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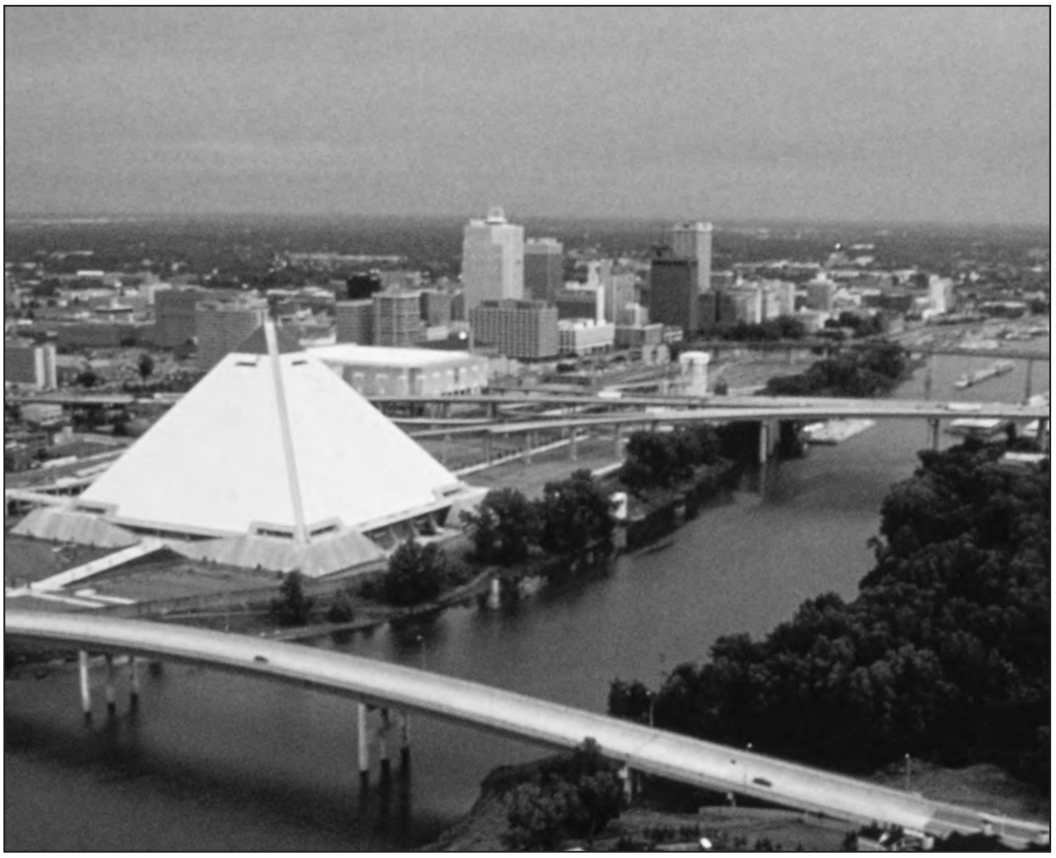
EARTHQUAKE LOSS REDUCTION:
ELEMENTS OF A STRATEGY

The earthquake hazard in the Central United States presents policy makers, emergency managers and other key officials with a unique combination of problems, constraints, and challenges in developing a long-term risk reduction strategy. Earthquakes in this region are a *low-probability/high consequence hazard.* This means, in practical terms, that very few policy makers in the Central U.S. have experienced a damaging earthquake, yet are called upon to support mitigation, and to invest – politically and financially – in risk reduction programs. Yet, when an earthquake *does* strike – and there is a fifty percent probability that a magnitude 6.0 to 6.3 earthquake will occur in the next fifteen years – there is a high likelihood that damages will be significant, and widespread.



This issue of the *Journal* focuses on mitigation, or those actions that can be taken *before* an earthquake or other disaster to reduce damages and losses. In the Central U.S., and nationally, there is a growing awareness and conviction that greater emphasis needs to be placed on mitigation. The reason is straightforward. If we continue to build in unsafe areas, and build unsafe structures, we are simply adding to the problem. The result will be more casualties, damages, and economic losses following an earthquake, and a longer recovery period.

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Mitigation efforts in the Central U.S. will be influenced by several factors, including:

1. Availability of accurate, reliable, and accessible information on the nature of the **earthquake risk** in the Central U.S. Mitigation decisions are inherently investment decisions. Local officials and others need to have accurate information on the nature, magnitude, and characteristics of the earthquake risk, upon which they can examine – and choose – mitigation options.

2. A **core constituency** that can serve as a focal point for "mitigation advocacy efforts," technical advice, and general political support for earthquake mitigation initiatives. At the State level, *seismic safety advisory commissions* can become a catalyst for change in promoting mitigation. In Missouri, Arkansas, and Kentucky, seismic safety commissions have assumed a valuable advocacy, leadership, and advisory role in these states.

> "The greatest challenge facing policy makers in the Central U.S. is *what to do with existing hazardous buildings?*"

On a technical level, professional associations can serve as useful conduits for training and information. For example, the newly formed New Madrid Chapter of the Earthquake Engineering Research Institute will become an important link to the key disciplines in the Midwest that have a direct role in earthquake mitigation, including engineers, architects, geoscientists, and planners.

3. A **mitigation strategy** that sets forth goals, objectives, and an action plan that will lead to measurable progress in earthquake risk reduction in communities throughout the Central U.S.

Among the features of a mitigation strategy: *an awareness and eduction plan for communicating the earthquake risk to a broad range of constituencies; identification and prioritization of mitigation tools and techniques that contribute to earthquake risk reduction, and are politically acceptable; and an implementation strategy that includes incentives for adoption of mitigation programs and measures.*

The following sections examine the important elements of an earthquake mitigation strategy, starting with a discussion of "HAZUS" – the FEMA-NIBS Loss Estimation Methodology, a scientifically-based, user-friendly tool that will allow the states, and interested communities, to estimate potential losses from earthquakes.

Having assessed the risk, there are a variety of "core" mitigation policy and program options that can be adopted at the state and/or local level to begin to systematically reduce the potential impact of earthquakes and other hazards.

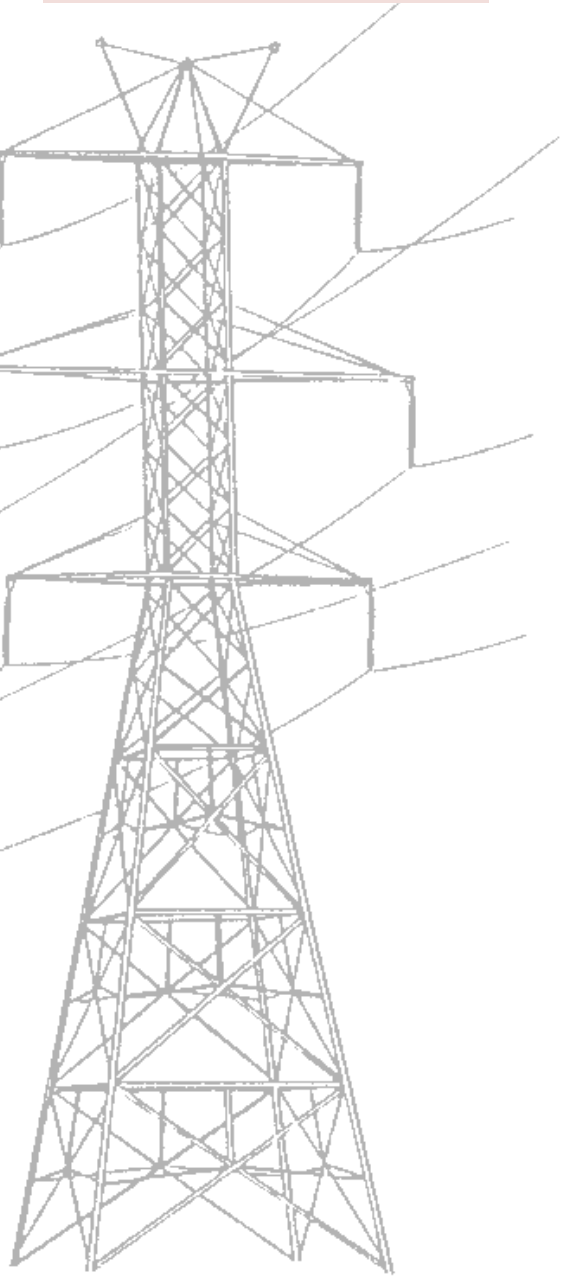
For new construction, states and communities have traditionally turned to the most broad-based of mitigation tools – the incorporation of seismic provisions in building codes. By using codes to effect seismically resistant construction, a community can replace the bulk of its building stock with one that is less vulnerable to damage and collapse. The key to codes effectiveness, however, is proper enforcement.

The greatest challenge facing policy makers in the Central U.S. is *what to do with existing hazardous buildings?* By some estimates, hazardous structures – notably unreinforced masonry buildings – comprise up to 70 percent of the building stock in the downtown areas of our communities. An article on *Seismic Rehabilitation of Existing Buildings* examines some of the key issues associated with hazardous buildings, and outlines an approach to strengthening or "rehabilitating" these structures.

In summary, mitigation is, and will continue to be the priority of the Central U.S. Earthquake Consortium. While the challenge is formidable, the good news is that mitigation practices are "taking hold" in the member states. Several examples are featured in this edition of the *Journal.* At this point, it is perhaps most important to clearly define our mitigation priorities, identify and organize key decisionmakers and "stakeholders" who can advance mitigation in the Central U.S., and be prepared to take action when interest is high, particularly after a damaging earthquake in or near an urban area.

