, location, recurrence, and degree of hazards

2. Extensive existing development

3. Infrequency of seismic events to develop and maintain an awareness of the problem

4. High costs of hazard mapping, and implementation of certain hazard-reduction measures

5. Social/political resistance to land-use controls in some areas.

Overcoming these constraints to effective earthquake-hazard reduction in the Eastern United States will require concerted and dedicated effort by all concerned professionals--scientists, engineers, planners, sociologists, disaster preparedness and response specialists, communicators, and decisionmakers. Critical to the adoption of land-use measures in the face of the constraints noted above is the integration of seismic safety measures with other natural hazard-reduction programs, such as those for floods, hurricanes, tornadoes, and landslides, and with other community concerns such as open space and urban redevelopment.

APPROACHES TO LAND-USE PLANNING IN OTHER PARTS OF THE UNITED STATES

Although California is regarded as a leader in earthquake-hazard reduction, much of the current progress made there is the result of knowledge gained from the Alaskan earthquake of 1964. That earthquake produced a variety of postearthquake land-use measures, which through immediate adoption,

are likely to greatly reduce losses from future earthquakes (Mader and others, 1980). For example, recognition of the vulnerability of the town of Valdez led to its complete relocation. Other measures to preclude redevelopment in high-risk areas, particularly in Anchorage, have gradually been eroded, so that less than 15 years later, high-occupancy, high-rise structures have been built at the head of the L-Street slide and pressures are mounting for development of single-family residences in "Earthquake Park," the site of the disasterous Turnagain Heights landslides, has been authorized. Many of these measures were adopted as the result of strings attached to Federal disaster assistance and had little local support; the erosion of many of these measures can be attributed to local pressures and to inconsistent and uncoordinated Federal actions.

An unexpected fallout from the Alaskan earthquake experience was not only the spreading of a general awareness of earthquake hazards to California, Washington, and Oregon, but also the specific hazards expectable in those States. For example, the severe ground shaking and landslide damage to structures on thick, soft, saturated sediments elicited strong concern by a number of people in the San Francisco Bay area as to the safety of structures built on "bay mud" adjacent to San Francisco Bay. These concerns led to public opposition to several proposed new housing developments on reclaimed bay marshland. The public debate arising from this opposition served to create a local awareness of the problems and focused attention as important land-use issues to deal with them.

That awareness also, probably more than any other single factor, brought about the creation of the California Joint Legislative Committee on Seismic Safety, which has spawned many of the earthquake-hazard reduction measures adopted since 1970. Although some of these measures were conceived prior to the February 9, 1971, San Fernando earthquake, it is questionable as to whether they would have been enacted by the California legislature had that earthquake not occurred. Similarly, other advances in earthquake-hazard reduction have usually followed destructive earthquakes, such as the 1933 Long Beach earthquake, which stimulated the California legislature to adopt the Field Act, which sets earthquake-resistant standards for school building construction, and the Riley Act, which regulates unreinforced masonry structures.

Many States authorize local governments to plan and regulate development, but few States mandate local planning. In California, all cities and counties are required to prepare and adopt a general plan that includes certain specified elements; zoning and subdivision of land also must be consistent with the general plan. Nevertheless, local communities generally have the latitude of tailoring the plan to their needs and to determine which measures to adopt and how to implement them.

So, although local governments have land-use planning responsibilities, their concerns usually are limited to 5-, 10-, or even 20-year plans--far shorter than the recurrence intervals for most large earthquakes. Even after a large earthquake, unless a community has a strong prior commitment to land-use planning and has adopted a postearthquake reconstruction plan it seldom has the financial resource in the midst of devastation to resist the pressures to return to normal, which usually means reconstructing according to existing uses (Mader and others, 1980). As a consequence, most of the land-use examples I will discuss have been the result of State-mandated amendments to land-use authority delegated to communities.

Geologic Hazards Special Studies Zone

One notable exception to local responsibility for planning is the California Geologic Hazards Special Studies Zone Act, which is an example of State-level seismic zoning. Originally known as the Alquist-Priolo Special Study Zone Act, the legislation established a zone one-eighth of a mile beyond the outermost of all known traces of active or potentially active faults. Within this zone no structures for human occupancy are to be built without a geologic study to ensure that the structure is not located on an active fault trace. The Act was later amended to exclude developments of four dwelling units or less. The zone is to be delineated by the State Geologist, but requirements for geologic studies and the approval or denial of siting plans are implemented by local governments from guidelines established by the State Mining and Geology Board; the State Geologist also is responsible for reviewing the geologic reports. Kockelman (1980) discusses and illustrates the provisions and applications of the Act.

Impetus for the act was twofold: (1) it seemed the height of irresponsibility to locate structures for human occupancy on the trace of a fault that could move during the lifetime of the structure when such structures cannot be designed to resist the displacement of the fault; and (2) faults appeared to be one of the easiest of the earthquake hazards to identify and map.

Implementation of the Act has eliminated fairly effectively large new subdivisions in and across active fault zones. This result was achieved without necessarily reducing the number of dwelling units in a subdivision because most jurisdictions have waived density requirements and have permitted clustering of dwelling units to maximize land use. However, the Act has had limited effect in restricting the siting of single, or small numbers of, dwelling units on faults, because the owners presumably are unable to afford the cost of geologic studies. A few communities have undertaken to bear the cost of the geologic investigations to relieve landowners of the financial burden and to encourage safe siting. Interestingly, a study of existing land use in several Special Studies Zone areas by Risa Palm (written commun., 1980) indicates that despite California's real estate disclosure law, prices and sales of homes in such zones have not been affected by the Act. The reasons appear to be varied: (1) real estate personnel are not the most effective communicators of hazard information, especially when it is not in their financial interest; (2) disclosure often is not made until after buyers are committed to the sale; (3) the study was conducted in sought-after residential areas; and (4) other attributes of the property (access to shopping, schools, and transportation) were more important to house buyers than an unknown risk from a fault that may not have moved in 100 years, especially when the buyers might relocate in 5-10 years.

Seismic Safety Element

One of the first pieces of legislation passed after the 1971 San Fernando earthquake became known as the Seismic Safety Element. The legislation was simple, short, and ambiguous. It amended the State Planning Law to include the element as one of the mandated elements of the General Plan (Chapter 150, Section 65302 (f) of the California Government Code) and requires:

A seismic safety element consisting of an identification and appraisal of seismic hazards such as susceptibility to surface ruptures from faulting, to ground shaking, to ground failures, or to effects of seismically induced waves such as tsunamis and seiches.

The law was later amended, broadening it to include an appraisal of mudslides, landslides, and slope stability.

The initial impetus for the seismic safety element, drafted before the 1971 earthquake, was to at least make planners aware that there were seismic hazards, what they were, and to "consider them" in development of a general plan. With the San Fernando earthquake came a much greater awareness of earthquake-related hazards and pressures to formalize consideration of such hazards in the general plan. For example, the California Council on Intergovernmental Relations (CIR, now consolidated in the State Office of Planning and Research) prepared guidelines (1973) to assist local governments in preparing seismic safety elements. The guidelines provide that the element include:

A. A general policy statement that:

1. Recognizes seismic hazards and their possible effect on the community.

2. Identifies general goals for reducing seismic risk.

3. Specifies the level or nature of acceptable risk to life and property (see Safety Element Guidelines for the concept of "acceptable risk").

4. Specifies seismic safety objectives for land use.

5. Specifies objectives for reducing seismic hazard as related to existing and new structures.

B. Identification, delineation, and evaluation of natural seismic hazards.

C. Consideration of existing structural hazards. Generally, existing substandard structures of all kinds (including substandard dams and public utility facilities) pose the greatest hazard to a community.

D. Evaluation of disaster planning program:

1. For near-term earthquakes, the most immediately useful thing a community can do is to plan and prepare to respond to and recover from an earthquake as quickly and as effectively as possible, given the existing conditions of the area. The seismic safety element can provide guidance in disaster planning.

E. Determination of specific land-use standards related to level of hazard and risk.

These guidelines, prepared long after drafting of the Act and the San Fernando earthquake, went well beyond the thoughts in the minds of the drafters of the legislation (A1, 2, 4, 5, and B), and accomplished much more than was thought possible.

The response by communities to the legislation, guidelines, and outpouring of proposals from consulting firms seeking to prepare the elements, was predictably varied. Few communities had staff members with expertise to provide all the information needed to satisfy the CIR guidelines. A few prepared highly simplified goals and general policies (A1, 2, and 4), using existing planning staff. Many contracted with geotechnical firms for the earth science input which was incorporated into a plan prepared by in-house staff. Others contracted to consortiums of geotechnical, structural engineering, and planning firms. Fees for such seismic safety element plans ranged from $1,000 to $125,000.

Assessing Seismic Risk

Blair and Spangle (1979) expanded considerably on the CIR guidelines, noting that "Evaluating seismic hazards is only part of assessing seismic

risk. The other part is assessing the vulnerability of land uses and occupancies to earthquake damage." Such an assessment includes: an inventory of current land use (number of dwelling units, rate of occupancy, location of businesses, number of employees, and so forth); structures with high and involuntary occupancy (large apartment buildings, office buildings, major employment and shopping centers, auditoriums, stadiums, hospitals, schools, prisons, and convalescent homes); hazardous structures (older, nonearthquake code buildings, particularly masonry buildings and those with poorly attached parapets, cornices and other appendages); lifelines (water, sewage, gas, electric transmission, telephone, and railway lines and highways, plus related facilities, such as water and gas storage area, telephone exchanges, power stations, airports, harbors, and bridges); facilities for emergency response (command and communication centers, hospitals, medical offices and supply centers, fire and police stations, potential emergency shelters such as schools, churches, and theaters); and other critical facilities (nuclear powerplants, large dams, and storage facilities for toxic materials). Inventories of these land uses should be prepared in map form at scales comparable to those for maps of geologic hazards.

Risk can be expressed in a variety of ways and with varying degrees of precision. Blair and Spangle (1979) describe examples of several such methods, including estimating dollar losses on a statewide basis (Alfors and others, 1973), deaths and injuries on a regional basis (Algermissen, 1972), population at risk on a national basis (Ayre and others, 1975), relative risk on a community basis (Armstrong, 1973), and through scenarios for a given community (San Diego County, 1975). They point out that each of these methods also can be applied as a part of consideration of any proposed land use or occupancy change.

Policies and actions based on hazard and risk assessment inherently involve either an explicit or implicit definition of acceptable risk. Blair and Spangle (1979) define acceptable risk, from the point of view of the public agency, as "that level of risk at which no governmental response is considered necessary." They also consider it "as a measure of willingness to incur costs to reduce risks." Such a determination is commonly made explicitly when a public agency is considering land-use plans and regulations,

siting and design of major public facilities, renewal or rehabilitation of existing built-up areas, emergency-preparedness plans, and building code requirements.

PLANS, REGULATIONS, AND ADMINISTRATIVE PROCEDURES TO REDUCE SEISMIC RISK

In the discussion that follows, I have drawn heavily on previously published material, extracting sections from Seismic Safety and Land-Use Planning (Blair and Spangle, 1979) and Seismic Hazards and Land-Use Planning (Nichols and Buchanan-Banks, 1974). Kockelman and Brabb (1978) discuss seismic zonation methods developed in the San Francisco Bay area and present six examples of how local governments have used the methods in their local earthquake hazard reduction programs--assessments, plans, and implementation. Different plans, regulations, and administration procedures may be appropriate for different forms of seismic risk. The forms of seismic risk can be divided into ground shaking, ground failure, surface faulting, and flooding effects.

Ground Shaking

Seldom can a structure, without regard to its height, be declared inappropriate if it is carefully designed for the characteristics of a given site (Nichols and Buchanan-Banks, 1974). Nevertheless, as a broad planning tool, knowledge of expectable ground shaking effects, in combination with other community objectives, could lead to low-density land uses in high-shaking intensity areas. Elsewhere, such knowledge can lead to adoption of building code provisions appropriate to the shaking characteristics of that area. For example, Redwood City, Calif., adopted special building code requirements for structures to be built on thick saturated sediments that have high (long) fundamental ground periods and that could be subject to differential settlement during an earthquake (Kockelman, 1980).

Ordinances also might require that increasingly detailed geologic, soil engineering, and structural engineering analyses be performed for buildings with high-projected occupancies in areas of greatest expected shaking motion. Blair and Spangle (1979) cite the San Jose seismic safety element and the San Francisco Community Safety Plan as such examples. Because it is

difficult to predict strong ground motion characteristics and their effects quantitatively, except for a given structure on a given site, it is desirable to establish a legal and procedural framework that remains flexible enough to accommodate increasingly sophisticated methods of prediction.

Other measures that are critical to a lessening of ground-shaking losses, particularly human life, include the adoption and strict enforcement of a hazardous building abatement ordinance and an ordinance to require removal of dangerous parapets as has been so successfully implemented in Long Beach, Calif. Because of the high potential economic impact, hazardous building abatement regulations might best be imposed gradually on a priority basis, selecting first those structures that are the most dangerous and that have the highest occupancies, followed by buildings that constitute a lesser hazard and that have lower occupancies. Such abatement actions often can coincide with urban renewal objectives. Parapet ordinances, if enforced in urbanized areas, particularly where older high-rise structures may have poorly secured appendages, have the potential for sharply reducing casualties and property damage during earthquakes.

Ground Failure

General land-use policy to limit damage from ground failure might be guided partly by knowledge of broad areas where instability is believed to be so pervasive that, along with other considerations, its preservation as open space or other nonoccupancy, may be indicated. On the other hand, except during earthquakes, such failures generally occur fairly slowly, may be preceded by precursors, and usually do not result in loss of life, even though extensive or complete destruction of property is common. Therefore, the problem might be ignored. Alternatively, because ground failures can be life hazards during earthquakes, areas of known or likely low stability might be designated as geologic hazard zones. In such zones, background studies (geologic and soil engineering reports) should be required to demonstrate that both static and dynamic hazardous conditions either do not exist or can be overcome by site preparation work or engineering design prior to approval of subdivision and site development applications. Although individual structures may be sited safely in such areas, roads, gas, water, and sewerlines seldom can be built without crossing

unstable areas. Long-term costs in the form of maintenance of public service facilities may be great and generally must be borne by the entire community.