Mitigation to be the Theme of CUSEC Annual Meeting November 18-20, 1996

Mitigation will be the focus of CUSEC's 1996 Annual Meeting, to be held in Memphis at the Peabody Hotel. Topics to be addressed include the National Earthquake Program, Loss Estimation Methodology – Putting it to Work, Implemention Strategies, Financing Mitigation, Role of Business Councils in Mitigation, Marketing Mitigation, and Construction Quality, Education and Seismic Safety. For more information, please contact Jim Wilkinson at CUSEC.



EARTHQUAKE LOSS ESTIMATION:
THE BASIS FOR RISK REDUCTION PLANNING

The starting point for a community-based preparedness and mitigation program and strategy is an accurate assessment of the earthquake risk in the Central United States. In essence, *what is the vulnerability of our communities, homes and businesses to the effects of earthquakes? When an earthquake occurs, what will happen to our schools, hospitals, utility systems, roads and bridges – and the general public?*

Actual damages, losses and casualties from an earthquake will be depend on several factors, including: size, location and duration of the earthquake; type of construction; quality of construction; time of day that the earthquake occurs; economy of the region; and density of the population in the impacted region.

Risk assessment, then, is central to planning for earthquake mitigation, response and recovery. Officials in the public and private sectors are more inclined to invest in mitigation if they have reliable information on *potential losses* (economic and social) from earthquakes and other hazards, and the *potential benefits* – short term and long term – from adopting and implementing mitigation measures.

Acknowledging this, FEMA and the National Institute of Building Sciences (NIBS) have been working closely with CUSEC and other organizations to develop a user-friendly *risk assessment tool* that can be used by State and local officials and others to estimate potential losses from earthquakes. For a given magnitude earthquake, the "loss estimation methodology" will describe the scale and extent of damage and disruption that will result, including the following:

- *Quantitative estimates of losses*, including direct costs for repair and replacement of damaged buildings and lifeline system components; direct costs associated with loss of function (e.g., loss of business revenue); casualties; people displaced from residences; quantity of debris; and regional economic impacts.
- *Functionality losses*, including loss-of-function and restoration times for buildings, critical facilities such as hospitals, and components of transportation and utility lifeline systems and rudimentary analysis of loss-of-system-function for electric distribution and potable water systems.
- *Extent of induced hazards*, including fire, flooding, and hazardous materials releases.

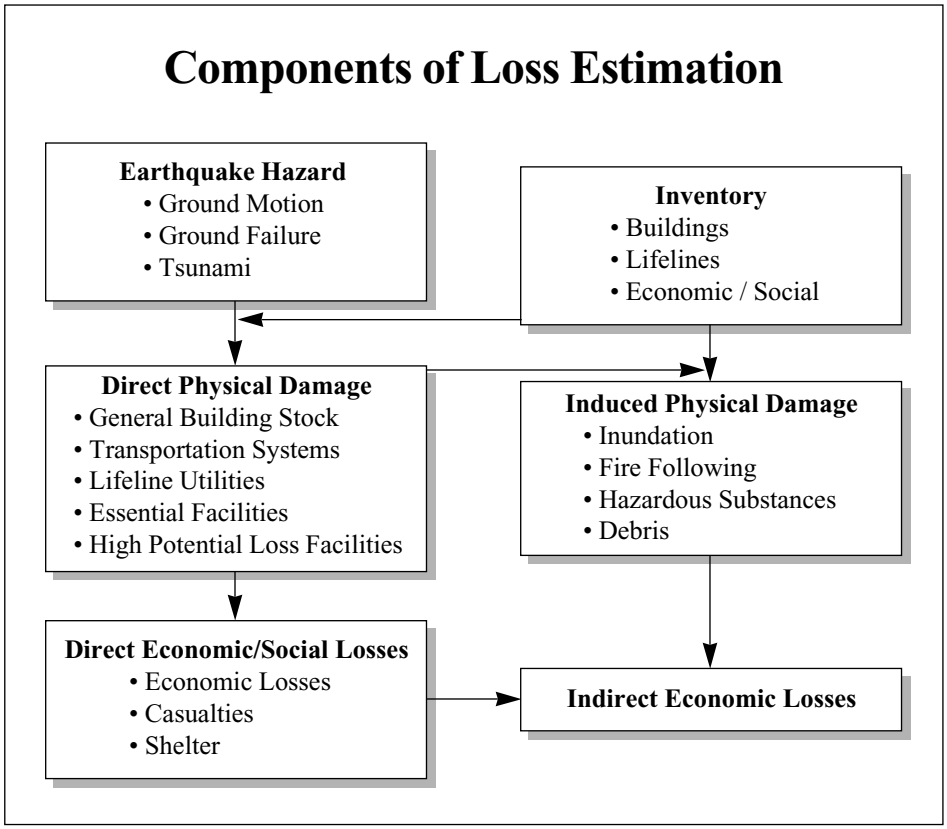
FEMA-NIBS LOSS ESTIMATION SOFTWARE PROGRAM

FEMA, through NIBS, has developed "HAZUS" – a software program that forecasts the level of damages and economic and human impacts that may result from future earthquakes.

The FEMA HAZUS loss estimation methodology uses mathematical formulas and information about building stock, local geology and the location and size of potential earthquakes, economic data, and other information to estimate losses from potential earthquakes. HAZUS uses a Geographic Information System (GIS) to map and display ground shaking, the pattern of building damage and demographic information about your community.

For example, the HAZUS user - perhaps a building official, city engineer, planning director, or emergency manager - may want to estimate the effects of a magnitude 6.8 earthquake with an epicenter near Marked Tree, Arkansas. Rough estimates can be made from information that will come with the software, and will allow the user to make a **Level One** analysis, including: an estimate of the number of buildings damaged, the number of casualties, the amount of debris generated, and the number of people displaced from their homes.

More accurate estimates of losses require more detailed information about a particular community. To produce a **Level Two** estimate of losses for a given community, the user will have to provide detailed information on local geology, an inventory of buildings in the community, and data on utilities and transportation systems.



The most accurate estimate of loss, a **Level Three** analysis, will require the user to provide detailed engineering and geotechnical input to customize the methodology to reflect the specific conditions of the community.

It is important to recognize that while the HAZUS software program is a powerful tool for estimating potential losses from future earthquakes, the *level of detail of analysis* is directly related to the *level of input* on building stock, soil conditions, and other variables. Such an effort might involve:

- Development of maps of soil conditions affecting ground shaking, liquefaction, and landsliding potential.
- Use of locally available data or estimates concerning the square footage of buildings in different occupancy classes.
- Preparation of a detailed inventory of all essential facilities.
- Development of inundation maps.
- Gathering of information concerning high potential loss facilities and facilities housing hazardous materials.

POTENTIAL APPLICATIONS

The HAZUS Loss Estimation software program is a significant development in the evolution of hazard and risk assessment in the United States. When completed, it will provide a broad range of users with a "state-of-the-art" tool for estimating losses from earthquakes, and eventually wind and flood hazards.

The ultimate value of HAZUS will depend on how extensively it is used, and by whom. By design, HAZUS is a flexible, versatile *decision support tool* that can be used by a variety of organizations and individuals for developing mitigation policy, for developing and testing emergency response plans, and for planning for post-disaster recovery and reconstruction.

Before an Earthquake: Mitigating Future Losses

HAZUS can be used by State and local decisionmakers to estimate potential losses for the purpose of developing short-term and long-term mitigation policies and priorities. Some examples of potential applications are provided.

Development of earthquake loss scenarios to illustrate dimension and complexity of the earthquake risk, locally and regionally.

HAZUS can become a very useful awareness and constituency building tool. A Level Two analysis can be used to demonstrate the effects of scenario earthquakes on buildings, lifelines, and people. This information can then be used to "set the stage" for an examination of mitigation options and priorities.

Demonstration of the costs and benefits, over time, of adopting and enforcing building codes, and the implementation of other mitigation measures.

HAZUS can be used to model "base line" losses for a given scenario earthquake, and then be used to estimate losses from future earthquakes based on the presence of seismic safety legislation, programs and policies. The strength of HAZUS is that it is a *dynamic and interactive* tool; it can be used to graphically depict cost-benefits of mitigation policy options. City managers, urban planners, building officials, public works directors, and budget analysts are among a key group of municipal officials who can be benefit from HAZUS loss estimation analyses.

Establishing mitigation priorities.

Loss estimates can provide land use and development agencies with a basis for planning, zoning, building codes and development regulations and policy that would reduce the risk posed by violent ground shaking and ground failure. Loss estimates can also be used to evaluate the cost effectiveness of alternative approaches to strengthening hazardous buildings.

Before an Earthquake: Preparing to Respond

To be effective and realistic, response plans and recovery strategies need to be based on accurate scenarios of damages and losses. The Loss Estimation Methodology will provide Federal, State and local planners and operations personnel with a level of detail that to date has not been available, including earthquake induced fires, flooding and hazardous materials releases. Already, the methodology is being used to support pre-disaster planning for multi-state response to earthquakes in the New Madrid seismic zone, as reflected below.

Provide loss estimation data to support the development of a Memphis/Shelby County Housing Recovery Plan.

The Loss Estimation Methodology is being used to provide CUSEC and other agencies with data on the number and distribution of potentially displaced persons in Memphis/Shelby County due to a 7.6 earthquake, as part of a major initiative to develop a Housing Recovery Plan. To ensure that the plan addresses the true nature and scope of the problem, CUSEC has turned to FEMA-NIBS for a *demographic profile* of the potentially displaced, including: number and distribution of displaced; ownership patterns of displaced population; number of single family and multi-family displaced; estimated recovery times by building types; functionality of electric power; and direct physical damage to essential facilities.

Provide loss estimates of a magnitude 7.6 earthquake for use in FEMA's CAT-97 Exercise.

The methodology is being used to generate potential impacts of an earthquake near Charleston, Missouri for use in preparations for CAT-97. Included in the CAT-97 scenario were loss estimates not previously available, such as a "summary of buildings to be inspected, by county." This information is critical to establishing priorities for building inspection, and in determining the number of inspection teams to be formed, trained and equipped.

COST OF HAZUS LOSS ESTIMATION CAPABILITY

There are three basic ingredients necessary for a HAZUS loss estimate: a computer system, data, and engineering and technical expertise.

The cost of a HAZUS estimate can vary depending on the level of estimate (**One, Two** or **Three)** being performed, the availability of data, the computer system available in your office, and the necessity and availability of technical expertise.

To run a **Level One** estimate, all that is required is the computer system described below and the MAPINFO and HAZUS software. HAZUS software will be available

to State and local governments from the Federal Emergency Management Agency, with a release date set for early in 1997. MAPINFO must be purchased to by the user; the costs vary, but are generally under $2,000. **Level Two** and **Level Three** estimates will require both detailed data and engineering and geotechnical expertise. The exact cost of using HAZUS is determined by your needs and the availability of data.

Computer Hardware and Software

- Intel 486 or greater (Pentium preferred) computer (the faster, the better)
- CD-ROM drive
- Gigabyte or greater hard drive
- Color printer or plotter
- Microsoft Windows 3.1 or greater software
- MAPINFO software

Data

- Default data provided in HAZUS
- Maps depicting local geology
- Building inventory data
- Inventory of utility systems, including water, sewer, power, telephone utilities
- Inventory of transportation systems

Engineering and Technical Expertise

- Structural engineers to customize building inventory for your community
- Geologists to interpret and/or provide geologic maps of your region
- Computer and/or GIS analysts to operate the system

In summary, the HAZUS Loss Estimation Methodology has great potential. FEMA-NIBS has given priority, from the outset of the project, to the development of a *user-friendly* methodology that has technical credibility. Currently, the software is undergoing a rigorous analysis through two pilot projects (Portland, OR, and Boston, MA), and two calibration studies. In the final analysis, the real value of the HAZUS Loss Estimation Methodology, at least in the short-term, may be its use as an *integrating tool* to bring together key disciplines that are essential to making the model work: geologists, building/urban officials, emergency managers, engineers, planners, and researchers.

Loss Estimation Outputs (Level 2)

Maps of seismic hazards
- Contour maps of intensities of ground shaking
- Contour map of permanent ground displacement
- Liquefaction probability
- Landslide probability

Characterization of damage to general building stock
- Structural and nonstructural damage probabilities by census tract building type and occupancy class

Transportation and utility lifelines
- For all components of all lifelines: damage state probabilities, cost of repair or replacement and expected functionality for various times following earthquake
- For potable water system: percent service reduction to serviced areas
- For electric power systems: probabilistic estimate of service outages

Essential facilities
- Cost of repair or replacement
- Loss of beds in hospitals and medical facilities

High potential loss facilities
- Location of dams
- Location of nuclear plants
- Location of military installations
- Others

Fire following earthquake
- Number of ignitions by census tract
- Percentage of burned area by census tract

Inundated areas
- Exposed population and exposed dollar value of facilities

Hazardous material sites
- Location of facilities with hazardous materials

Debris
- By weight and type of material

Social losses
- Displaced households
- Number of people requiring temporary shelter
- Casualties in four categories of severity

Dollar losses associated with general building stock
- Cost of repair or replacement
- Loss of contents
- Business inventory damage or loss
- Relocation costs
- Business income loss
- Loss of rental income

CUSEC Sponsors Loss Estimate Methodology Pilot Training

FEMA, the National Institute of Building Sciences, and CUSEC collaborated to conduct a pilot training program of the HAZUS Loss Estimation Methodology at a CUSEC workshop that brought together State Earthquake Program Managers, CUSEC State Geologists, representatives from the Earthquake Engineering Research Institute (EERI), and several local Memphis officials.

The purpose of the pilot training was to introduce the HAZUS Data Collection Module to a key group of users and to provide them with the "hands-on" experience needed to implement the software package in their respective agencies. The training program included the following sessions:

1. Installing MapInfo and the Methodology Software
2. Creating User-Defined Study Area
3. Navigating through the Methodology Software
4. Modifying the Default Inventory Data
5. Importing and Geocoding Existing Inventory Data
6. Creating New Inventory Data
7. Creating or Importing Soil and Geologic Hazards Maps
8. Selecting a Scenario Event
9. Creating, Editing, and Printing Maps
10. Performing Queries to Assess Hazard/Vulnerability Information

It was generally agreed that the software is *user-friendly*. This is important if HAZUS is going to be widely used by local governments and "non-computer-sophisticates." A technical manual will be available for users, to allow them to take advantage of the full range of potential applications.

SEISMIC HAZARD MAPPING

Seismic hazard maps show where earthquakes are likely to cause damage. They provide scientific information regarding expected future locations and probabilities of ground shaking and ground failure from earthquakes.

Seismic hazard maps are an important feature of any earthquake hazard reduction program. This information is vital for making decisions regarding the safety of new or existing buildings. Such maps also assist emergency response planners to identify the areas within their states and communities that are most vulnerable to earthquakes.

Earthquakes

An "earthquake" technically refers to trembling or strong ground shaking caused by the passage of seismic waves through the earth's rocky interior. These waves radiate away from a rupturing fault much in the same way that ripples in a pond spread outward from a splashing pebble. The waves decrease, or *attenuate*, with distance from the source.

Fundamental questions that earth scientists are researching include:

- *What causes a particular fault to rupture?*
- *How do seismic waves move or propagate through the earth?*
- *How do seismic waves and local geology interact to produce strong ground motions or damage to the earth's surface?*

There are two methods of evaluating the severity of an earthquake: 1) calculating the *magnitude*, and 2) estimating its *intensity*. The magnitude of an earthquake is related to the amount of seismic energy released at the quake's source. The magnitude scale most widely used is the Richter magnitude. Each unit of magnitude represents a 30-fold increase in energy. Of more interest to most people are the effects of a given earthquake – how hard it shakes, and over how wide an area.

A commonly used measure of ground shaking is the *Modified Mercalli Intensity Scale*. In contrast to magnitude, an earthquake's *intensity* is a highly subjective measure. It is a qualitative scale that describes the observable effects of earthquakes, such as structural damage and ground behavior, at a location. The MMI scale is useful because it describes damages in terms that people can understand and relate to – the degree of damage to structures and contents.

Mapping Seismic Hazards

Earthquake hazard maps can identify locations where earthquakes have occurred in the past, and will likely occur in the future. From knowledge of past earthquakes, the Applied Technology Council and the U.S. Geological Survey have developed maps of expected forces of earthquake shaking throughout the United States. These maps form the basis for the *seismic zonation maps* used in all the seismic building codes in the United States. The purpose of such maps is to identify large zones of common earthquake hazard. Each zone requires a specific level of building design and construction.

Missouri Produces Seismic Hazard Maps

Section 6 of the State of Missouri Geologic Preparedness Act requires the Missouri Department of Natural Resources to prepare a "Geologic Hazard Assessment" that identifies *high seismic risk areas*, described as those areas in the state that can be expected to experience an intensity of ground shaking equivalent to a Modified Mercalli Intensity VI within a fifty year period. In consultation with the State Emergency Management Agency, the Department of Natural Resources has prepared two maps: 1) *Earthquake Hazards Map of the St. Louis, Missouri, Metro Area* (1:100,000 scale, 1995), and 2) *Earthquake Hazards Map of Southeast Missouri* (1:300,000 scale, 1993). These maps show potential for severe and moderate liquefaction, soil amplification, landslide potential, and collapse potential. They are intended to be used by land use planners and regulators as a generalized guide to regional earthquake hazard potential, as well as a tool for emergency managers to support planning for response and recovery. For more information on these maps, contact the Missouri Geological Survey, P.O. Box 250, Rolla, MO 65401; (314) 368-2101; fax (314) 368-2111.

CUSEC STATE GEOLOGISTS: A TECHNICAL RESOURCE IN EARTHQUAKE RISK REDUCTION IN THE CENTRAL U.S.

The New Madrid region is the most seismically active area east of the Rocky Mountains. Since its inception, CUSEC has recognized the importance of basing its policies and programs on scientifically-sound information – and maps – of the seismic hazard. Against this backdrop, CUSEC approached the U.S. Geological Survey and the State Geologists from the seven member states to request their assistance in identifying, gathering, analyzing, and interpreting seismic hazard information. The objective was to put this information to use in planning for mitigation, response, and recovery. In 1992, the CUSEC State Geologists were organized, with funding from USGS, and since that time, have become an integral part of CUSEC. The following article was written by **Paul B. DuMontelle**, recently retired from the Illinois State Geological Survey, where he served as the CUSEC State Geologists Project Coordinator.