Blair and Spangle (1979) cite Portola Valley's response to landslide problems as being to avoid hazardous areas--"a response consistent with the town's existing and planned pattern of low-density residential development and policies for preserving the natural environment." They also note that "in jurisdictions fostering urbanization or in already intensively developed areas, special site and building design or engineering to mitigate the risk from slope failure may be emphasized," and refer to the special site investigations proposed in the San Francisco Community Safety Plan and the Santa Clara County Baylands Plan.

Other solutions to instability problems that have been pursued include adoption of a program to allow tax deductions for property owners whose land is particularly susceptible to ground failure. Such a program might be designed to alleviate tax burdens on property where existing structures are being damaged and on unimproved land, as long as it remains unimproved, or until the owner can demonstrate that he has eliminated the hazardous conditions. For those relatively few developed areas where severe instability problems are known to exist and disaster merely awaits the triggering action of an earthquake or an exceptionally wet winter, consideration should be given to the implementation of a hazardous building abatement ordinance or to the initiation of nonconforming use or nuisance procedures.

Surface Faulting

In zones of potential surface faulting and deformation, the consequences of rupture to existing or planned uses should be assessed and alternative uses compatible with fault rupture, and with adjacent and regional land uses, should be considered. Alternatively, controls may be placed on the method of construction and the location of structures so that an undue hazard would not occur. Implementation regulations might call for establishment of a fault hazards easement (Mader and others, 1972) that would require a setback distance from the active fault traces. The amount of setback might differ with the type of faulting and deformation expected. It might also vary with

respect to the character of individual faults and even segments of a single fault, as well as with the knowledge, or lack thereof, of the fault zone and the structure or development being considered. Thus, the more critical the structure, the greater should be the setback limit.

In addition to adoption of a fault hazards easement, similar to a scenic easement, jurisdictions might consider adoption of "fault hazard zoning" or the broader "geologic hazard zoning," which would include such hazards as landslides and floods as well as faults. Such zoning might override conventional zoning, prohibit human occupancy, require a land use compatible with both the hazard and adjacent areas, or stipulate minimum site investigation and safety standards. Certainly, any development to be considered within, or immediately adjacent to, an active fault zone should require geologic studies to demonstrate that the proposed construction would conform to standards of community safety and that an undue hazard to life and property would not ensue.

Alternatively, prohibition of all uses other than those essential to the public welfare (utility and transportation facilities) could be considered in areas of extremely high hazard. Certain types of land use are compatible with the high level of hazard attendant even to such areas as the San Andreas fault zone. Some of these uses include open space, recreation areas (including golf courses, nurseries, horseback riding, bike trails, and so on), cemeteries, freeways (but not interchanges), parking lots, and solid-waste disposal sites (under some conditions).

Where development already is present within active fault zones, jurisdictions can adopt policies leading to the removal of critical engineering structures on the most accurately located active fault traces. Nonconforming building ordinances should be considered that could require eventual removal of structures in the greatest danger, starting with those that endanger the greatest number of people--hospitals, auditoriums, office buildings, and apartment houses, followed by commercial buildings, and perhaps eventually by single-family residences. The nonconforming building ordinances could be based on either an arbitrary time schedule or on the depreciated life of the structure involved. Other innovative options for control of

development include tax incentives and adoption of urban renewal policies that would encourage removal of hazardous structures and that would prohibit reconstruction in hazardous areas after earthquakes or other natural disasters (Diplock and Nichols, 1972). Another approach might involve the exchange of existing public land dedicated to uses compatible with fault hazards with private land actually subject to those hazards.

Flooding

Although little is known about possible tsunami, seiche, or dam-failure effects in the Eastern United States, a considerable amount of flooding is known to have occurred during the 1811-12 New Madrid earthquakes. A concerted effort should be made in each jurisdiction to assess potential flooding risks and to adopt various methods of reducing them:

1. Restrict land uses to those that are economically essential (docks and warehouses) and warn owners, builders, and occupants of the hazard. Prohibit siting of high-occupancy and critical structures (schools, hospitals, police and fire stations) in potential inundation areas.

2. Place areas of potential inundation under flood-plain zoning, prohibit all new construction, and designate existing occupancies as nonconforming.

3. Where economically feasible and without encouraging a false sense of security, construct restraining or diversion structures to minimize potential inundation.

4. Institute appropriate systems to warn of impending failure or inundation.

5. Adopt and implement evacuation plans.

6. Seek elimination or strengthening of potentially hazardous dams.

Other approaches are discussed by Waananen and others (1977).

From the examples of land-use policies, plans, regulations and procedures discussed earlier, I hope that certain basic approaches to earthquake-damage reduction have become apparent. In the approaches discussed below, there is an implicit understanding that earthquake-hazard reduction is but one aspect of an overall hazard reduction program that must be integrated with other community concerns, such as redevelopment and open-space planning, in order to achieve community goals at the least cost.

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SUGGESTED APPROACHES FOR IMPROVING THE STATE OF EARTHQUAKE PREPAREDNESS IN THE EASTERN UNITED STATES THROUGH LAND-USE PLANNING

A. Establish State hazard mapping programs that provide needed information as to the types, locations, and degree of hazards from ground shaking, surface faulting, landslides, liquefaction, subsidence, and flooding in each local jurisdiction within the next 5-year period.

B. Amend existing State statutes that pertain to the planning authority of cities, towns, and counties to require consideration of safety from natural hazards.

C. Encourage local governments to inventory their current land uses, including the integrity of existing structures, in order to assess the risk to those uses from the hazards mapped. Base future land-use decisions on acceptable risk.

D. Adopt legislation requiring that evaluations of risk be made in advance of permitting and construction of critical facilities, including high-occupancy structures.

E. Prepare model legislation, regulations, and development policies for natural-hazard areas.

F. Prepare model local safety policies, plan criteria, and plan implementation devices consistent with all hazards faced in each State.

G. Prepare postearthquake reconstruction and mitigation plans as a condition for receiving State and Federal assistance following a damaging earthquake.

RESPONSE TO A DAMAGING EARTHQUAKE

by
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BACKGROUND OF THE ISSUE

An adequate response to a major disaster doesn't just happen. It requires a great amount of planning, coordination, cooperation, and ingenuity to trigger a response equal to the challenge of an unscheduled event.

The mechanism for managing a presidentially declared disaster is rather simple with the major responsibility for the overall coordination being assigned to the Federal Emergency Management Agency. Numerous Federal, State, local and voluntary agencies have unique capabilities and resources which are made available in major disaster situations and these must be channeled appropriately to achieve the maximum benefit from their response efforts.

We have a great deal of experience in responding to floods, tornadoes, hurricanes, forest fires, and similar disasters. In some areas major floods are almost an annual occurrence so there is adequate motivation for response preparedness. Because we have had no experience with devastating major earthquakes during this century in the Eastern United States little or no contingency planning for such an occurrence has been undertaken. Until now most of our efforts have been focused on the West--California, Puget Sound, and Salt Lake City.

In view of the probability for a major earthquake in the Central United States as detailed in the immediately preceding conference on "Earthquakes and Earthquake Engineering - Assessing the Earthquake Hazard and Evaluating The Risk," we must proceed with haste to develop approaches to meet this potential threat and to reduce our vulnerability.

It is necessary to recognize that secondary effects of earthquakes such as fires, floods caused by dam failure, landslides and spills of hazardous

materials could cause catastrophic damage. Damaged utility networks might present multiple hazards at a time when they are needed most. These additional hazards further complicate the task of preparing to respond to an earthquake.

Vulnerability analysis, warning, emergency resources and response organization, legislation, and public information are all elements of earthquake contingency planning. They are identified for purposes of contingency plan development.

High seismic risk areas in the Eastern United States have already been identified. Planning effort should be concentrated in the communities at highest risk. States and the identified high seismic risk communities or regions should commence at once to identify potential problems and to suggest possible solutions.

Weather forecasting can give us a high probability of occurrence at a specific location within a short timeframe of an hour or so. Earthquake prediction is not as precise. At present it is more of a statistical probability in a given location for a longer period of time and is probabily more useful for planning purposes than for warning. In preparing for a response there may be no timely warning of an imminent event. It is therefore extremely important that we be prepared to cope with the devastating effects of a major earthquake without any warning.

The public looks to its governmental organization for quick and effective response in an emergency. The key to an effective response then is to coordinate and reinforce existing organizational entities, building on existing relationships. An emergency is not the time to introduce a new and unfamiliar system. Emergency response roles and responsibilities, therefore, must be reviewed and agreed upon. All aspects of coordination and control must be considered. Executive direction to search and rescue must be examined to insure adequate and timely response and unusual needs arising from earthquakes should be identified and responsibility for satisfying them assigned.

First, the vulnerability analysis and the potential damage assessment indicates the geographic area to be included in the contingency plan. Usually multiple jurisdictions will be involved with communities, water, fire and utility districts overlapping each other. Also power, gas, and transportation services, while regulated, may be private enterprises that add further dimension to the problem.

State and Federal agencies can be helpful in assisting local government with intergovernmental emergency response planning. One of the most important elements of an emergency response plan is communication among the agencies. This is important in all major disasters, but it becomes even more critical when dealing with an earthquake because of the severity of the damage that an earthquake is capable of causing. With Federal, State and local governments being aware of this critical element they can insure that adequate information will flow among them. The need for communications hardware and capability is obvious and also requires special attention.

Earthquakes present a unique situation that requires scientific evaluation to base decisions for emergency actions. Typical questions include: 1) How were the underground utilities and transportation systems (such as water, sanitary, telephone, oil, and gas, etc.) affected? 2) What additional damage may occur? 3) Were the dams, storage, or water transportation facilities affected? Decisionmakers need to know what potential problems exist or are likly to occur as the result of aftershocks. Also, they need to know who has the responsibility for coordinating such efforts and what the Federal and State roles are in supporting these necessary evaluations.

Fires can be a devastating secondary effect following an earthquake. Again this has many facets--ranging from fighting fire strategies and reaction to the need for cutting off utilities and other possible fuels. Some States have a Fire Marshall's office, others do not; so the normal constituent relations vary considerable from State to State. Because of the greatly varying fire organization capabilities and responsibilities, this is an element that requires considerable attention. Ordinances or orders may have

to be devised or amended to permit needed arrangements for the support of various fire organizations.

Health care facilities should be assessed for adequacy in handling numbers of victims and also for possible damage to their facility by the earthquake. Plans may exist for a particular facility but an overall plan for the areas must be developed. Depending upon the vulnerability analysis, arrangements may need to be made with facilities outside the area. Along with health care, the need exists to develop an adequate search and rescue capability. Not every community would have 3000 National Guardsmen in their city on the day a major natural disaster hit as did Rapid City, South Dakota in 1972. Governor Kniep requested and was granted use of them for search and rescue and other emergency activities. Search and rescue is an urgent and immediate need. Locals authorities must be able to respond immediately.

Housing to best meet the needs of displaced persons must be identified. Housing has a number of elements ranging from immediate mass shelter to temporary housing and then to long range solutions. Voluntary agencies such as Red Cross, Salvation Army, Seventh Day Adventist, Mennonites and others may be able to provide urgently needed immediate assistance and even longer term housing in some situations. Local and State housing authorities, where they exist, can be helpful when brought into the planning effort utilizing their capability.

Many knowledgeable and capable people exist in every community who can contribute to an effective emergency response. Once the potential threat is identified it is the responsibility of governmental officials to make adequate plans so that a meaningful response can be made utilizing their capability.

There may be little recognition of your day-to-day preparations but when the damaging earthquake occurs you can be assured that the public will expect an effective response.

While planning for the emergency response is taking place, very positive loss prevention or reduction actions should also be undertaken. These actions include the development of structural engineering and materials standards for

new and existing buildings and in restricting use of land in high risk areas. Loss prevention or reduction, of course, is a long-range approach and should include every measure that significantly reduce damage, loss, and injuries. All actions that we can take to reduce the suffering and hardship resulting from a major earthquake are worth the effort and cost when the event becomes reality.

George Lincoln, a former Director of the Office of Emergency Preparedness, stated that disaster preparedness represents an unbroken chain of tasks stretching form prevention through recovery requiring continuous effort at all levels of government. While I have focused primarily upon disaster response, there are a great many elements of total emergency preparedness. All are important and necessary for successful preparation and response to a damaging earthquake.

SUGGESTED APPROACHES FOR IMPROVING EARTHQUAKE PREPAREDNESS THROUGH IMPROVING RESPONSE TO A DAMAGING EARTHQUAKE IN THE EASTERN UNITED STATES

Issue: Earthquake contingency planning in the Eastern United States is inadequate to ensure that public officials at all levels of government can respond effectively to a damaging earthquake.

Suggested Approaches

A. Conduct vulnerability analyses and earthquake loss studies in all high seismic risk areas.

B. Develop a comprehensive total emergency management plan for each urban area that has the potential of being impacted by a damaging earthquake, emphasizing all aspects of mitigation, preparedness, response, and recovery.

C. Develop intergovernmental emergency response plans and communication linkages between agencies.

D. Define Federal-State-local government roles for scientific and engineering investigations and decisions about emergency actions. Examples of such decisions include: 1) Were the underground utilities (water, sanitary, telephone, oil, gas) damaged by the earthquake? 2) Were dams, water storage, and water transportation systems damaged? 3) What kinds of additional damage are likely to occur from aftershocks?

E. Develop fire fighting capability in local communities; safeguard fire fighting equipment to withstand damage in earthquakes to ensure that fire fighting capability remains functional during and after a damaging earthquake.

F. Assess health care facilities to determine their ability to withstand earthquake ground shaking and their adequacy to handle victims of a damaging earthquake.

G. Develop a search and rescue capability that can be implemented immediately after a damaging earthquake.

H. Develop housing resources to meet the needs of persons displaced by a damaging earthquake. Develop plans that fully utilize voluntary organizations such as Red Cross, Salvation Army, Seventh Day Adventist and Mennonite Churches, and others to provide immediate housing assistance.

ENHANCING SEISMIC SAFETY IN THE CENTRAL UNITED STATES

by
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INTRODUCTION

Major earthquakes not only can occur in the east and mid-west--but they also have. The area on which this paper focuses, the Central United States, is one of them. As a matter of fact, the earthquakes that centered around New Madrid in the winter of 1911-1812 have been called "unique in their awesomeness" by Dr. Otto W. Nuttli (1), who has devoted a great deal of study to the seismicity of this area.

Table 1 lists the most damaging earthquakes that have occurred in the United States since European settlement. This table uses the area subject to major damaging potential as a measure of the "size" of an earthquake. The first four of these events affected substantially larger areas than the other five. Figure 1 illustrates the comparative size of the area impacted in these events.

Table 1: Ranking of damaging earthquakes by area of impact

	Location	Year
1.	New Madrid, Missouri	1811
2.	New Madrid, Missouri	1811
3.	New Madrid, Missouri	1812
4.	Charleston, South Carolina	1886
5.	Owens Valley, California	1872
6.	Fort Tejon, California	1857
7.	San Francisco, California	1906
8.	Hebgen Lake, Montana	1959
9.	Prince William Sound, Alaska	1964

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[1] Charles Thiel is now with Woodward Clyde Consultants, San Francisco, California.

The geology and seismology of the Eastern and Western United States are such that we expect substantial differences in the nature of damaging earthquakes in these respective areas. There are four geological and seismological characteristics of the Central United States that are very significant (1,3,4,5):

1. The ability to generate truly catastrophic earthquakes--of magnitude 8 or greater. In the 1811-1812 sequence, for example, three of the shocks were of surface-wave magnitude 8 or greater with an epicentral intensity of Modified Mercalli X or higher.

2. Return periods of some 600 to 700 years for earthquakes of surface-wave magnitude of 8.4 or greater. These return periods have been established by analysis of the historic seismicity of the area and by a recent intensive investigation, including the collection of seismic, aeromagnetic, gravity, geomorphic, tectonic, seismic refraction and reflection profiling, and trenching data. This investigation has associated the earthquakes in the area with an ancient intraplate rift that is buried under the Mississippi embayment and has had periodic tectonic and volcanic activities. Earthquakes of much lower magnitude but significant damage potential, and correspondingly greater frequency are expected.

3. Low Attenuation--because of geologic formation in this part of the North Atlantic Plate--of seismic waves of low frequency (1 to 10 cycles per second), and a long duration (1 to 4 seconds) of ground shaking, thus potentially causing damage to long-period structures (tall buildings) at great distances from the earthquake source.

4. Large aftershocks, possibly occurring for a few years. The 1811-1812 sequence of three major events, and the occurrence of many smaller potentially damaging earthquakes for many years afterwards, is distinctly different from the California experience where aftershocks tend to be of smaller magnitude and to occur for only a few months.

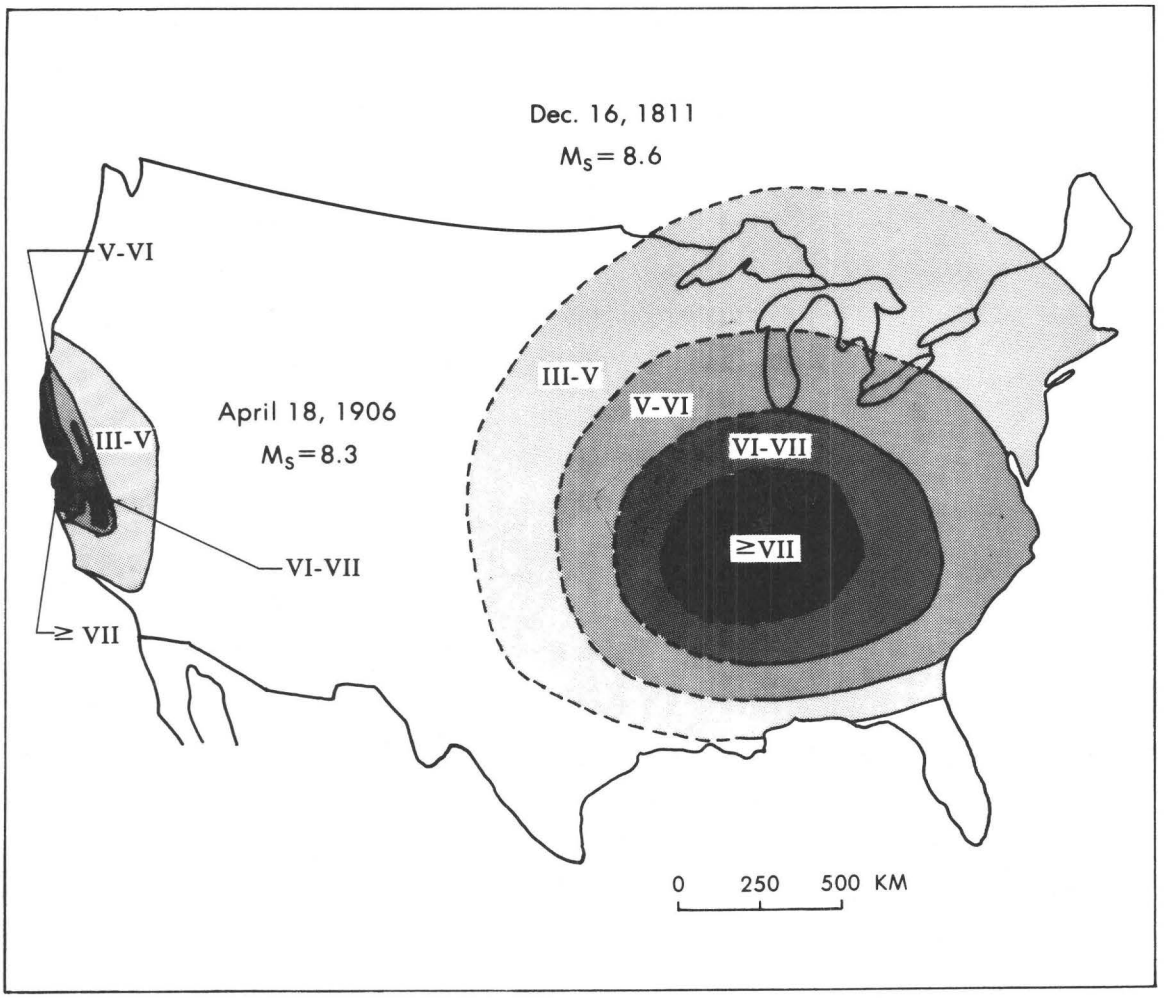


Figure 1.--Comparison of isoseismal contours for the 1906 San Francisco, Calif., and 1811 New Madrid, Mo., earthquakes. The contour lines connect sites having the same value of Modified Mercalli intensity, a numerical index of the effect of an earthquake on man, the Earth's structure, and on buildings. The New Madrid earthquakes were felt over almost 1 million square miles and produced damage ranging from minor structural and architectural damage (MM intensity VII) to total destruction (MM intensity X to XII). The San Francisco earthquake, in comparison, was felt over 60,000 square miles.

Earthquakes in the Central United States have the potential for damage and life loss larger than experienced to date from any U.S. natural hazard occurrence, whether from floods, hurricanes, or tornadoes. Figure 2 shows areas (MM intensity VII) within which major damage may be expected to occur. A rough estimate prepared by Petak (6) of the building losses alone in a recurrence of the 1811-1812 New Madrid earthquakes amounts to some $13-14 billion (1980 dollars). On the other hand, earthquakes in this part of the country contrast markedly with those in California with regard to the area in which damage occurs and over which the earthquake is felt. For approximately the same Richter magnitude (8+), the area in which structural damage is likely to occur is at least five times greater in the Central United States than in California and at least 25 times greater for architectural damage--the kind that contributes heavily to both material and life losses (1). The greater area of impact means more complex and extensive mitigation and preparedness, measures, involving a myriad of political and administrative jurisdictions and creating intergovernmental managerial problems that have not been addressed, let alone resolved. The long-period character of ground motion requires preparedness measures for some structures (e.g. buildings over 10 stories high or very long buildings) in localities hundreds of miles away from the epicentral area, where no other significant damage is likely to occur.

In recognition of its risks, for almost 50 years California and its local governments have required a series of progressively more stringent earthquake safety measures involving land use and building regulations. On the other hand, the Central United States has little history of legislation at the State level favorable to an improvement in the seismic safety requirements in building codes, professional practices, or land use regulations. With minor exceptions, most construction does not consider explicitly earthquake hazards and consequently has limited earthquake resistance. Public perceptions of earthquake hazards also are radically different in the two regions. "Everyone" in California knows that they are in "earthquake country;" however, few in the Central United States realize that major damaging earthquake can occur in their area and that steps to reduce vulnerability can be taken. These distinctions force a different view toward earthquake hazards reduction in the two areas, and particularly force a different approach for earthquake preparedness in the Central United States than that adopted in California.

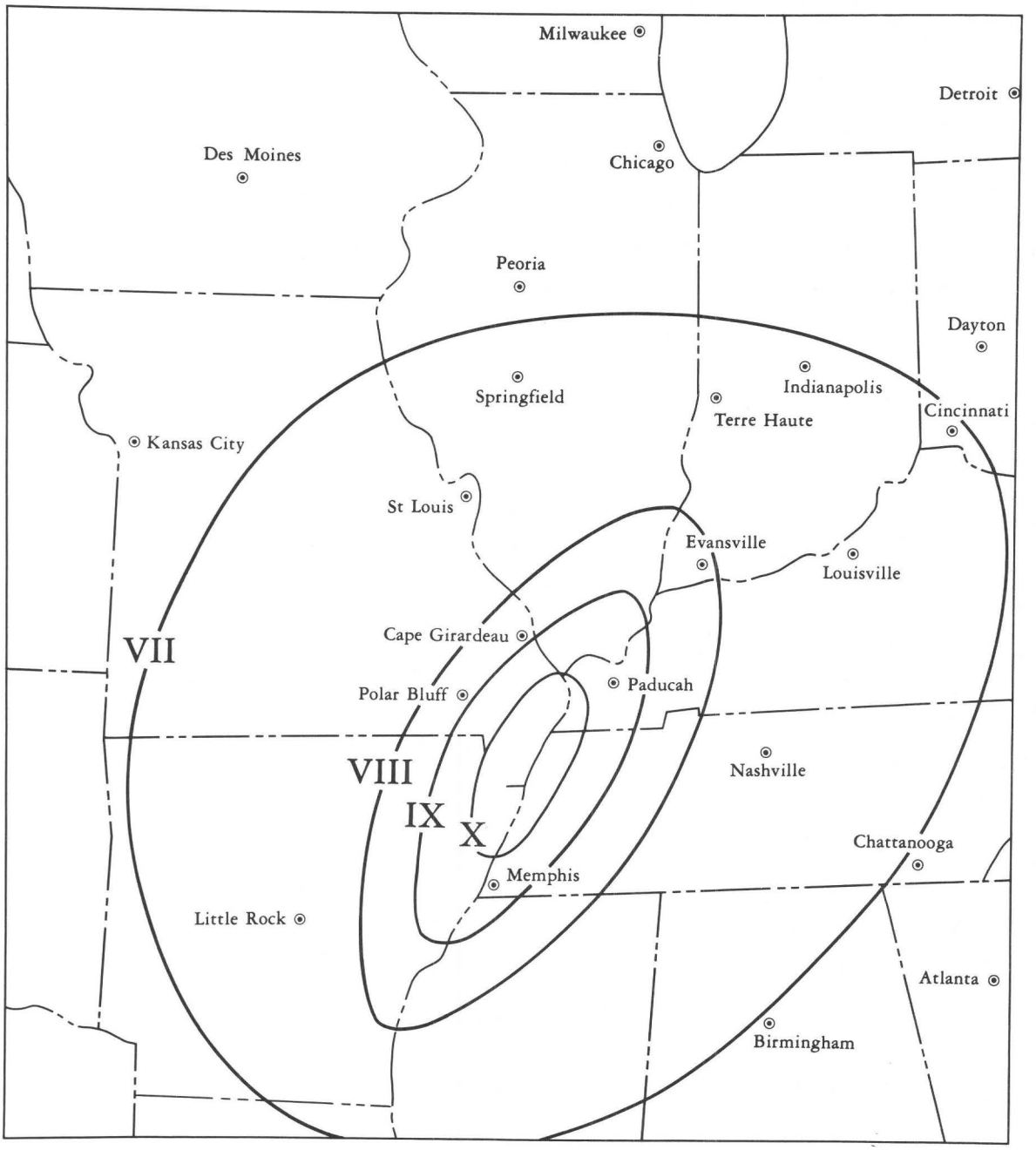


Figure 2.--Location of communites in the Central United States relative to isoseismals corresponding to a recurrence of the New Madrid earthquakes. Structual damage would be expected for MM intensities of VIII or greater; architectural damage would be expected for MM intensities of VII.

However, much of the specific content of California programs may be directly adoptable. Experience in earthquake hazards reduction in California, Nevada, and Utah suggests three general observations:

-- Even in areas of high risk which are recognized by the public, there has been a long series of false starts in comprehensive earthquake mitigation programs.

-- Once programs are in place they may degrade quickly through misuse and or non-use.

-- Every damaging earthquake has surprised us in major ways by damage which has or has not occurred.

This experience indicates that the objective of improving earthquake safety and preparedness in earthquake-prone areas will be one that requires long and continuing efforts. Attempts at quick fixes are certain to fail.