Earthquakes occur in the CUSEC region every year. Many of these earthquakes are so small that they are only felt by people in the immediate vicinity of the quake, or their vibrations are recorded, using highly sensitive instruments. If earthquakes in the New Madrid region are so small, why do we have anything to be concerned about?

Geologists, geophysicists, and seismologists assure us that large earthquakes are possible and could cause severe damage and loss of life. Through the work of CUSEC, the CUSEC State Geologists and the USGS, there is a growing awareness of the earthquake hazard and risk in the Central United States. In 1992, the CUSEC State Geologists were formed, and their activities were guided by the following objectives:

1) To compile databases for seismic zonation studies and prepare regional and local seismotectonic maps.
2) To better communicate scientific results to the

nontechnical community.

3) To identify information and processes that will lead to improvements in land use and engineering construction practices.
4) To develop effective ways to deliver hazard information products and methods for hazard assessments in a usable format to those responsible for mitigating risk.
5) To develop methods to educate government officials, media and the public about the nature, extent, and likelihood of earthquake hazards.
6) To conduct regional courses to help local user groups and organizations in presenting hazard research results in a relevant format.

The CUSEC State Geologists have been working closely with CUSEC staff, member States, USGS, and others to develop and carry out programs that address these objectives. Key programs are discussed below.

CUSEC Mapping of Geologic Materials for Ground Response

Ground response is the behavior of soil materials above bedrock and beneath a given location of interest during an earthquake. Ground response varies considerably from place to place during an earthquake. It is the aspect of earthquakes that controls location of the great majority of damage that occurs in a quake. In mitigating earthquake risk, ground response is of far more significance than the particular location of the specific fault that generated the earthquake. By characterizing the ground response quantitatively or qualitatively, the maps provide powerful tools for the mitigation of the earthquake risk.

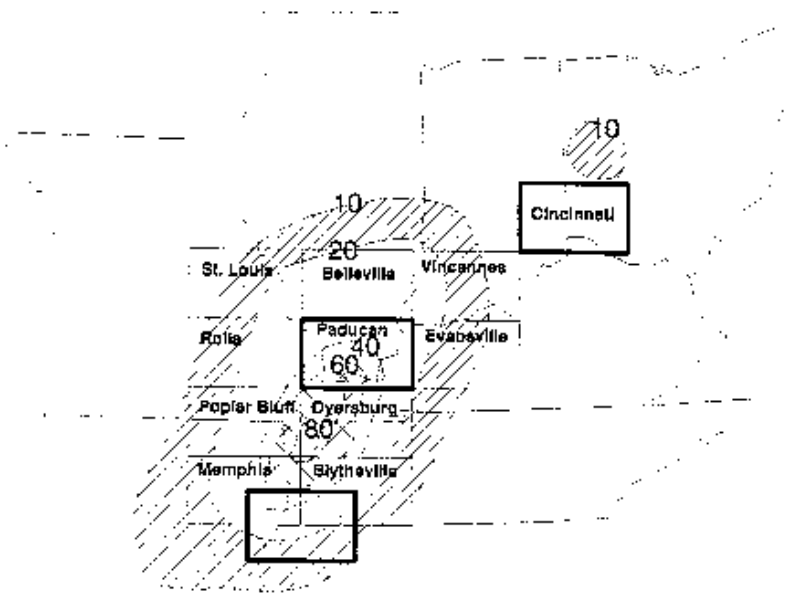
The CUSEC State Geologists are collaborating to map the geologic hazards and produce a series of geologic hazard maps. When completed, these maps will have numerous general applications. For example, the maps and supporting data can be used by emergency managers to generate earthquake scenarios for earthquake response and recovery exercises. The maps can be also be combined with building inventories and statistical data, and used by regional and local planning groups, utilities, and other agencies to guide them in decision making on land use issues, mitigation options, and a variety of other uses.

This year, the first geologic hazard map was coordinated and published by the CUSEC State Geologists. The mapping was funded by the USGS through a grant to CUSEC as part of a contract under the National Earthquake Hazard Reduction Program. The map depicts the seven states at a scale of 1:2,000,000 and shows areas of greater or lesser potential for enhancement of shake and/or liquefaction. Mapping at the next larger 1:250,000-scale map series is now underway. These maps are designed to be used by State agencies and others as geologic input into the FEMA Loss Estimation Methodology Program.

Currently, the CUSEC State Geologists are mapping the Paducah quadrangle, which covers most of Southern Illinois. The first draft of this map is in review and publication is scheduled for October, 1996.

CUSEC Earthquake Prediction Evaluation Council

Everyone remembers Iben Browning and his earthquake "prediction" in 1991. As that episode demonstrated, an earthquake prediction can raise public concern, and place considerable pressure on government agencies and the scientific community to take action. Clearly, a mechanism is needed to evaluate any future predictions. In recognition of this, a CUSEC Earthquake Prediction Evaluation Council (CEPEC) was organized by the CUSEC State Geologists to address this issue. In April, this Council of eminent seismologists and geologists met for the first time in St. Louis. Now, any earthquake prediction that develops credibility leading toward possible public activity will be reviewed and evaluated by CEPEC. Subsequent action by the public can then be based on scientific merit, and hopefully not emotion and unnecessary concern about the unknown.



Map shows the 1 x 2 degree named quadrangles superimposed over the newly proposed USGS probability mpa showing peak acceleration (%g) with a 2% probability of exceedance in 50 years. Heavily outlined quadrangles are currently being mapped for seismic amplification by the CUSEC State Geologists.

Rapid Response Program

Although much of what we know about earthquakes is learned by detailed geologic mapping, geologists and geophysicists gain some of the best knowledge through ongoing monitoring of earthquake events. The difficulty is in getting equipment and scientists to the epicenter and deployed in time to record valuable information. CUSEC State Geologists, the USGS, universities, and National Laboratories are now participating in a regional program to share equipment and expertise to quickly monitor aftershock data. Even medium-size earthquakes can result in equipment from New York reaching the epicenter within 24 hours. If successful, this program will be the first time institutions from throughout the region have achieved this level of cooperation.

In summary, the CUSEC State Geologists can become an important "scientific arm" of CUSEC and member states as we collectively move ahead in our efforts to promote earthquake risk reduction in the New Madrid region. In the coming months, we will be assisting in scenario development for CAT-97, a Federal exercise that is based on a 7.6 earthquake in the New Madrid Seismic Zone. The CUSEC State Geologists will also be active in promoting and sustaining a Mitigation program in the seven state region. Mapping the seismic hazard, and the buildings and lifelines that sit on top of this seismic hazard, is the starting point. The next step is to develop a series of earthquake *probability maps* and large 1:24,000-scale geologic ground response maps of the population centers in the Central U.S. This program, which will get underway in the Spring, 1997, will be a key contribution to a successful loss reduction program in the Central United States.

USEFUL PUBLICATIONS

Seismic Hazard Mapping. *Central U.S. Earthquake Consortium. Robert Olshansky, editor. 1994. 26 pp. $5.00. Available from CUSEC, 2630 E. Holmes Road, Memphis, TN 38118. (901) 345-0932. Fax: (901) 345-0998.*

This booklet, another in the CUSEC series on *Reducing Earthquake Hazards in the Central U.S.,* is a useful primer on seismic hazard mapping, with emphasis on the use of seismic hazard maps in the Central U.S. to support earthquake risk assessment and mitigation programs and measures.

Reelfoot Lake formed by a series of great earthquakes in 1811-12.

LOCAL EARTHQUAKE MITIGATION PLANNING

Hazard mitigation is largely a local responsibility. The following article, by **Robert Olshansky**, Department of Urban and Regional Planning at the University of Illinois, Urbana-Champaign, outlines an approach to hazard mitigation planning that can guide local government efforts.

Reducing the earthquake risks in your community may at first seem to be an impossible task.

Your time and resources probably are limited, and thinking of all the potential dangers existing in your town can be overwhelming. Yet, with a little bit of thought and initiative, every community, whatever the size, can begin to plan for long-term seismic safety.

What should a local mitigation plan look like? Plans can vary, depending on local conditions, but most should address the following: the earthquake hazard to the community, vulnerability of existing buildings, vulnerability of existing lifeline systems, and possible actions to improve the safety of both existing and future buildings. The plan should involve all agencies of the municipal government – planning, building, public works, emergency management, city manager,

community redevelopment – and it should include key citizens and organizations in the community.

Identify the Hazard

The first task of the mitigation plan is to clearly define the problem, so that the rationale for the plan is apparent to all parties. First, the plan should say something about the potential for earthquakes. What is the largest plausible earthquake that could occur in this area? What are the chances of it occurring? What are the chances of smaller, but still damaging, earthquakes occurring? Where are the various seismic sources in the area? How much might it shake in our community? Second, the plan should identify any problematic soil conditions that could increase the effects of the earthquake by causing liquefaction, enhanced ground shaking, or landslides. A map of such areas in the community would be a valuable contribution to the plan.

Assess Vulnerability of Existing Buildings

At a minimum, every community should complete a seismic safety inventory of existing buildings, particularly public structures and buildings with high occupancy. Fortunately, a simple, feasible, affordable method exists, outlined in the CUSEC publication, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Guide for Communities in the Central United States*. This method, known as ATC-21, can be used by local building officials and emergency service personnel to survey the buildings in their communities. It can be done gradually over time, as other duties permit. The State of Illinois, for example, has used engineering graduate students for several summers to survey public structures in the southern part of the state.