Now let us turn to the significance of an earthquake in the Central United States. The area that would experience the most serious impact of the earthquake lies astride the central valley of the Mississippi River and its major mid-stem tributaries, the Missouri and the Ohio. It includes portions of seven States. The total area of these seven States covers almost 10 percent of the country. The 1975 population of this same seven-State area was over 33 million people, or over 15 percent of the Nation's total. This area contains a significant segment of the National economy, with over 15 percent of the total employment of the country and almost 19 percent of the value added by manufacturing found there. In general, the northern portion of the area is heavily industrialized, with, Indiana and Illinois accounting for almost 40 percent of the total value added by manufacturing in the area.

A PLANNING APPROACH FOR THE CENTRAL UNITED STATES

An effort to improve earthquake preparedness that covers all the geographic areas that might be impacted and prepares for all the possible effects of a damaging earthquake will require an effort of substantial

magnitude. To succeed, there is a need to proceed in an incremental fashion, identifying segments that can be discretely addressed and time-phased within an overall grand plan for performance by government, professional organizations, business, voluntary organizations, and individuals. In this context, an initial five-year effort appears to be reasonable. Experience in other geographic areas emphasizes the necessity for close cooperation among all elements of government and the public in both the design and conduct of preparedness and mitigation programs. While recognizing the necessity for wide involvement, it is still useful to propose a program as an initial point of departure. Such a program should be formulated to achieve the following basic integrated objectives:

1. Develop vulnerability analyses and identify opportunities for reducing damage, injury and disruption.

2. Initiate a cooperative planning project focusing on building capability within diverse local, State and Federal jurisdictions and ultimately delivering a comprehensive, integrated preparedness and mitigation program among the affected institutions.

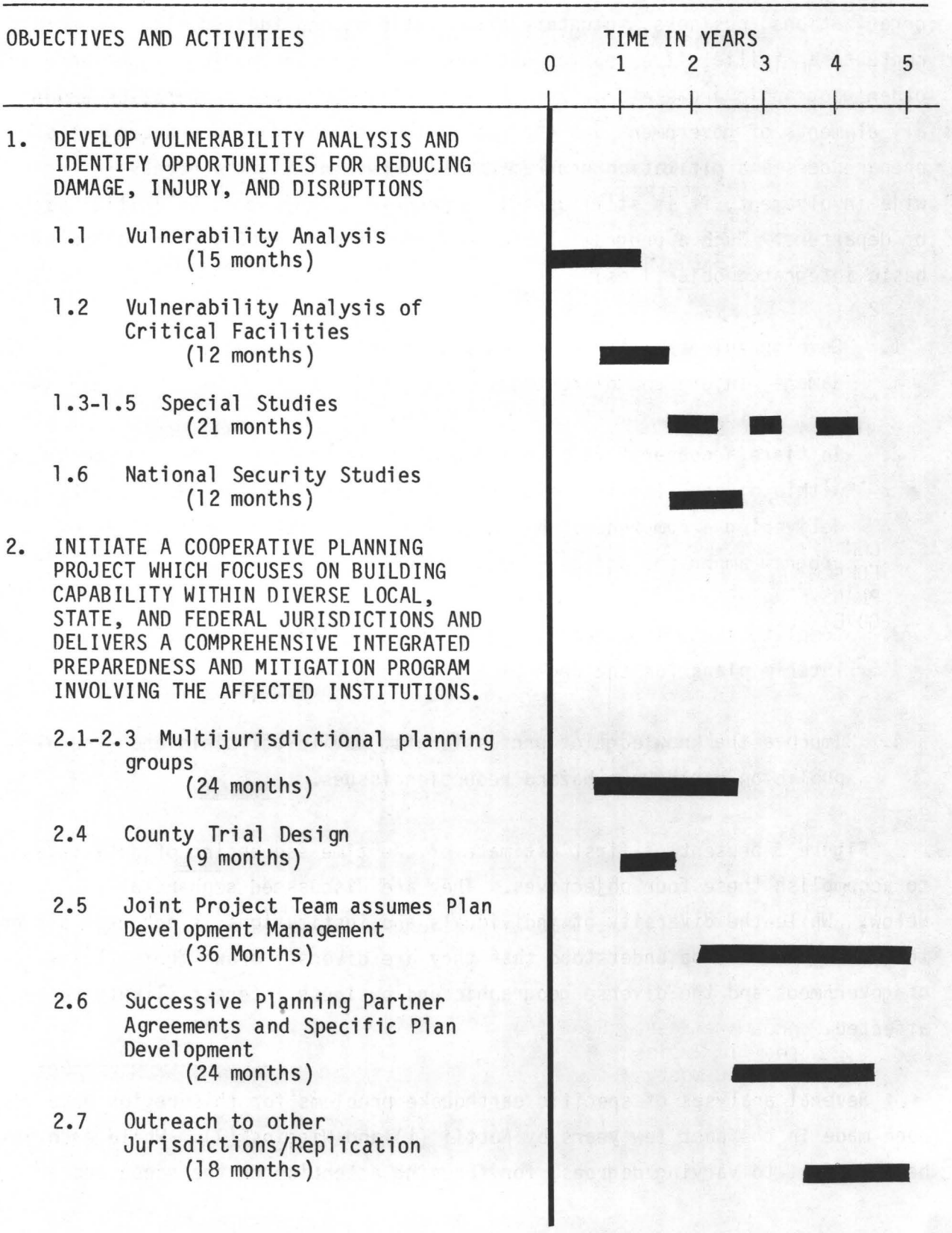
3. Complete specific preparedness plans for critical facilities and interim plans for the Federal and State governments.

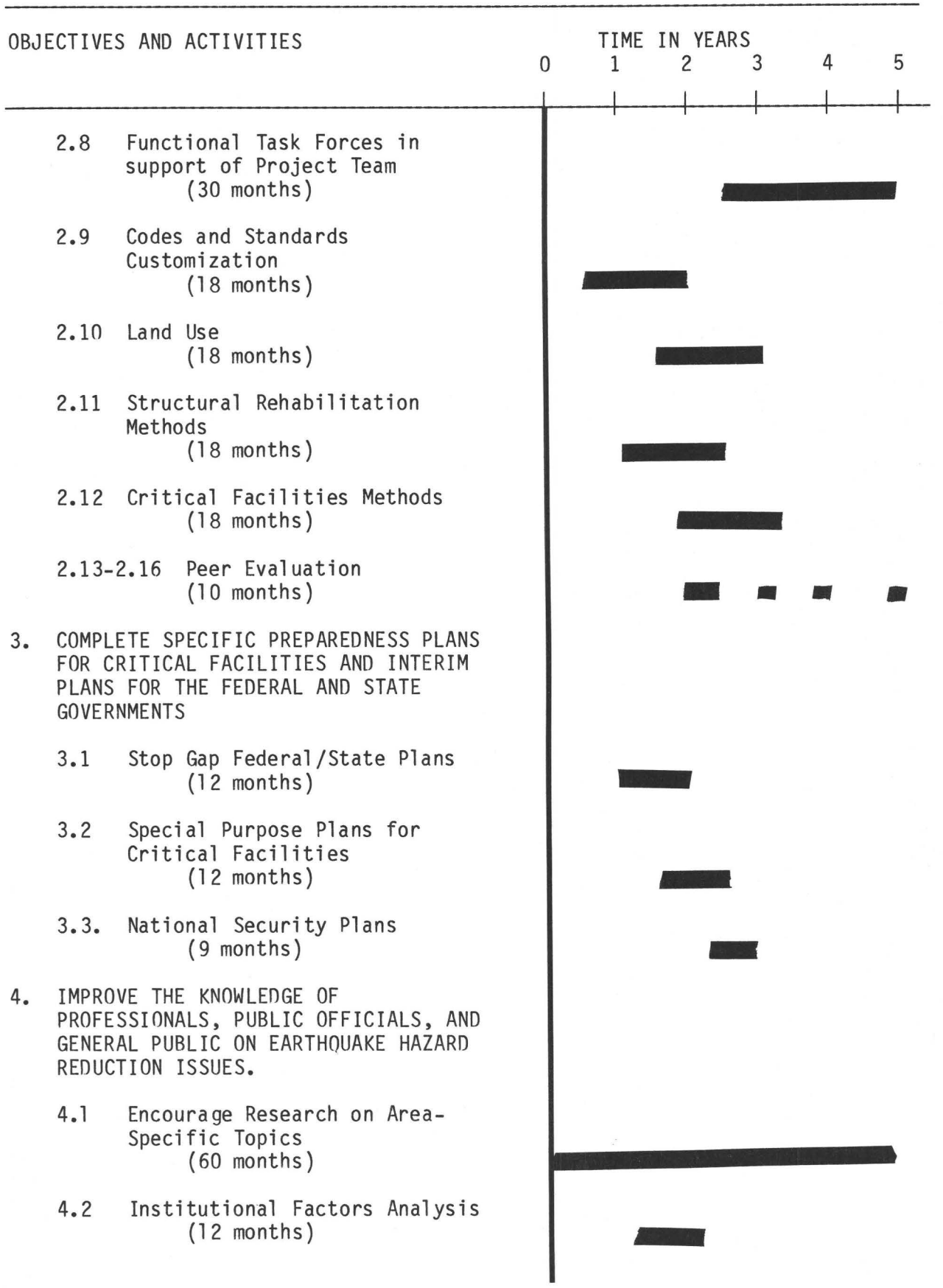
4. Improve the knowledge of professionals, public officials and general public on earthquake hazard reduction issues.

Figure 3 presents a first estimate of the time sequencing of activities to accomplish these four objectives. They are discusssed sequentially below. While the diversity of individuals and institutions is not explicit on the chart, it must be understood that they are diverse, drawn from all levels of government and the diverse geographic and business interests likely to be affected.

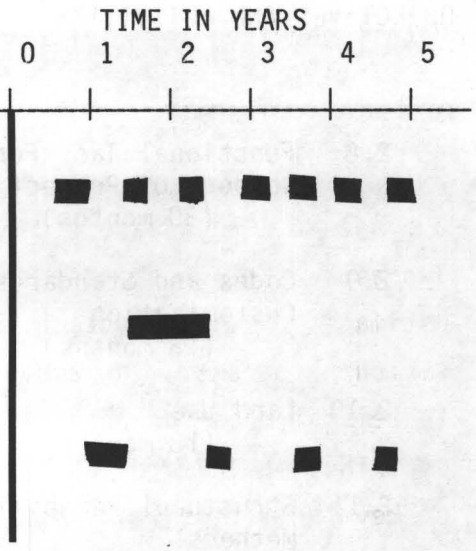
Several analyses of specific earthquake problems for this region have been made in the past few years by Nuttli (1) and Wiggins (7). While each has been useful, to varying degrees, for focusing attention on the scope and

Figure 3: DRAFT 5-YEAR PLAN FOR EARTHQUAKE HAZARDS REDUCTION IN THE CENTRAL UNITED STATES




OBJECTIVES AND ACTIVITIES
TIME IN YEARS
0
1
2
3
4
5
2.8 Functional Task Forces in support of Project Team (30 months)
2.9 Codes and Standards Customization (18 months)
2.10 Land Use (18 months)
2.11 Structural Rehabilitation Methods (18 months)
2.12 Critical Facilities Methods (18 months)
2.13-2.16 Peer Evaluation (10 months)
3. COMPLETE SPECIFIC PREPAREDNESS PLANS FOR CRITICAL FACILITIES AND INTERIM PLANS FOR THE FEDERAL AND STATE GOVERNMENTS
3.1 Stop Gap Federal/State Plans (12 months)
3.2 Special Purpose Plans for Critical Facilities (12 months)
3.3. National Security Plans (9 months)
4. IMPROVE THE KNOWLEDGE OF PROFESSIONALS, PUBLIC OFFICIALS, AND GENERAL PUBLIC ON EARTHQUAKE HAZARD REDUCTION ISSUES.
4.1 Encourage Research on Area-Specific Topics (60 months)
4.2 Institutional Factors Analysis (12 months)

OBJECTIVES AND ACTIVITES



4.3-4.10 Seminars
(14 months)

4.11 Public/Professional Education in Design
(12 months)

4.12-4.15 Regional Scientific Conferences
(8 months)

nature of the earthquake problem in the region, they have not provided the detail required to make specific judgments fo development of preparedness plans of mitigation strategies--only Wiggins has made preliminary estimates of the benefits (and costs) that would accrue if different mitigation strategies were adopted. These assessments must be augmented to ascertain the extent of the hazard, the nature of impacts and the distribution of losses (Task 1.1). Two aspects of these assessments are the measurement of vulnerability and estimates of the reduction in vulnerability caused by the implementation of various programs. The assessment of vulnerability should yield estimates isoseismal maps for potential life loss and injury, building damage and distribution, damage to lifelines, the likelihood of fire, and loss of service of key facilities (e.g. hospitals), which are vital in the post-earthquake emergency response period, and damage to facilities (e.g., toxic chemical storage), whose failure could cause large secondary consequences. Models for these assessments have been prepared for San Francisco, Los Angeles, Puget Sound, and the Salt Lake City areas (8), although more complete quantification of the specific benefits (costs) which might accrue based on adoption of different mitigation strategies need to be quantified. The focus should be upon the geological and seismological problems in those areas expected to experience MM intensity VII or greater. The vulnerability and adjustments phase of the analysis should proceed through the following sequence of ranked priorities:

1. Centers with 100,000 people or more in areas of anticipated maximum impact (MM intensity VIII and higher)--Little Rock, Arkansas; Evansville, Indiana; and Memphis, Tennessee. Casualties and dollar losses become truly substantial in the area subjected to MM intensity VIII and higher. Further, assistance operations are more likely to become difficult--and hence require prior planning--in urbanized areas where population and industries congregate.

2. The 125-150 counties (in seven States) falling within MM intensity isoseimals VIII and higher. Communities difficult to reach, potential inundation areas downstream from major dams, and areas adjacent to large industries that might use harmful products should receive special attention.

3. Cities of 100,000 population or over falling within MM intensity VII.

4. Counties falling within MM intensity VII.

A special class of problems within this region is posed by the potential failure of dams and petroleum product pipelines, the failure of which could cause large secondary impacts. Table 2 reviews current results of the ongoing survey of dam safety by the U.S. Army Corps of Engineers.

Table 2: HIGH HAZARD DAMS IN THE CENTRAL U.S. (9)

	HIGH HAZARD	UNSAFE	URGENT
Missouri	644	389	42
Illinois	125	20	1
Indiana	235	68	3
Kentucky	210	75	5
Tennessee	145	66	2
Arkansas	129	39	2
Mississippi	77	36	4

NOTE: A "high hazard" dam is one whose failure would cause substantial loss of life, while an "unsafe dam" is one judged to be inadequate structurally to withstand expected loading conditions. "Urgent" denotes those facilities which are judged to pose imminent failure risks which must be resolved immediately. Unsafe dams include those which have inadequate spillway capacity, degraded structural properties, or any of a variety of other defects which pose a substantial probability of failure under regularly expected conditions.

Few dams in this region have been designed to withstand earthquake loads (the Corps' assessment included earthquake considerations). The superposition of earthquake loads on an inventory of already unsafe structures suggests that a substantial number of dam failures can reasonably be expected in any major

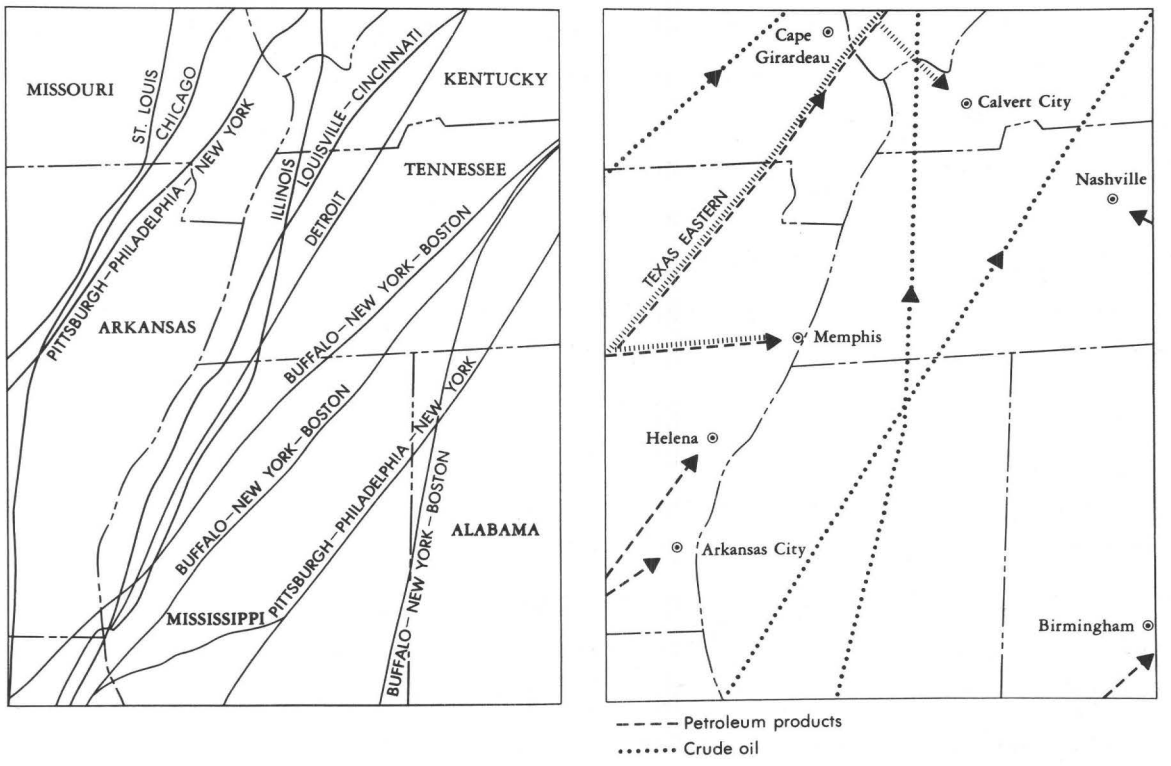


Figure 4 and 5.--Location of natural gas (left) and petroleum product pipelines (right) in the Central United States that would be vulnerable to a repeat of the 1811-1812 New Madrid earthquakes.

earthquake which affects the Central United States. This situation tends to be exacerbated by the fact that the predominately earthen dams at risk are particularly vulnerable to the long-period oscillation expected to propagate very efficiently over long distances from such earthquakes.

Many interstate natural gas and petroleum product pipelines traverse the areas where strong ground shaking or induced soil failure could cause damage. (Figures 4 and 5) Other major lifelines (railroads, telecommunications, inland waterways, electric power networks) are similarly located. The important characteristic of damage to many of these so called critical facilities is that the secondary costs of their damage (e.g. interruption of service, fire,) far exceed the loss to the facility itself. Task 1.2 is intended to assess the vulnerability of such faciltiies as a special topic. While it may be reasoned that failure of dams and petroleum pipelines are secondary hazards, the safety of each has high public salience. Thus, a focus of these specific types of facilities may offer access to the public process which is not readily available through other channels. After such issues are aired, it may be easier to address in public forums the more pervasive earthquake hazards.

Our understanding of risks and vulnerability in this region are changing quickly, especially because of the emphasis being given by the USGS on such studies. Many researchers within universities and government are focusing considerable effort to unravel the geology and seismology of the region. This, coupled with the evolving understanding of what is required for adequate preparedness and mitigation, require the planned conduct of vulnerability reassessments and of special-purpose onsite studies (Tasks 1.3-1.6). Two such special-purpose studies are already tentatively identified. First, an analysis of vulnerability in cities removed from the areas of strong impacts but subject to long-period ground motion that might affect tall (25-30 story and higher) structures (Task 1.3) the geologic properties of this area indicate that strong, long-period earth motion may be felt at much greater distances than observed in the western part of the country. Short period ground motion is expected to decay rapidly by comparison. Generally speaking, tall structures are more vulnerable to long-period excitation, while short structures are relatively unaffected. This segment would require some prior

geotechnical investigations of distances to which such motion might travel, its characteristics, and the potential impacts on long-period structures. Feasible structural and nonstructural measures to provide protection to occupants of these structures should also be identified. Second, the special problems posed to facilities and installations of particular national security importance or of National economic importance (Task 1.6). There is a need to identify facilities contributing to national defense that are at risk, so plans can be made to cope with their loss. Similarly, this area makes a major contribution to the country's Gross National Product. The widespread dislocation in employment, production of new materials and semifinished goods, financial and other kinds of services, and employment could be large enough to impact the National economy. This would be especially significant if the country were faced with serious economic problems at the time of the earthquake, such as high inflation, a recession, high unemployment, or similar economic difficulties.

The importance of building earthquake hazards reduction initiatives from the local level cannot be overemphasized. If the disaster period is to be managed competently, State and local governments must have realistic expectations of what the Federal Government can and will do; and, the Federal Government must have realistic expectations of what State and local governments can and will do. All indications are that a major earthquake will made demands far exceeding the response capabilities of any element of government. These considerations put a premimum on thoughtful, long-term Federal, State, local and private sector planning. A key to successfully meeting the earthquake challenge will be for the Federal Government to assist in a way that reinforces and supports local initiatives, and not disrupt, preempt, or impede them. Without a ture partnership in Federal, State and local earthquake prepareness program planning, severe problems in emergency response and recovery operations will arise following a major earthquake.

Any comprehensive effort to enhance preparedness for a major earthquake must be based upon the recognition that:

-- no element of government has sufficient resources to "go it alone" should a major earthquake occur or be predicted;

-- different elements of government and the private sector must act in cooperation;

-- local organizations must take the principal leadership for they bear the brunt of the emergency;

-- the problem of earthquake preparedness is essentially and foremost one of management--whether in the allocation of responsibility, the distribution of resources, or the resolution of conflict;

-- mitigation activities are integral with preparedness to achieve acceptable levels of earthquake safety; and

-- we must prepare now and not depend upon luck and our ability to improvise when the big event comes.

These observations, benign as they may appear, represent a major transformation in the traditional approach to preparedness planning and dictate a substantial change in institutional relationships. The cooperative approach is one of equal partners with dominant concern for achieving a workable, local capability to prepare for and respond to a damaging event. Because each element of government would participate in the design and management of this program, they would share the responsibility for error.

Tasks 2.1 through 2.3 are sequentially designed to involve more and more institutions and key individuals in the design of the program which can evolve from this proposal. Such individuals should be drawn from local, substate, State, regional, and national organizations, since preparedness and response will require close cooperation and coordination among all. At the first stage (Task 2.1) a limited group, possible as many as 15 or 20 individuals would be convened to participate in initial design discussions and studies. Under their direction, one or two pilot planning efforts could be conducted at the county level (Task 2.4). The purpose of these studies is to provide ground-level experience not to develop specific response plans. Task 2.2 represents an extention of participation from the individual to the institutional level,

based upon experience gained. During Task 2.1 each person serves without specific organizational portfolio, while in Task 2.2 organizations (principally governmental, professional, the public interest) assume principal responsibility through their representatives. By the initiation of Task 2.3 this planning group has matured in its experience and perspective to assume overall management responsibility for the establishment of a joint project team (Task 2.5), the initiation of planning partner arrangments (Task 2.6), the formation of functional task teams (Task 2.8) which prepare specific preparedness and mitigation modules for use by the planning partners, and ultimately replication throughout the region (Task 2.7). To assure utility and workability, special care must be exercised to involve all elements of governments (local, State, and Federal) and the private sector as equal partners.

Success of the planning process invisaged in Tasks 2.1 through 2.8 will depend on and be limited by, first the completion of vulnerability analyses (Tasks 1.1-2), second, the development of codes, standards, building practices, and land use procedures which are customized to the specific problems and capabilities of the region, and third, with a technical basis for repair or upgrading of substandard structures. The Applied Technology Council (10) and Building Seismic Safety Council have made great strides in developing nationally applicable earthquake-resistant building design practices, but prior to their incorporation into locally applicable codes, they wil have to be evaluated and customized for local use (Task 2-9), particularly for application in rural and small town settings. Similarily, questions of assessing the hazard of particular building sites, and incorporation of hazards into locally enforced land use regulation must be developed (Task 2-10). While experience in other geographic areas will be of utility, this effort will need careful, local consideration and development. Tasks 2-11 and 2-12 are designed to specifically develop technical guidelines for the identification and upgrading of hazardous structures and the adaptation of hazard reduction practices for critical facilities. Task 9.13 is also intended to give technical individuals who are highly motivated a base from which to be more effective as they seize opportunities to effect decisions within their area of expertise. It is particularly important to note that earthquake-resistant design is not costly when it is undertaken as part of the

original design effort. Periodic peer evaluation (Tasks 2.13 - 16) by those within the affected communities and experts in science and engineering is a vital tool to assure quality and applicability. A delicate balance must be maintained throughout Tasks 2.1 - 2.16, while constantly striving for wide involvement, we must also identify, cultivate and nurture key long-term individual participants. Wide participantion can become a thin veneer, especially if there is not a simultaneous development of a few key people who can make sustained contributions. It is expected than as each task progresses opportunities to improve earthquake safety through legislation and administrative action will be continual and actions to implement them will take place as they occur.

It is not expected that a basic integrated preparedness and mitigation program will be in place for at least five years. Thus, it is incumbent on Federal and State organizations, at the minimum, to prepare interim adaptations and stop-gap additions to existing emergency plans (Task 3.1). This will be required particularly for those critical facilities identified as high hazard in Task 1.2 and 1.6 see also (Tasks 3.2 and 3.3). These latter plans should be based on models prepared for specific site application.

Much of what we know about earthquake hazards in the Central United States has been developed by individual researchers generally working alone on topics identified by themselves. The U.S. Geological Survey has initiated specific hazard assessment studies and the National Science Foundation has supported engineering and policy studies. These have been few in number, and occasionally performed outside the region. The conduct of more research on and within the region not only will increase our knowledge, but also add to the cohort of "experts" with local perspectives who can consult and participate in local earthquake hazards reduction. Federal and State organizations supporting and performing research should be encouraged to commit more time, expertise and resources. Of equal importance is the identification of research and information needs of the professions, businesses, and government within the region. In cooperation with the research community, the multijurisdictional planning group (Tasks 2.1 though 2.12), and representatives of affected communities, a substantial continuing effort to identify research needs and priorities is required (Task 4.1).

Clearly, one pressing need is to determine the institutional framework in which earthquake safety decisions will be made (Task 4.3). There are seven States whose territory will receive from severe to moderate direct and indirect damage. That number can easily double when indirect and long-period consequences are calculated. These States have different legislative structures, perceptions, and attitudes toward seismic hazards; they are in different stages of economic development with varying social characteristics. Local autonomy, probably strong in all of them, nonetheless exhibits marked differences from one State to the next as does the capability to act and the interest. The same is also true of the organizational and legal structures of sub-state and local entities and of planning units. The Federal structure involves four or more regions that often cut across the boundaries of organizations such as the U.S. Army Corps of Engineers. The intergovernmental structure needs to be clearly understood, influentials identified, and an overall approach designed so that coordination, awareness, and education efforts can be targeted, and mutually supporting institutional arrangements can be established between the seismic safety planning group and existing State, local and Federal agencies.

As more investigators become involved, meetings to coordinate research and identify results which should be disseminated will be required, perhaps on an annual basis (Task 4.12 through 4.15). These meetings also will serve the purpose of identifying new research needs, preventing overlaps and generally giving focus and direction to the research effort. Stronger interest in earthquake preparedness in this area can be expected to be fostered throughout the research and academic establishments with the consequent recruitment of capable investigators into the effort. The USGS specialty research conferences and workshops are models of the meetings that we have in mind (Tasks 4.12 - 4.15).