Assess Lifeline Systems

The public works or engineering department in the municipality should identify vulnerable elements in public lifeline systems providing water supply, sewage service, and transportation. Utilities providing electricity, gas, and communications services should do the same. In addition, the community should assess the vulnerability of other vital services: fire, police, and medical. The plan should estimate the consequences of failure of these systems, as well as their interactive effects (e.g., water system failure would impede fire-fighting capability).

Identify Actions to Improve Community Safety

It is relatively easy to identify hazards in the community, as outlined above. More difficult is to find the time and resources to correct the problems. The key is to tackle the problems one step at a time, using the information you have gathered to help establish priorities. Highest priority actions are likely to include:

- Seismic building codes. Communities need to adopt and enforce seismic building codes to ensure the safety of all new construction. Development review processes should involve all relevant city departments, and should include review of site characteristics.
- Strengthen or rebuild critical structures. Structures may be termed "critical" because they support emergency services after an earthquake (lifelines, police and fire stations, hospitals), pose hazards if damaged (dams, toxic material storage), or house vulnerable populations (schools, nursing homes). As funds become available, these structures must have top priority for structural improvement or replacement.
- Develop programs to encourage reduction of nonstructural hazards. Nonstructural hazards include everything not part of a building's basic structure. They include ceiling tiles, wall panels, heating systems, file cabinets, computers, water pipes – in short, all the elements that make the building function. Nonstructural damage can injure people and can halt the business of the building's occupants. Programs should especially target schools, hospitals, and other critical structures.

Loss Estimates: For Response, Recovery, and Mitigation Plans

A fine line separates the planning requirements for mitigation, preparedness, response, and recovery. All of these planning goals share a need for the first planning steps identified above: identify the hazard, and assess vulnerability of existing buildings and lifelines. These are the ingredients of a *loss estimate.*

What would happen throughout the community as a result of a reasonably expected large earthquake? A loss estimate can reveal where to emphasize emergency resources, how many people to shelter, and where weak links in critical facilities might cause problems. Similarly, a loss estimate also provides the basis for preparing a long term recovery plan. Less well-recognized is that a loss estimate also reveals which structures are most in need of mitigation.

A loss estimate is a vital tool in determining mitigation priorities. A community need do only a few response and recovery exercises before it realizes that the same buildings seem to fall down in every earthquake scenario. Fixing them might be better than enlarging the county morgue. The best emergency plan is a mitigation plan – one that reduces the need for post-disaster response. What every community really needs is an *integrated earthquake safety plan, which* places mitigation at the top.

A new method for estimating earthquake losses will soon be available to communities. Called the *Standardized Earthquake Loss Estimation Methodology*, this method is being developed by the National Institute of Building Sciences, under contract to FEMA, and will be available within the next year. Designed to run on desktop PC's, this software will give all local governments the capability to perform their own loss estimates. The software will offer several options, so that even data-poor communities can prepare rough estimates. But the better the input data, in terms of geologic hazards and building stock, the more accurate the results.

A Hierarchy of Mitigation Choices

Mitigation is important, because, if done well, it can dramatically reduce the size of a future disaster. But priorities depend not only on importance, but also on available resources. To that end, I suggest the following hierarchy of mitigation choices for local governments in initiating an earthquake safety planning effort:

Essential

Collect information regarding:

- Geologic hazards (regional seismic sources and local ground characteristics)
- Structural vulnerability (especially critical structures)
- Lifeline vulnerability
- Nonstructural vulnerability (especially critical structures)
- Code enforcement and plan review procedures for new structures

Essential

Prepare loss estimates for a range of probable earthquakes (this also forms the basis for response and recovery planning)

Necessary

Use the information and loss estimates to:

- Prioritize repair/replacement (especially critical structures)
- Prioritize nonstructural efforts (especially critical structures)
- Improve code enforcement and development review

Necessary

Integrate the information into:

- Comprehensive land use plan
- Capital improvement plan and critical facility siting process
- Maintenance activities
- Disaster response and recovery plans

Desirable

Develop or support programs to:

- Strengthen existing buildings
- Reduce nonstructural hazards
- Plan for long term post-disaster recovery
- Prepare more detailed hazard maps
- Complete more detailed structural vulnerability inventories

In summary, there are a range of mitigation options available to local governments. It is important to start with a few "success stories;" that is, identify local initiatives that can be implemented, and that can serve as catalysts for future mitigation programs and strategies at the local level.

SEISMIC BUILDING CODES

Arguably the most important single step that local governments can take to minimize future damages and casualties from earthquakes is to adopt and *enforce* building codes. Recent earthquakes reinforce a central fact: communities that adopt and enforce building codes fare much better than those communities that do not. The 1988 Armenia earthquake, which measured 6.8 on the Richter scale, left 25,000 dead. A similar sized earthquake in California (Loma Prieta, 1989) – where seismic codes are largely in place – resulted in only 60 deaths.

Definitions

A building code is a set of legal requirements intended to ensure that a building is so located, designed, and constructed that, if it is subjected to natural or man-made destructive forces, it will present no significant threat to the life, health, or welfare of its occupants or the general public. In addition, a code is intended to ensure *uniform minimum standards of health and safety* with reasonable economy and to obviate the need for expensive and difficult studies for every building project, large or small.

Seismic codes are intended to protect the safety of a building's occupants during and immediately following an earthquake. They are designed to save lives and reduce injuries, not to prevent property loss. Their purpose is to allow for safe evacuation of a building. Seismic provisions attempt to prevent general failures (collapse of non-critical sections). Therefore, a building in compliance with the code probably will not collapse, but it may be rendered unfit for continued use. This highlights the fact that seismic codes are only minimum design standards.

To Regulate Design and Construction or Not?

Increasingly, community leaders are faced with decisions on whether to introduce into the building regulatory process new or more stringent seismic design and construction requirements. In the Central United States, these decisions are influenced by a number of factors: compelling evidence that a damaging earthquake will occur in the next 50 years (the lifetime of any new building that is constructed today); a desire among the states to attain – and maintain – a competitive edge in recruiting new industries and jobs, and the prevailing "belief" that building regulations will serve as impediments to recruitment efforts; and the fact that community leaders in the New Madrid seismic zone have never experienced an earthquake, therefore are less inclined to make changes in the *status quo.*

> *"Recent earthquakes reinforce a central fact: communities that adopt and enforce building codes fare much better (after a quake) than those communities that do not."*

Within the seven charter member states of the Central U.S. Earthquake Consortium, code coverage varies. Arkansas, Indiana, Kentucky and Tennessee have comprehensive statewide building codes. The remaining states, Illinois, Mississippi, and Missouri have codes that regulate some aspects of buildings. Missouri has a seismic design requirement. In Illinois, over 300 communities have adopted the Building Officials and Code Administrators (BOCA). Typically where there is no comprehensive statewide building code, the State regulates through individual standards some of the following: fire safety, building accessibility, manufactured housing, health facilities, schools, and plumbing.

What then, are the major concerns about seismic code provisions?

1. *Do seismic code requirements really make a difference in an earthquake?*

Although there is no definitive study that quantifies the effectiveness of seismic codes (for example the number of lives saved and injuries prevented), experience in recent earthquakes provides convincing evidence that properly designing buildings to meet a modern seismic code will dramatically reduce the impact of an earthquake. An oft cited example is the Field Act, enacted in California following the 1933 Long Beach earthquake that caused heavy damage to 75 percent of the public school buildings in that city. Thelegislative response – the Field Act – required that future public school buildings be designed and constructed with sufficient earthquake resistance to protect occupants from death or injury. Since 1933, no students or teachers have been killed or injured in a post-Field Act school building during an earthquake. In the 1994 earthquake in Northridge, California, no public school suffered even partial collapse. Furthermore, no structural elements such as beams or columns failed and fell to the floor.

The implications for the Central United States can be summarized as follows: There is an estimated 90 percent probability of a damaging earthquake – in the magnitude 6.0 to 6.5 range – in the next 50 years, which corresponds to the lifespan of all new buildings. Given the evidence that seismic provisions in building codes have been a significant, contributing factor to reduced injuries and deaths in earthquakes, it follows that all new construction in high seismic risk areas of the Central U.S. meet at least a minimum standard of seismic design and construction, depending on the facility, its

Illinois Ties Seismic Design Training to Licensing for Design Professionals. The Structural Engineering Licensing Act of Illinois was recently amended to require submittal of satisfactory evidence of seismic design knowledge as a condition of renewal of licenses for those who design buildings, including structural engineers and architects. To provide engineers and architects with the knowledge and skills to conduct technical analyses, BOCA International is conducting seismic design courses. This Act is an important development in the ongoing effort to ensure that new construction has appropriate seismic design.

function, and the number of occupants.

2. *Does seismic design and construction cost alot?*

Although the purpose of seismic design is to save lives and prevent injuries, the decision to design against earthquakes and to establish seismic design standards is often based on economic considerations: By how much can we afford to reduce the risk of damage to our buildings? New construction can be very expensive to build and operate; the economics of seismic design can be critical. In fact, in the Central U.S. and elsewhere, it is widely believed that seismic design and construction are extremely costly. What are the actual figures?