In a number of States, professional societies of engineers, architects, planners and public administrators, and individuals in these constituencies have played a key role in initiating, leading and encouraging earthquake hazards reduction measures in State and local governments. These types of professional associations and their members should be the subject of special

professional development efforts beginning early in the planning process (Task 4.3 -4.10). The design of a wider professional education program (Task 4.11) is intended to help guide this semiannual effort. A first seminar should be held on the state-of-the-art and the results of seismic planning efforts in other parts of the country. Subsequent seminars directed at specific audiences should be held perhaps every six months, constantly striving to reach wider and wider audiences. Thus, the goal is to build knowledge and broader capability incrementally until the point is reached where the media and public can be involved. A word of caution is in order at this point. Experience shows that research results need to be put through a "translation effort" in order to have an impact on decision and practices. The new information must be interpreted and adapted to the different needs of the various audiences we want to reach, otherwise it will be left unused on bookshelves. Further, the meetings should be structured around a minimum of instruction and a maximum of discussions "hands on" and exercises.

Active raising of awareness among the general public and enlisting their assistance in both self-help and community action should come later, perhaps in the fifth year of our proposed planning effort. This is not to say that the general public should be kept in the dark or be excluded. It merely means we must have information available that is reliable and ready for action on their part. Their involvement then will allow them to gain a proper perception of the hazards, undertake useful measures to protect themselves, and decide how best to join the effort. Premature involvement will only cause needless apprehension and waste much needed energy in a nonproductive way. Prior to such an effort, well considered products should be made available to groups participating in the tasks that have been enumerated or making a specific request.

THE WORKSHOP FORMAT AND THIS PLANNING APPROACH

This workshop has organized its discussion in six topical areas:
Topic 1--Hazard awareness and public information;
Topic 2--Public sector participation;
Topic 3--Intergovernmental and organizational relations;
Topic 4--Local earthquake resistant design;
Topic 5--Land use; and
Topic 6--Response to a damaging earthquake.

Further, the workshop has separated its planning activity into three geographic areas for consideration; Central, Southeastern and Northeastern United States. While our program proposal of Figure 3 is not presented in terms of these topics, they are implicit in the variety of tasks to be performed. Table 3 presents our estimates of the relationship between tasks and topics. Two notations are given: P--principal relationship; S--major supporting relationship. Some tasks, for instance Task 4.1, pertaining to research encouragement, are not specific to any of the topics, but supportive of all.

This planning approach is presented as a proposed course of action. It is hoped that through the discussions that it will generate, a more refined and definitive planning document will evolve.

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TABLE 3.--Relationship of Workshop Discussion Topics to Tasks Proposed in Figure 3. (P denotes principal relationship, S denotes supporting relationship).

TASKS (See Figure 3)		WORKSHOP TOPICS					
		1	2	3	4	5	6
1.1	Vulnerability Analyses	S			S	S	P
1.2	Vulnerability-Critical Facilities	S				S	P
1.3-1.5	Special Studies	S					P
1.6	National Security Studies	S					P
2.1-2.3	Multijurisdictional Planning		S	S			P
2.4	2-County Trial Design		S	S			P
2.5	Joint Project Team		S	S			P
2.6	Planning Partners Agreements		S	S			P
2.7	Outreach to Other Jurisdictions	S	S	S			P
2.8	Functional Task Forces	S	S	S			P
2.9	Codes and Standards Utilization				P		
2.10	Land Use					P	
2.11	Hazardous Structures Rehabilitation				P		
2.12	Critical Facilities				P	P	
2.13-2.16	Peer Evaluation						
3.1	Stop Gap Plans			S		P	
3.2	Critical Facilities Plans			S		P	
3.3	National Security Plans			S		P	
4.1	Research						
4.2	Institutional Factor Analysis						
4.3-4.10	Seminars	P			S	S	S
4.11	Public/Professional Education	P	S		S	S	S
4.12-4.15	Regional Conferences	P	S		S	S	S

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A CRITICAL EVALUATION AND SUGGESTIONS FOR IMPLEMENTATION OF DRAFT ACTION PLANS BASED ON EXPERIENCE IN UTAH

by

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I have just emerged from the trenches in Utah where we engaged in an exercise of the type considered and planned by workshop participants during the past three days. Some of our experiences and, especially, a few hindsight views derived from this effort in Utah to develop a comprehensive State-level earthquake safety plan may be of interest and value to others.

PLANNING AND DEVELOPMENT ARE NOT THE SAME AS ADOPTIVE AND IMPLEMENTATION

At the beginning of this workshop, Art Atkisson, one of four speakers who provided an overview of the issues involved in earthquake safety planning and set the framework for the workshop, commented that the politics of earthquake safety policy would be the battleground for any plans that participants might develop and pursue in their own regions or States. From my own experience in Utah, I can only reaffirm and reemphasize the points that Art made in this regard. Plans and ideas for earthquake hazards reduction are matters involving public interest and participation, i.e., they are matters of public policy. The public in this case consists of almost everyone, each having his own special reasons for being interested--builders whose businesses may be affected, parents whose children may occupy the schools built under the policies, persons in need of medical care that might be affected by facilities damaged during an earthquake, building owners whose money must pay for the

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work created by the policies, building department officials and other government personnel whose responsibilities are to safeguard public health, safety and welfare, and a myriad of others. The plans and ideas are not public policy and only become so when they are accepted and adopted by the public through the normal political processes that operate in this Nation. It is my contention that the action--and the pitfalls--in earthquake safety lies not in developing the policy ideas but in accomplishing public acceptance and adoption.

I would be willing to wager that the ideas for earthquake hazards reduction that might be proffered by the workshop participants after just three days of initial planning and organizing will greatly exceed the number actually adopted collectively by all of your communities during the next five to ten years, no matter how good or how appropriate those ideas might be. By this, I mean simply to stress that the changing of public policy is a long-term, tedious, and sometimes fustrating task. Moreover, changes often is not accomplished, or, if at all, the policy changes are only a small portion of what ought to be done.

Art Atkisson's remarks regarding the politics of earthquake safety policy acknowledged six aspects of the political process which thwart the making of public policy. To these I will add three other elements that seem to me to affect the process of achieving change. Before doing so, I wish to review briefly the Utah experience for the benefit of some who may not be familiar with what we sought to do in Utah.

A BRIEF SKETCH OF THE UTAH SEISMIC SAFETY ADVISORY COUNCIL

In 1977 the Utah Legislature created a Seismic Safety Advisory Council and charged it to recommend public policy for earthquake hazards reduction appropriate for both the public and private sectors of the State, and to advise the Governor and legislature on earthquake safety matters. This charge was much like the charge given to the California Seismic Safety Commission in its beginning years, which may be more familiar to many. The important point to note at the outset is that the Utah Council was a creation of the State, and the recommendations of its members were sought by the State.

An eleven-member board, or Council, was appointed by the Governor to carry out the legislative charge during the ensuring four-year period just ended on June 30, 1981. The make-up of the Council remained the same for the four years. The executive director was employed by the Council.

During the four-year period, we carried out a comprehensive study of seismic risk in Utah, evaluated a broad range of risk conditions, and drafted policy recommendations for risk reduction that we believe are appropriate to the type of degree of risk and fit Utah's approach to governance. Because a comprehensive earthquake safety program necessarily is broad in scope, the policy recommendations reach across all levels of government in the State and into private sector activities as well as public sector activities. Not many activities pertinent to earthquake safety escaped scrutiny by the Council--among them building design and construction practices, land-use planning and zoning practices, geotechnical research and mapping procedures for building schools, health-care facilities, and publicly-owned buildings, design and construction of dams, design and construction of water systems, electric power systems, and natural gas systems, design of transportation systems, emergency response and recovery capability, and more. For each of these, policy recommendations were drafted that are intended to improve the performance of these facilities and activities during and after earthquakes.

At the end of June of this year, the Council presented to the Governor and the legislature the results of the studies and the policy recommendations, including drafts of suggested legislation when deemded needed to deal with particular problems, and including suggestions for administrative action when that means seemed more suitable. A total of 15 reports were submitted to the State leadership, one being an executive summary and the other 14 being detailed discussions of risk conditions and remedies for risk reduction.

The 1981 legislature chose not to act upon the recommendations and instead assigned the material to a legislative study committee for review. The Office of Legislative Research now has the studies and recommendations and is not expected to bring forth its recommendations for disposition of the Council reports before 1984. Hence, the Council's work has been redelegated

to further study even though we tried very hard to achieve some continuing forward motion for a process that, at least, had begun and, at one time, had legislative support.

The second point here to be observed for the Utah exercise just described is that studies do not create public policy. Legislators, other elected officials, and agency administrators create public policy when recommendations and suggestions are adopted and then implemented. Good technical work, or even bad work, makes little difference if the recommended policies are not adopted. In Utah, we have, I believe, set forth some sound public polices for earthquake hazards reduction; the State does not yet have earthquake safety policies.

COPING WITH THE POLITICAL PROCESS

For me and others who were involved in the Utah earthquake safety policy effort, the problem clearly lies in achieving adoption of policies and not in formulating suitable answers to earthquake risk problems. The question that follows logically is: How can one facilitate the process of policy adoption? Unfortunately, there seems to be no single path that one can follow and no means to achieve certainty of results. The writer makes no claim to be expert in this situation. Indeed, successes in Utah so far are greatly outweighted by nonsuccessful efforts. But, to the extend that hindsight has value, the Utah effort reveals some guidelines that may help others who have set similar courses.

Six aspects of the political process suggested by Art Atkisson match my own experience in Utah. I noted earlier that these six aspects tend to thwart the making of public policy. While I believe this to be true most of the time, I also optimistically believe these aspects can be managed and thereby lead to successful efforts in making of public policy. To manage them, however, requires first that they be recognized, and with this thought in mind the six points made by Art are restated, to be followed with additional points of my own.

The six points are restated in my own words as follows.

-- Legislators face numerous other public policy issues besides earthquake safety. Because there are so many, none receive the amount of legislative attention they might deserve. Unless the promoter of an issue successively persuades a legislature of the issues's importance, it may receive no attention. Hence, earthquake safety policy must compete with many other policy issues, including budgetary issues, and must stand on its own merits as perceived by the policymakers.

-- Earthquake safety, like any other policy issue, requires a constituency to bring the issue before the political bodies. My own view, seemingly supported by this point, is that policy bodies are reactive; they rarely lead. Thus, as Art notes, the perceived importance of a policy issue may be of no consequence if there is no constituency that keeps the issue in front of the policymaking body. The "squeaky wheel" concept controls much that is done.

-- It is essential that the policy issue be kept simple, even if the problem to be dealt with is not. Busy policymaking bodies rarely, if ever, will take the time to understand complicated problems or complicated solutions. I would add here that this point presents a real challenge in the drafting of earthquake safety policies that often are technical and often require complicated remedies. I also would suggest, in hindsight, that the 15 technical reports prepared by the Utah Seismic Safety Advisory Council fail to meet this point.

-- The cost of the problem solution, whether preceived or real, must not exceed the precived cost of the risk, or policymakers surely will choose the easy way out. When this possibility is in concert with an active constituency opposed to the action (possibly because the cost will be borne by them), then it becomes almost impossible to persuade the policymakers to adopt the policies. In this case, it matters little that the suggested polices may have real social value.

-- Reduction of earthquake safety policy concepts to actions involving simple yes or no political decisions fits my own view of the narrow perspectives and attention that political bodies typically develop and maintain for most public policy issues other than primary political platforms at a particular time. Politicians properly reserve the prerogative of deciding policy issues but rely upon line-agency staffs to work out details and administer the policies. Most of us, at one time or another, have heard the comment, "Don't confuse me with the facts!" The decisionmaking process for public policy too often is subverted by this kind of attitude.

I suggest to you that the above points are not trivial. The process of accomplishing adopted polices for earthquake hazards reduction, I believe, must be done within a framework in which these human traits prevail. I seriously doubt if any one of the points can be avoided, or has been avoided where earthquake safety policy has been shepherded successfully to adoption.

Reflections upon the Utah experience in promoting earthquake safety policy suggest to me three additonal aspects of the political process that seem to have great significance for successfully achieving adoption of recommended policies. I propose that these be added to the six aspects illuminated by Art Atkisson.

-- Earthquake safety policy recommendations should be separated into single, sharply-focusses issues and actions. The political process usually will accommodate no more. Indeed, at any one time, I would suggest that only a very small number of issues be brought into the process. I fear that in Utah we failed on this point, largely because our strategy called for something else. The Utah Seismic Safety Advisory Council was charged to develop a <u>comprehensive</u> earthquake safety policy for the State. Comprehensive efforts necessarily are broad in scope, and translation of any such effort into policy recommendations is destined to complexity, a complexity unsuited for policy action. In Utah we did what the legislature

charged the Council to do, but more issues were raised than the policymakers are able to handle. The result is that we now have no single policy in place, the entire package is being studied again, and no doubt many of the policymakers are apprehensive about opening "pandora's box." Comprehensive planning for earthquake safety is necessary, I believe, but the entire array of useful actions should not be brought forward as a single package for policy action.

-- Policy promotion efforts should be structured to fit within the working time frames of policymaking bodies. The makeup of policymaking bodies changes over time--by elections and by new appointments. Perceptions of importance also change over time--not only from new knowledge about the issue but also as a result of change completely extraneous to the issue, such as an era of tightened budgeting for Government. This point is nicely illustrated in the Utah effort. That effort began in 1977. During the ensuing four years, all public offices went through elections. The Utah Legislature was changed radically by two elections in the House of Representatives and one election in the Senate. The State experienced a complete change of direction in governance, essentially a retreat to reduce Government involvement. Legislators who authorized the studies of the Seismic Safety Advisory Council in 1977 are not around in 1981 to see the results. Interests and commitments of the 1981 legislature are different from those of the 1977 Legislature. The current political direction in the State toward withdrawal of Governmental involvement in many public affairs does not give me confidence that the Council's recommendations will be heeded by today's policymakers. Although I may be presumptuous in believing so, I think that the situation in Utah would be different today if the Council had returned its recommendations to the legislature that created it.

-- Persons and organizations seeking adoption of earthquake safety policies must learn to be opportunistic in their endeavors. Opportunities are to be found in changed conditions which may make earthquake safety policies more acceptable. An earthquake event

that arouses public concern is one such opportunity. At such times, one must be ready to propose appropriate policies dealing with the problem at hand, even if the policy means a change in priorities of the proposer. One way of looking at this is the concept of "strike while the iron is hot." Karl Steinbrugge first suggested this approach to me several years ago. Subsequent events have convinced me of the merits of his suggestion. I believe that California astutely has used such opportunities to establish its earthquake safety policies. The Field Act in California was passed after the 1933 Long Beach earthquake that seriously damaged several schools. The earthquake safety policy for hospitals came right after the 1971 San Fernando earthquake that damaged some hospitals. And not all opportunities arise as a result of earthquakes. Most recently, the California Seismic Safety Commission has taken advantage of a school building roof failure with the goals of strenghtening school construction standards and to address retrofit of existing schools built before earthquake safety standards were mandated. Althought the current California effort is incomplete, I predict further success in gaining new public policies as a consequence of follow-up action by the Commission on a problem that easily could has been passed by. In Utah, I passed up two similar opportunities that, in hindsight, I now believe we should have pursued.

CRITIQUE OF PRELIMINARY PLANS OF THE WORKSHOP PLANNING GROUPS

In the remainder of this paper, a few observations are made in the form of a critique of preliminary plans by the three workshop planning groups for developing earthquake safety programs in the midwestern and eastern States. It is acknowledged at the outset that the critique is based on a deeply held conviction that the nine points discussed above represent the "real world."

The critique begins with a brief restatement of the plans that were presented by three groups. No doubt my restatement of the plans is incomplete, possibly even inaccurate in detail, since this is written only with the benefit of rough notes and my attendance at the presentations.

For reasons apparent in the preceeding pages, the organizational and operational plans proposed by the three groups are of greater interest to me than are the technical activities. In this regard, it is noteworthy that three quite different organizational structures have been proposed for carrying out the earthquake safety development plans in the three regions.

-- The central States planning group proposes to follow what I hear call a "grass roots" approach. Their intent is to gain the support and participation of a key official in each of the participating communities before even embarking upon a program. In the event that the interest of these key officials cannot be aroused (participants in the planning group do not believe this will happen), the earthquake safety program will go no further. On the assumption that the effort will proceed, the group would seek a regional effort only to the extent that this might grow from a local involvement to a State involvement and, thence, to multi-State involvement.

-- The New England planning group proposes to develop its earthquake program from a regional council created initially by appointments at the State level, to be followed with a bisected effort to broaden public awareness about earthquake hazards in the regional and to improve the data base of technical information. This planning group, like the central States planning group, perceives State participation to develop through the State office of emergency services. The role of the workshop planning group is largely in taking initiatives to accomplish the apppointment of the multi-State council and to serve as a catalyst in program start-up.

-- The southeast planning group proposes a distinctly more direct and immediate effort than either of the other two groups. A multi-State consortium not only is proposed, an adhoc committee already is created. Workshop participants have taken the initiative to create the consortium and to designate themselves to serve on the board so created. It is claimed that the blessings of their respective State administrative officers already have been given or can be had. With this quick start, the planning group has outlined a broad list of

specific activites involving public participation, hazards awareness education, and technical objectives.

It is not for this writer to suggest that one of these approaches is right and that the others will not work. I think it is fair to observe that all may work, that all may not work, or that one or two may work. We simply do not know. However, each approach has advantages as well as pitfalls. These advantages and pitfalls are implied by the answers one gets to the following questions.

Who is to do the work both of promotion and of development?

What authority do the program and personnel have?

How much influence will the program effort and the personnel have?

Clearly, there are many possible answers to these questions. Some of those answers can pose real problems for the success for the effort. Suppose, for example, that one answer to the first question is that the personnel in the program are to be knowledgeable volunteers who will contribute time and energy, thereby avoiding an initial problem of budget. I suggest to you that a sustained earthquake safety program is not possible through volunteer effort. Public information and awareness programs alone soon will exhaust the volunteer. And, a sustained effort is essential, I believe, given the plodding workings of the political process.

Now, suppose, instead, that the answer given is that existing agency personnel (local or State) will be used to sustain the effort. My own experience with State government is that agency personnel are authorized to meet a predetermined work load. If these personnel are assigned new duties, associated with earthquake safety, than either the work load is not met or the earthquake program suffers from limited attention. The only viable alternative is to obtain approval and budget for a new program and new work load. As can been seen, public policy to support an earthquake safety program is a first challenge.

Answers to the other two questions pose parallel problems. One possible answer to the second question is that the chief administrative officer (either State or local) authorizes participation in the effort by the unit of government in his or her jurisdiction. Is that authority granted because the administrative officer understands the political risk that will come later when public polices are proposed, or is it granted simply to support a respected staff person or advisor? Far too often I have seen administrative support falter under the pressures created when a proposed policy is aired publicly. Even more often I have observed that policies are adopted but lack the administrative support for their full implementation. If these sorts of problems are not somehow dealt with, then the chances of accomplishing effective changes in, say, building codes or land-use practices are grim indeed.

One last point is made in this critique that seems to apply to each of the three proposed action plans for earthquake safety. Comparatively speaking, it is quite easy to set forth a comprehensive program for action and with a bit more time one even can fill in the details pertaining to the various parts of the plan. But plans are not public policy, as was noted earlier. The process of achieving public policy, in my view, is extremely slow and tedious. I submit that technical knowledge and capability greatly outpace our ability, possible even our willingness, to adopt the ideas as policy to guide everyone's actions. If this view truly represents reality, then my admonition is that the planning groups and the consequent program groups proceed with patience and with knowledge that not everything they might propose to improve earthquake safety will be accepted, but that they also proceed with optimism. The plans laid by all of the groups are very ambitious and, no doubt will not be realized in their entirety. To this prospect, I say: Take as much as can be had; each small policy adopted assuredly improves our ability to deal with damaging earthquakes.

EARTHQUAKE PREPAREDNESS CAN BE COST EFFECTIVE

By
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INTRODUCTION

The advocates of earthquake preparedness for the Central and Eastern United States face the task of selling their program in both the private and public sectors. In planning the program, it is well to recognize that, historically, earthquake preparedness efforts have been accepted by society in a direct proportion to the publicly perceived danger and in an indirect proportion to the cost effectiveness of the proposed program. Since there are no reasons to expect any other treatment by society, the earthquake preparedness program should be developed to effectively exhibit the seismic hazards and the cost-effectiveness of the proposed program.

In order to contribute to the success of the preparedness program, this paper is addressed to the rudimentary testing of proposals for cost effectiveness. The tests are relatively inexpensive and provide information whereby the protective effort can be seen in relation to the many other important efforts of society. In the market place, it is said that "a successful product must be a good buy". The planner may conclude with certainty that the earthquake preparedness program offered the public must be a "good buy"--it must be cost-effective--if it is to be supported by the public.

EFFECTIVENESS

In testing the cost-effectiveness of a proposal, the planner must address separately its effectiveness and its cost. The effectiveness of earthquake preparedness is measured by the reduction of losses attributable to the preparedness action. The reductions are based on the planner's estimates of losses suffered when ordinary construction is exposed to earthquake as compared with resistive construction. In the Central and Eastern United

States this is more difficult than in the west due to the long periods of quiescence between severe earthquakes. This is in contrast to the western United States, where the history of past earthquakes is fresh in the public mind and their record forms a readily accessible basis for future loss estimates. Planners in the Central and Eastern United States must estimate the potential losses through modeled logic. The best in-place estimating technique is known as "simulations" and it is based on a logic model embracing seismicity, geology, engineering and sociology. The process has been tested and found acceptably accurate for planning on a scale ranging from individual buildings to entire cities. Figures 1a and 1b are examples taken from a simulation by Mann, Howe and Kellogg for Memphis, Tennessee, a city of 800,000 population, and illustrate the property and life losses to be expected from credible New Madrid earthquakes assumed to occur in the year 2020. No special protection was assumed to be in place in this simulation and the quality of seismic resistance is referred to as the "Do-Nothing Extra" Strategy, S_0. Earthquakes of MM intensity as high as IX are seismically credible and were simulated.

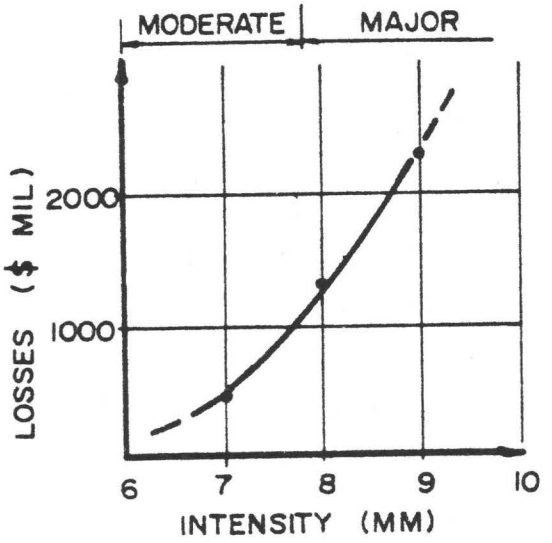

FIG. 1a

BUILDING LOSSES
"Do-Nothing Extra"
Strategy S_0

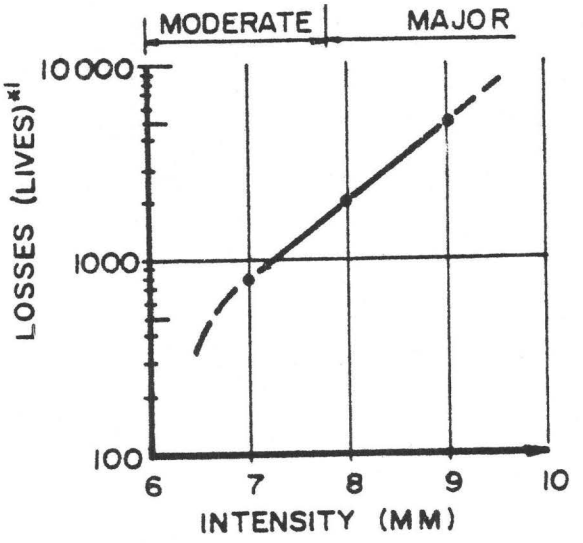

FIG. 1b

LIFE LOSSES
"Do-Nothing Extra"
Strategy S_0

*1 Day-Time Earthquake

If the simulation based on the current building conditions indicates losses that are not acceptable, it follows that a protective program is needed. The planner then defines feasible actions or strategies that are expected losses calculated. The results of one such analysis, Figures 2a and 2b, were taken from the simulations for the Central United States city mentioned in the preceding section. This simulation was based on a protective strategy. S_3 , requiring that all new structures, except residences, erected after 1975 be designed for Zone 3 UBC earthquake loading. It was made for the year 2020 and reflects the complete improvement in the earthquake resistance of all structures in the city.

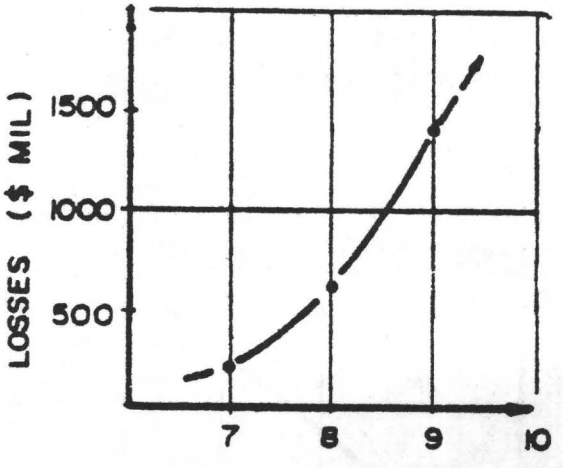

FIG. 2a

BUILDING LOSSES

Strategy S_3

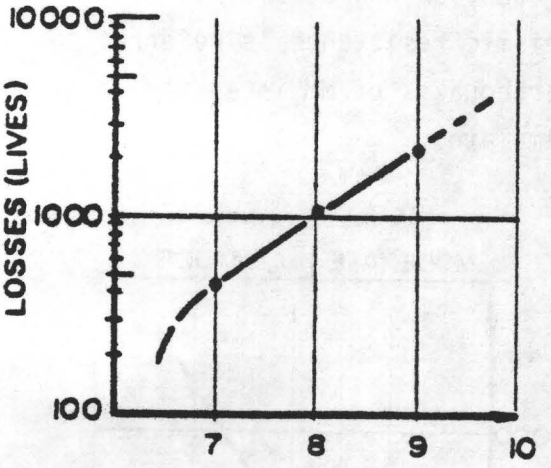

FIG. 2b

LIFE LOSSES

Strategy S_3

After simulating a protective strategy S_i, the planner tests its effectiveness. The effectiveness or benefit B_i is expressed as the difference between losses L_i with the protection and the losses L_0 with the "Do-Nothing Extra", S_0 s strategy.

$$B_i = L_0 - L_i$$

In Figures 2c and 2d such a comparison is made for buildings and lives in Memphis, Tennessee, for the year 2020. By subtracting the loss values shown in Figure 2a and 2b from those shown in Figures 1a and 1b, the effectiveness of preparedness strategy S_3 was determined. The year 2020 was chosen in order to reflect a complete phase-out of prestrategy buildings and thus indicated a true measure of the effectiveness of the protective strategy. The reduction in property losses is over a billion dollars and 3100 lives are saved. The strategy is unquestionably effective.