An analysis of information supplied to the Building Seismic Safety Council (BSSC) in 1985 indicates that the design and construction costs associated with theseismic upgrade of the structural components of a building *will increase the total cost of a building by an average of less than 2 percent.* While these estimates were made on the basis of somewhat limited data, and will vary from region to region, the point can be made: it is technically feasible to incorporate seismic safety into new buildings at a "reasonable" cost. The major factors influencing the increased costs of seismic design include:

- *The complexity of the building form and structural framing system*. It is much more economical to provide seismic resistance in a building with a simple form and framing.
- *The overall cost of the structural system in relation to the total cost of the building.* For a typical building, the structural system usually represents between 10 and 15 percent of the building cost.
- *The stage of design at which increased seismic resistance is considered.* The cost of seismic design can be greatly inflated if no attention is given to it until after the configuration of the building, the structural framing plan, and the materials of construction have been selected.

How to Adopt Seismic Codes

The process of adopting statewide seismic requirements will vary greatly among states, depending on whether your state is one of the 29 states with building code requirements, or one of the 21 states without mandated building codes. Following are some basic steps that need to be followed in adopting seismic codes.

Step 1: *Find out if your state currently has a building code requirement.* If so,

- Is it legislative or administrative?
- State pre-emption or local choice?
- Unique state code or model code?
- Which model code? Has your state modified it?
- Which edition is currently adopted?
- How is it updated? How often? By what decision body?
- Does it have seismic provisions?
- Do the seismic provisions reflect the latest National Earthquake Hazard Reduction Program (NEHRP) recommendations?

Step 2: *If your state has a building code, but has no seismic provisions, then add seismic provisions.*

- If the state code is based on one of the model codes (Uniform Building Code, National Building Code, Standard Building Code), each now has seismic requirements.
- Find out about your state's existing process of code adoption, whether administrative or legislative.
- If *administrative*, find out when the review is scheduled, and the opportunities for public comment.
- If *legislative,* it will be necessary to find a legislator to sponsor an amendment to the state building act.

Step 3: *If your state does not require building code requirements, then it is important to enact a statewide code.*

- A new code requirement can be established legislatively or administratively. To provide long-term assurance of safe building practices, legislative enactment is preferable, because it is more difficult to amend or repeal.
- The legislation should specify local adoption of one or the three model codes. To assure a minimum level of safety throughout the state, the legislation must also specify a procedure for periodic code updates.

In summary, building code adoption *and enforcement* are critical components of a long-term strategy to reduce the vulnerability of our communities to earthquakes and other potential hazards. For this reason, CUSEC is placing greater emphasis on code adoption, and enforcement procedures.

As we have discovered in the Central U.S., it is one thing to adopt a building code; it is another thing to make a

CUSEC Co-Sponsors Training Course for Building Officials. A two-day training course has been developed for building officials in the Standard Building Code region (NC, SC, MS, TN, AR) who are now required to enforce the new seismic provisions in the 1994 Standard Building Code. The overall objectives of the course are:

1) To raise the level of awareness and knowledge of building officials of their role and responsibilities in enforcing seismic provisions of building codes;
2) To increase the level of understanding of the technical and administrative aspects of building code adoption and enforcement; and
3) To identify strategies for building and maintaining State and local constituencies, including political, to support the enforcement of building codes.

This course was put together over an 18-month period by a team represented by CUSEC, FEMA, Building Seismic Safety Council (BSSC), Insurance Institute for Property Loss Reduction (IIPLR), and the Southern Building Code Congress International (SBCCI). Instructor teams will consist of State earthquake program managers, and SBCCI instructors. This team approach is designed to foster a closer working relationship among hazards managers and codes officials.

After pilot sessions in Charleston, SC and Memphis, TN, the course is ready to be deployed. If your community is interested, contact your Earthquake Program Manager, listed in the back of this issue of the *Journal.*

commitment to *enforcing* the codes. This means that: 1) the local code must be up-to-date; 2) All buildings requiring permits must obtain one; 3) Buildings must be designed to the minimum standards of the code; be reviewed carefully by a qualified plan inspector; be inspected by a qualified inspector, one who knows how to look for construction of seismic standards.

Central U. S. Building Departments To Be Rated. In response to the escalating property and commercial losses from hurricanes, earthquakes and other disasters, the insurance industry is implementing a system that will measure resources and support available to building code enforcement efforts in municipalities across the nation.

The premise of the Building Code Effectiveness Grading Schedule is that municipalities with effective codes that are well enforced should experience – relatively speaking – fewer disaster related losses, and therefore should receive more favorable underwriting recognition.

The new code grading system, which is patterned after the Fire Suppression Rating Schedule and the Flood Community Rating System, examines how well local resources are applied to mitigating common natural hazards, particularly earthquakes and hurricanes. The grading process includes interviews with municipal officials, examination of supporting documents, a careful look at training requirements and work schedules, staffing levels, and certification of officials who enforce building codes.

The Building Code Effectiveness Grading Schedule will be implemented in phases. The first phase, which targeted Florida, North Carolina, and South Carolina, is complete. Several CUSEC states, including Arkansas, Missouri, Illinois, Kentucky and Tennessee, are scheduled for Phase 3, to begin in 1997. Indiana will be reviewed in 1998. For further information on the grading schedule, contact *Dennis Gage, ISO Commercial Risk Services, 2 Sylvan Way, Parsippany, NJ 07054. (201) 267-0359.*

USEFUL PUBLICATIONS

Seismic Considerations for Communities at Risk. (FEMA 83/September, 1995). *Available from the FEMA Distribution System, P.O. Box 2012, Jessup, MD 20794. (800) 480-2520.*

Building codes are addressed in this handbook for State and local officials who are interested in developing and implementing a community based seismic safety program. A step by step approach is set forth, starting with the basic question, "*Is my community at risk?" and "What happens to structures when the ground moves?"* The chapter on *Codes, Standards, and NEHRP Recommended Provisions* covers the basics of building codes, their function, and key questions that local officials must address in considering whether to adopt and enforce seismic building codes. The appendices contain additional sources of useful information to assist community officials in establishing a seismic safety program in their jurisdiction.

Seismic Building Codes. *Central U.S. Earthquake Consortium. Robert Olshansky, editor. 1994. 69 pp. $5.00. Available from CUSEC, 2630 E. Holmes Road, Memphis, TN 38118. (901) 345-0932. Fax: (901) 345-0998.*

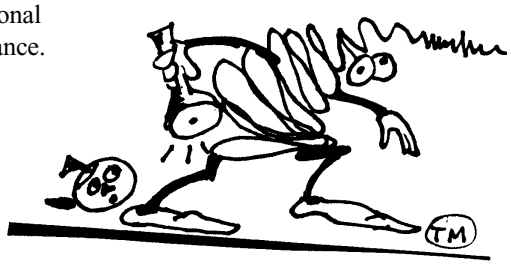
This manual, written for State and local officials who have the authority to adopt and enforce building codes, is an excellent primer on building codes. Sections include: the history of building codes; who uses codes; how seismic codes have evolved; the principles of seismic design; the relative effectiveness of seismic codes; and current seismic design practices in the Central U.S. The final chapter outlines a practical step-by-step process for adopting seismic building codes, with recommendations for State and local strategies, and sources for additional information and technical assistance.

Enforcing Sound Construction: Opinions of Building Code Officials in Administering and Enforcing Building Codes. *1995. 28 pp. $10.00. Available from the Insurance Institute for Property Loss Reduction, 73 Tremont Street, Suite 510, Boston, MA 02108-3910. (617) 722-0200. Fax: (617) 722-0202.*

This survey of building department administrators of the Southern Building Code Congress International (SBCCI) – a model building code organization that serves southern states – was intended to find out how these officials felt about their jobs, and their level of support (financial and political). Nearly half felt that they were understaffed and under funded to adequately complete their work. These findings are consistent with other survey findings on building code officials. The results reinforce the need for targeted programs that upgrade the building departments in the SBCCI region.

Summary of State Mandated Codes. *April, 1996. 6 pp. Available from the Insurance Institute for Property Loss Reduction, 73 Tremont Street, Suite 510, Boston, MA 02108-3910.*

This is an updated and expanded edition of IPPLR's compilation of major building code provisions throughout the United States. Tables provide useful building code information on each state, including: state code name, basis (e.g., which model code), edition (e.g., year), occupancies (16 categories of use), whether the code covers retrofit, whether building officials and contractors are licensed, and whether code provides for local amendments.



MEMBER STATES	STATE CODE NAME	BASIS*	EDITION	OCCUPANCIES (See Key) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Arkansas	Arkansas Fire Prevention Code	SBC	1991	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Illinois	State (plumbing only)[1]	State	1993										•						
Indiana	Indiana Building Code	UBC	1991	•	•	•	•	•	•	•	•	•	•	•	•	•	•		
Kentucky	Kentucky Building Code	NBC	1993	•	•	•	•	•	•	•	•	•	•	•	•	•	•		
Mississippi	None																		
Missouri	None[2]																		
Tennessee	SBC	SBC	1994		•	•		•	•	•	•	•	•	•	•	•	•		
ASSOCIATE STATES																			
Alabama	Alabama State Code	SBC	1994							•	•	•	•		•	•	•		
Georgia	GA State Min. Std. Bldg. Code	SBC	1994	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Iowa	Iowa State Building Code	UBC	1991						•			•							
Louisiana	State Uniform Construction Code	SBC	1991		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Nebraska	State Fire Marshall Act	UBC	1979					•											
N. Carolina	State Building Code	SBC	1994	•	•	•	•	•	•	•	•	•	•	•	•	•	•		
Ohio	Ohio Basic Building Code	NBC	1993			•	•	•	•	•	•	•	•	•	•	•	•		
Oklahoma	Title 61, Oklahoma Statutes	NBC	1993									•							
S. Carolina	SBC	SBC	1991	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Virginia	VA Uniform Statewide Bldg. Code	NBC	1993	•	•	•	•	•	•	•	•	•	•	•	•	•	•		

Source: Adapted from *Summary of State Mandated Codes*, Insurance Institute for Property Loss Reduction, April, 1996.