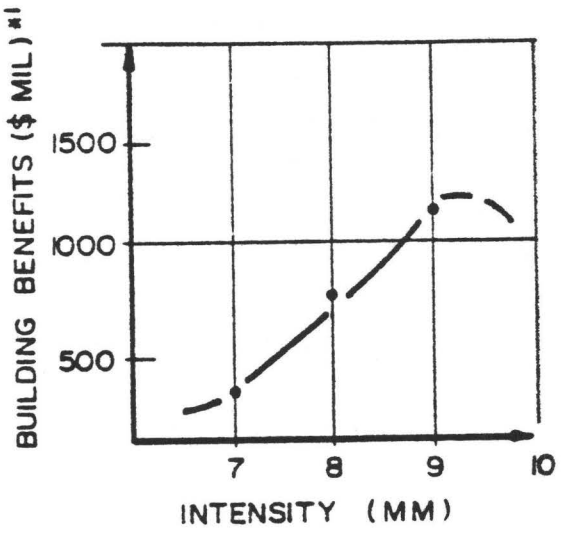

FIG. 2c

BUILDING BENEFITS

*1 Strategy S_3 vs S_0

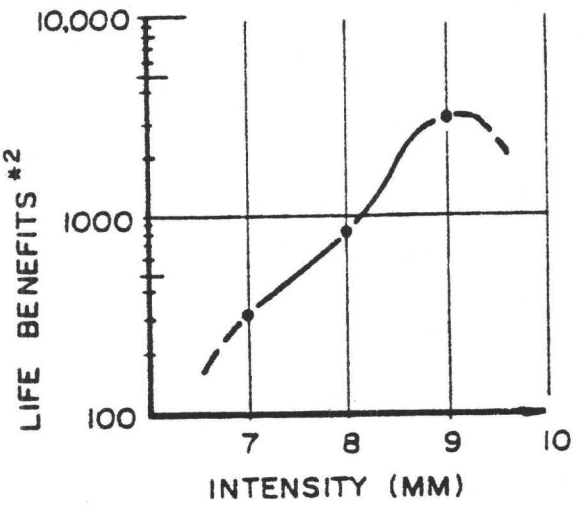

FIG. 2d

LIFE BENEFITS

*2 Strategy S_3 vs S_0

COST

For those protective strategies that are found effective, the planner must next address the cost of each. This is accomplished by following techniques used by design engineers, building contractors and property

appraisers. It is a straight-forward process in which the planner identifies "what is to be done" and "how it is to be done". The engineer, estimator or appraiser then determines the dollar cost required to place the strategy in effect. The difference between the cost of the strategy C_i and the cost of the "Do-Nothing Extra" strategy C_o is the real cost of C of the strategy

$$C = C_i - C_o$$

COST EFFECTIVENESS

Given a determination of the benefits and the cost of an effective strategy, the planner now has at his disposal the information necessary to test its cost-effectiveness in terms of lives saved and value of property saved. A simple and effective test is based on benefit to cost ratios, B/C, using the developed quantities as described in proceeding paragraphs. Managers in both public and private sectors are accustomed to evaluating a proposed program in terms of B/C ratios and communications between planners and decisonmakers are much better in B/C rather than seismic terms.

The strategies previously used for illustration of benefits and costs are expressed in B/C terms in Figures 4a and 4b. The two-to-one return on investment for aseismic buildings, Figure 4a, is clearly a "good buy" in a geographic area where an earthquake of Modified Mercalli intensity VII or greater is expected within the useful life span of the buildings. Perhaps a more cogent argument for earthquake preparedness is made by the number of lives saved for each million dollars spent. As shown in Figure 4b, ten lives will be saved during an earthquake of MM intensity IX for each million dollars spent on strategy 3 protection. The average claim for damages in the recent MGM Hotel fire in Las Vegas, Nevada, is over one million dollars per person killed which is ten times the amount necessary to spend to save a life from a severe earthquake. These examples from real life show that earthquake protection can be made cost-effective provided the available data and analytical techniques are used by planners to properly design their protection plans.

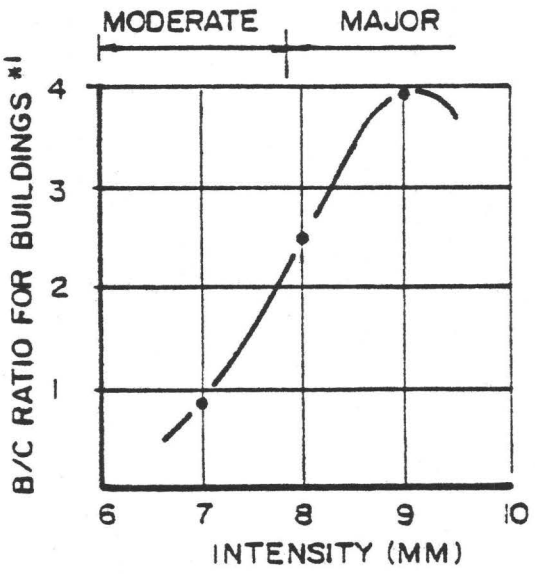

FIG. 4a

B/C RATIO FOR BUILDINGS

Strategy S_3 vs S_0

*1 Dollar value saved for each dollar spent on protection.

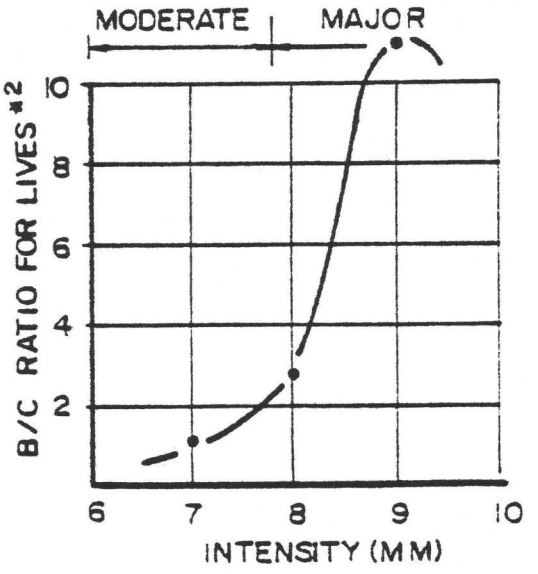

FIG. 4b

B/C RATIO FOR LIVES

Strategy S_3 vs S_0

*2 Lives saved for each million dollars spent on protection.

CONCLUSION

While a great deal could be said about cost effectiveness of earthquake preparedness activities, the important thing for planners to recognize is that all the world is a market place and society has the last word - "Yes" or "No" - on preparedness. It is not enough that a plan be effective - it must be cost-effective. Cost-effective preparedness plans are definitely possible. Techniques are available that give the planner the capability to test plans for cost-effectiveness in the quiet of his office and give the information needed to persuasively present these plans to the public.

There is no longer an excuse for going to market with a product that is not a "good-buy" or for proposing an earthquake preparedness plan that is not cost-effective.

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Mann, O. Clarke, Howe Warner, and Kellogg, F. H. , "Regional Earthquake Risk Study-Technical Report", Memphis, Tennessee, September 1974.

EARTHQUAKE VULNERABILITY STUDY IN THE CENTRAL UNITED STATES

by
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The Central United States Earthquake Project was begun in earnest in FY 81 with FEMA Region VII as the lead entity. The first meeting was with FEMA Region VII personnel and technical advisors involved with the project in San Francisco, November 7, 1980. At the meeting, contractual procedures were discussed for the Hazard Vulnerability Study. During this same time frame, FEMA National and FEMA Region VII developed a detailed public awareness program plan.

On December 16 and 17, 1980, Regional Directors and representatives from FEMA Regions IV, V, VI and VII met in Dallas, Texas, to review the work plan which was amended as a result of the November meeting. The amended work plan was approved by all FEMA Regions.

On January 28, 1981, a meeting was held by a recently organized FEMA Regional Task Force in St. Louis, Missouri, to explain to representatives of the area affected by the New Madrid fault of the intent of FEMA to conduct a project in their area. Thirty-three representatives attended this initial meeting. They were informed that the project would consist of: 1) a hazard vulnerability analysis, 2) Federal, State and local plans addressing that vulnerability, 3) a hazard mitigation study, and 4) a public awareness program.

After the St. Louis meeting, the Regional Task Force prepared a plan to conduct the hazard vulnerability study. Funding of $100,000 was needed to begin work on the project. The FY 81 funding became available on May 21, 1981. A request for proposal was issued to gain the assistance of a contractor for the technical portion of the work. A schedule was then drawn up to make an inventory of six cities in seven states by the Regional Task Force.

The cities were selected in such a way that each state (with the exception of Mississippi, which had no urban area in the northwest corner of the state) would receive exposure and training in conducting such an analysis.

On July 13 and 14, 1981, the Task Force assembled in Kansas City to review the work plan and approve the selection of cities. It was observed that in light of scarcity of funds, the Regions should use their own personnel to conduct the hazard vulnerability inventory. The Regions agreed and a pre-inventory meeting was conducted in Poplar Bluff, Missouri on July 15th.

On July 28, 1981, the Task Force began its efforts with the hazard vulnerability inventory of Poplar Bluff, Missouri. This effort was to serve two purposes, (1) to act as a pilot project and (2) to collect data. The data collected from Poplar Bluff was then discussed with Karl Steinbrugge, FEMA earthquake consultant, in San Francisco in August. Modifications were made in inventory procedures and data forms in preparation for Memphis, Tennessee. A preliminary meeting to enlist the cooperation of Memphis was held with the Memphis and Shelby County, Tennessee staff on September 15, 1981. The inventory, scheduled for October 5-9, has since been conducted successfully.

The U.S. Geological Survey presented a proposal to perform the technical portion of the work in the hazard vulnerability study to FEMA in September and the contract was let that same month.

At the close of FY 81, the Regional Task Force has completed two inventories (Poplar Bluff, Missouri and Memphis, Tennessee) has scheduled Little Rock, Arkansas; Paducah, Kentucky; Carbondale, Illinois; and Evansville, Indiana for completion prior to February 1982. The project is moving along as scheduled and additional progress is expected in FY 82.

MASSACHUSSETS CIVIL DEFENSE AGENCY EARTHQUAKE PREPAREDNESS PROJECT

by
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Framingham, Massachusetts

The Massachusetts Civil Defense Agency (MCDA) began its earthquake preparedness project on June 1, 1981. Funding for the project was provided by a $100,000 grant from the Federal Emergency Management Agency.

The primary objectives of the project are as follows:

1) to evaluate the earthquake risk for the entire New England area (New Hampshire, Massachusetts, Maine, and Rhode Island).

2) to perform a detailed evaluation of the earthquake risk for the Commonwealth of Massachusetts, focusing upon eastern Massachusetts.

3) to conduct a loss analysis study in an urban area of Massachusetts considered to have the highest potential vulnerability to a damaging earthquake.

The first step in the project was to assemble a committee of scientists, engineers, and architects to define the problem and to devise solutions to it. This committee is known as the MCDA Earthquake Project Advisory Committee. It has 15 members who serve on a voluntary basis.

1) Kenneth C. Ponte, Chairman

2) Dr. Patrick J. Barosh
Weston Observatory
Weston, MA

3) Dr. John Ebel
Weston Observatory
Weston, MA

4) Dr. Adam Dziewonski
Harvard University
Cambridge, MA

5) Dr. Urs Gauchat
Harvard University
Cambridge, MA

6) Dr. Gabriel LeBlanc
Weston Geophysical Corporation
Westboro, MA

7) Dr. Nafi Toksoz
Massachusetts Institute of Technology
Cambridge, MA

8) Jay Pulli
Massachusetts Institute of Technology
Cambridge, MA

9) Dr. Robert V. Whitman
Massachusetts Institute of Technology
Cambridge, MA

10) Raymond S. Spinosa
Federal Emergency Management Agency
Maynard, MA

11) Dr. Eugene Williams
Southeastern Massachusetts University
North Dartmouth, MA

12) Karl V. Steinbrugge
Consulting Engineer
El Cerrito, CA

13) Paul Marshall
Southeastern Massachusetts University
New Bedford, MA

14) Joseph A. Sinnott
State Geologist
Commonwealth of Massachussets
Boston, MA

15) Alice Rojko
Division of Water Pollution Control
Westboro, MA

Two other individuals regularly attend the committee meetings, but are not official members. They are:

1) William G. Bozicas
Federal Emergency Management Agency
Maynard, MA

2) Albert A. Gammal, Jr.
Federal Emergency Management Agency
Boston, MA

The MCDA Earthquake Project Advisory Committee formed two subcommittees: 1) risk analysis and 2) loss analysis. The risk analysis subcommittee was assigned the task of completing the risk analysis of the New England area, with particular attention on eastern Massachusetts. Dr. Nafi Toksoz serves as chairman; Messrs Barosh, Ebel, Dziewonski, LeBlanc, Pulli, and Williams are members. In addition, Dr. S. T. Algermissen, of the U.S. Geological Survey, serves as a consultant. The loss analysis subcommittee is responsible for utilizing the risk analysis data produced by the first subcommittee and for advising MCDA in the selection of a contractor to conduct the loss analysis study. It is made up of the remaining members of the overall Committee.

The risk analysis subcommittee has completed and released an interim report entitled, "The Seismicity of New England with Emphasis on Massachusetts." A final report is currently being completed and it will be available for distribution after it has been adopted by the MCDA Earthquake Project Advisory Committee.

Upon acceptance of the final report, the MCDA will work with the loss analysis subcommittee to select a contractor to perform the loss studies in the urban area of eastern Massachusetts considered to be the most vulnerable. It is anticipated that the contractor will be selected and working on or before January 15, 1982. The contractor will devise a number of plausible scenarios using hypothetical damaging earthquakes having various magnitudes (or epicentral intensities) and occurring under various assumed conditions. The contractor will anlayze the potential impact of a damaging earthquake on lifeline systems such as: hospitals, bloodbanks, ambulance services, and utilities (water and electricity).

The results of the loss analysis study will be used to formulate an earthquake emergency response plan. It will be incorporated in the Comprehensive Emergency Response Plan of the Commonwealth of Massachusetts.

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