[1]*Illinois has an Executive Order that applies to the construction of all State owned, leased, or regulated buildings. In addition, over 300 communities in the state adopted NBC standards.*

[2]*Most communities follow either NBC (e.g., St. Louis) or the Uniform Building Code (e.g., Kansas City). In addition, Missouri's Geologic Hazard Preparedness Act (S.B. 539) contains requirements for seismic design for those counties that are expected to experience Modified Mercalli intensities of VII or greater from a magnitude 7.6 earthquake.*

Arkansas' Act 1100. In March 1991, the Arkansas General Assembly chose to emphasize the importance of seismic design by enacting Act 1100, "An Act to Safeguard Life, Health and Property by Requiring Earthquake Resistant Design for all Public Structures to be Constructed or Remodeled within Boundaries of this State Beginning September 1, 1991." The Act requires that all "public structures" (buildings open to the public, as well as all public works) be designed to resist seismic forces, in accordance with the 1988 Standard Building Code (SBC) or latest edition. The structural design must "be performed by a professional engineer registered in the State of Arkansas who is competent in seismic structural design according to current standards of technical competence." Structural plans must be signed and sealed by a professional engineer. The Act does not apply to residential structures of four units or less, nor to agricultural structures.

Another key element of the Act is that is specifies a penalty of $1,000 per day of violation. There is no such penalty for violating building codes.

Although the state already has a building code, Act 1100 legislatively underscores that the State requires seismic design, establishes zones more specific than those in the SBC, is self-updating by the most recent published SBC, and sets forth penalities for non-compliance.

DOES CODE COVER RETROFIT?	ARE BUILDING OFFICIALS LICENSED?	ARE CONTRACTORS LICENSED? New Const.	Retrofit Const.	Major Const.	Other Const.
Yes	No	No	No	Yes	
Plumbing only	No	No	No	No	
Yes	No	Plum	Plum	Plum	
No	Yes	No	No	No	Some
No	No	No	No	Yes	
No	No	No	No	No	
No	Yes	Yes	Yes	Yes	Yes
No	No	Yes	Yes	Yes	Yes
No	No	No	No	No	Yes
No	No	Yes	Yes	Yes	
No	No	No	Yes	Yes	
No	No	No	No	No	
No	Yes	Yes	No	Yes	
Yes	Yes	No	No	No	
Yes	Yes	Yes	Yes	Yes	Yes
No	No	Yes	Yes	Yes	Yes
No	No	Yes	Yes	Yes	

*MODEL CODE UPON WHICH STATE CODE IS BASED

NBC - National Building Code - Building Officials & Code Administrators

UBC - Uniform Building Code - International Conference of Building Officials

SBC - Standard Building Code - Southern Building Code Congress, Int.

KEY TO OCCUPANCIES

1. 1 & 2 Family Dwellings
2. 3 or more Family Dwellings
3. Commercial Buildings (Low & High Rise)
4. Condominiums
5. Hi-Rise Condominiums
6. Manufacturing Buildings
7. Pre-engineered Buildings
8. Public Buildings - Local Government
9. State Buildings
10. Schools
11. Hospitals
12. Hotels & Motels
13. Auditoriums
14. Theaters
15. Farm Buildings
16. Farm Storage Buildings

Shaded area - Building Code covers all occupancies

CUSEC AND EERI: OPPORTUNITIES FOR COLLABORATION

The Earthquake Engineering Research Institute (EERI) recently established a New Madrid Chapter to further the development and dissemination of knowledge on the problems of destructive earthquakes in this part of the country. This article was written by **Alan Scott**, EQE, St. Louis, who was elected as the first President of the New Madrid Chapter.

The formation of the New Madrid Chapter of the Earthquake Engineering Research Institute presents a number of opportunities for closer collaboration between EERI and CUSEC in a mutual effort to reduce the vulnerability of this region to damaging earthquakes. This article briefly describes EERI, and outlines several areas of potential collaboration with CUSEC.

The Earthquake Engineering Research Institute, founded in 1949, is the principal nonprofit society of engineers, geoscientists, architects, planners, public officials, and social scientists concerned about earthquakes and their effects. The activities of the Institute are guided by two main objectives: 1) The advancement of the science and practice of earthquake engineering; and 2) The solution of multidisciplinary problems in order to protect people and property from the hazardous effects of earthquakes.

To further the advancement of earthquake engineering research and practice, EERI sponsors seminars, conferences, and symposia, providing formal and informal opportunities for members and others to exchange knowledge on earthquake hazards reduction.

The Institute is also engaged in a variety of technical activities, including investigations of destructive earthquakes, technical workshops, and coordination of research on problems in earthquake engineering. Since it inception, EERI has conducted more than 200 post-earthquake investigations for the purpose of improving the science and practice of earthquake engineering and earthquake hazard mitigation.

For many, EERI is known for its publications. It publishes a wide variety of works on earthquake engineering, including technical monographs, earthquake reports, conference proceedings, seminar notes, educational slide sets, and videotapes. A monthly newsletter and a quarterly journal – *Spectra* – are published for members.

Today, EERI has over 2500 members, worldwide. Three regional Chapters have

been created – Alaska, the Great Lakes region, and the newest one, the New Madrid region, chartered in November, 1995. It encompasses the states of Alabama, Arkansas, Kentucky, Mississippi, Tennessee, Southern Illinois, and Southern Indiana. The new Chapter, in its formative stages, is currently developing by-laws, preparing plans for presentations and seminars, and working with other organizations in the Midwest, including CUSEC, that have a role and vested interest in earthquake risk identification, mitigation, and planning.

Representatives of the New Madrid Chapter met with CUSEC and member states during the Earthquake Program Managers meeting on March 27-29, 1996. The purpose of the meeting was to investigate ways that EERI and CUSEC can collaborate. Several opportunities for collaboration were identified, including:

1. Jointly sponsor technical seminars in the region. There is an emerging "critical mass" of earthquake expertise in the Central U.S. – engineers, planners, architects, emergency managers, insurance representatives, building officials, and others. Technical and non-technical seminars are one way of bringing this expertise together to address common problems, to examine current "state-of-the-art" practice to address these problems, and to otherwise share experiences and expertise in the field of earthquake risk reduction.
2. Jointly sponsor post-earthquake briefings, after major damaging earthquakes. These briefings have been popular in the past. Reconnaissance team members have an opportunity to share observations and lessons learned with local engineers, architects, building officials, and other disciplines that are involved in risk assessment, mitigation and response.
3. Jointly participate in one another's training programs, where expertise can be drawn from both the EERI and CUSEC organizations. For example, EERI members can participate in *Post-Disaster Safety Assessment Training (ATC-20),* conduced by CUSEC and member states, in an effort to develop teams of building safety inspectors that can be deployed following a major earthquake. EERI can also assist in the recruitment of engineers to take this training.
4. Share databases, mailing lists, newsletters, and other resources that can be used by each organization to reach a broader audience in the Central U.S. with quality products and services.

These are only a sample of opportunities for collaboration between two organizations that share mutual goal and challenge – to establish and expand a constituency of professionals in the Central U.S. who can work closely with one another to promote earthquake risk reduction in this part of the country.

EERI WHITE PAPER ADDRESSES CRITICAL ISSUES IN SEISMIC SAFETY

The Northridge earthquake underscored a well-recognized problem that has important implications for the Central U.S.: high costs associated with earthquake damages can be attributed in large part to poor quality in design, plan review, inspection, and construction. These findings are the focus of a white paper prepared by EERI, *Construction Quality, Education, and Seismic Safety* (April, 1996).

In an effort to improve the quality of seismically resistant construction, EERI's Endowment Fund Committee commissioned a study to examine why construction practices remain a key cause of earthquake damages. The focus quickly turned to the status of seismic resistance information in education programs provided to those who construct and inspect buildings. The objectives then became how to identify how these individuals are trained, what knowledge they need, what motivations exist for them to obtain training, and how best to deliver that information.

The major findings in the white paper include:

1. Seismic resistance is not currently a priority topic for building officials, inspectors, or the trades.
2. There is a lack of conceptual understanding of building performance in an earthquake.
3. There is inadequate communication among education providers.
4. Training materials are inadequate in content, and delivery methods are ineffective.
5. There is a lack of certification and continuing education programs.
6. There is a need for improved on-the-job training.

What do these findings mean for efforts in the Central U.S. to improve the ability of the built environment to resist earthquakes?

First, the findings clearly suggest that while it is important to educate design professionals, engineers and building officials, it is time to place a greater emphasis on teaching those who *implement* seismic design – tradespeople and building inspectors. Furthermore, the white paper recommends that such training programs:

- Provide a clear understanding of earthquake effects on buildings
- Link earthquake damage to specific job responsibilities
- Use hand-on approaches, involve practical application, relate to the "big picture," and focus on performance.

Construction Quality, Education, and Seismic Safety is a valuable contribution to the seismic safety field. The message is clear: we must do a better job of training those individuals whose work is directly linked to the performance of buildings in earthquakes.

EERI Announces Technical Seminar

The Earthquake Engineering Research Institute, in cooperation with CUSEC, will be conducting a Technical Seminar on September 25-26, 1996 at the Peabody Hotel, Memphis. The seminar will cover a range of topics of interest to engineers, architects, planners, building code officials, hazards managers, geoscientists, and other disciplines that have a role in earthquake mitigation and building seismic safety. For more information on the details of the seminar, please contact *Jim Wilkinson,* at CUSEC, or *Alan Scott*, EQE, (314) 726-1771.

SEISMIC REHABILITATION OF EXISTING BUILDINGS

Without exception, the downtown business districts in communities throughout the Central U.S. are made up largely of unreinforced masonry buildings. These buildings, many of which are local landmarks, add to the character and "soul" of our communities. Yet, these buildings also pose a significant hazard in an earthquake, since they were built prior to modern codes and not designed to withstand the forces of earthquakes.

A local strategy to reduce the risk of our communities to earthquakes should consider the options available to strengthen or *rehabilitate* existing buildings.

Why Address Existing Buildings?

The basic argument for the seismic rehabilitation of buildings is that strengthened buildings are less likely to fail during an earthquake, thereby resulting in fewer casualties, a lower demand on urban search and rescue teams, emergency medical services, emergency shelter, and other services.

From a commercial perspective, less damage to structures means that more businesses will survive an earthquake. Buildings and inventories will be better protected, business interruptions will be reduced, and business resumption times shortened. Recent disasters have shown that the pace of community recovery is closely tied to business and economic recovery.

From a governmental sector perspective, less damage to structures means that key government agencies that manage and coordinate State and local housing, human services, finance and administration, planning and community development, natural resources and other services – can resume normal operations in a more efficient manner, thereby expediting response and recovery.

In essence, an investment in the seismic rehabilitation or strengthening of hazardous buildings is an *investment in the resistance of these buildings and their contents against the effects of future earthquakes.* Seismic rehabilitation programs can save lives, reduce injuries, protect property, maintain continuity of business and industry, and preserve affordable housing and historic buildings. The following section examines the key decisions and actions that need to be taken to develop a seismic rehabilitation program.

Seismic Rehabilitation: A Step by Step Process

A step by step process can be followed by a community to develop and implement a seismic rehabilitation program.

Step One: Define the Problem

The first step is to assess the vulnerability of the building stock, focusing on those building types known to be hazardous. This vulnerability analysis in turn leads to a loss estimate, in which the potential dimensions of the problem, in lives lost, injuries, and economic losses can be assessed. The FEMA-NIBS Loss Estimation Methodology (HAZUS) can be an important tool for local jurisdictions in Step One. A vulnerability assessment can involve several organizations:

- CUSEC, State Geological Surveys, and U.S. Geological Survey can provide seismic hazard maps, and statements on seismic risk for the community or county.
- State emergency management agencies can provide information on hazardous structures, and provide assistance to local jurisdictions that want to undertake surveys of hazardous buildings.
- Planning and building departments can provide property tax assessment data identifying building characteristics, square footage, values, and owner names and addresses.
- Engineering consulting firms can provide statements on the vulnerability of building types.

Armed with information on the nature of the earthquake hazard, and the potential losses from earthquakes to a community's housing stock, business and industry, public facilities (including schools) and other building categories, a community can proceed to the next step – assessing the political, economic and social implications of developing a seismic rehabilitation program.

Step Two: Examine Political, Economic and Social Implications of Rehabilitation

Because rehabilitation deals with existing, and usually occupied buildings, it is important to examine – on the front end – some of the important political, economic and social factors that are associated with this approach to mitigation. This section examines some of these issues.

Economic Impacts

Seismic rehabilitation projects often affect the financial status of owners and tenants of the targeted buildings. It may lead to relocation of building owners, employees, commercial tenants, and residents. Rehabilitation strategies should minimize the disruption to owner operations, including continuous cash flow for debt service and operating expenses.

Surveying Critical Facilities: The Illinois Model

The Illinois Emergency Management Agency has carried out a comprehensive Critical Facility Survey in thirty southern Illinois counties, and is using this information as the basis for training and outreach programs. Using a method developed by the Applied Technology Council called, *Rapid Visual Screening of Buildings for Potential Seismic Hazards (ATC-21),* IEMA has developed a data base of more than 2,200 critical facilities (e.g., hospitals, schools, nursing homes, police stations, churches, and government buildings).

The data that has been collected is being put to use. Presentations have been made to local elected officials in thirty counties in southern Illinois, with the message that a local seismic safety program can start with *the adoption and enforcement of building codes* which have current seismic construction specifications – especially for construction of new schools, hospitals, and government buildings. The Illinois model has been examined by other CUSEC states for possible replication.

Direct and Indirect Costs

The costs of seismic rehabilitation will be a factor. Two cost categories need to be considered.

Direct costs include the cost of construction materials, labor, professional and building permit fees. Four major determinants of the direct costs of strengthening are: 1) the governing code; 2) the building characteristics (size, number of stories and configuration); 3) the particular structural design methods employed; and 4) the building occupancy or use.

Indirect costs include the costs that building owners pass on to tenants or customers and the costs of permanent or temporary relocation of tenants.

Social and Political Implications

A decision to pursue seismic rehabilitation of existing buildings *will* have social and political ramifications. It is important to anticipate the impacts of rehabilitation, the local groups that are likely to become involved, the costs of rehabilitation, the coalitions that will be for, and against, rehabilitation, and the media's reaction. Special attention needs to be given to historic buildings.

Step Three: Develop a Local Seismic Rehabilitation Strategy and Process

Assuming the seismic risk is perceived high enough to justify seismic rehabilitation of certain buildings, the next step is to develop a strategy that includes building priorities, and a process for engaging key groups in the decision making process.

Building Priorities

There are two main steps in setting priorities: the first is that of determining which *categories of building* will be the focus of the rehabilitation program. The second is that of determining priorities *within the selected building category.*

Two issues help determine the building categories that will be the subject of a seismic rehabilitation program: *1) Which structures are the most hazardous? and 2) What occupancies or building use?*

To date, most seismic rehabilitation programs have focused on one structural type – the unreinforced masonry building. These buildings are a major life hazard, whose seismic vulnerability is well documented. Unreinforced masonry buildings comprise up to three-fourths of the buildings stock in the downtown business districts of communities in the Central U.S.

The *occupancy* issue typically focuses on four occupancy characteristics.

- high occupancy (such as theaters and auditoriums)
- special occupancy (such as schools)
- essential facilities (such as hospitals, fire or police stations)
- buildings with hazardous contents or processes (such as chemical or other industrial plants).

Rather than developing a program relative to an identified hazardous building type (e.g., URM's), another approach is to target a single category of facilities – such as schools and hospitals – and develop a program that incorporates a combination of structural retrofitting, and rehabilitation of nonstructural components (computer equipment, light fixtures, ceilings, etc.).

Rehabilitation Program Types

Another decision that has to be made is, *what type of seismic rehabilitation program* is best suited for a given community? Based on experience with such programs, primarily in California, it is a given that seismic rehabilitation programs will: 1) entail direct costs (e.g., engineering evaluations, the rehabilitation itself, temporary relocation); 2) entail some degree of social disruption; 3) involve some degree of controversy. In the Central U.S., where there is little experience with seismic rehabilitation, it will prove inherently difficult to explain to the affected populations the earthquake risk, and the effectiveness and justification for rehabilitation. Against this backdrop, there are generally three acknowledged types of seismic rehabilitation programs that involve varying degrees of regulation and potential conflict.

1. **Minimum Programs.** Preparation of an inventory of hazardous buildings is an example of a "minimum program" that is an essential first step in developing a seismic rehabilitation program. The most useful procedure for initiating a hazardous building inventory is set forth in the FEMA publication, *ATC-21: Rapid Visual*

Screening of Buildings for Potential Seismic Hazards: A Handbook.

Variations in the minimum programs relate to the use made of the hazardous building inventory, including: 1) notification of the building owners of the potential hazard to their buildings; 2) notification and *posting* buildings as unsafe; and 3) notification, posting, and a *mitigation plan* that describes actions to reduce the vulnerability of the building to earthquakes.

2. **Voluntary Programs.** Private and public building owners have, in the past, undertaken seismic rehabilitation of buildings for reasons of public safety, protection of investments, and other factors. *Voluntary programs* are common in areas of high seismic risk, particularly in the private sector.

A voluntary approach in the Central U.S. stands a higher likelihood of succeeding if there are financial incentives for owners of buildings with the greatest danger to the community. These might be: essential facilities, high occupancy buildings, unreinforced masonry buildings, historic buildings, and buildings in high hazard areas (e.g., areas subject to significant liquefaction). The advantages of voluntary programs are that they provide effective disclosure of hazards to owners, flexible timeframes for compliance, and a phased approach to hazard reduction that is in line with the resources of the building owners.

Among the disadvantages of this approach: it may prolong serious and effective efforts to make meaningful progress in reducing the stock of hazardous buildings, and it is not effective with owners who choose not to participate.

3. **Mandatory Programs.** These programs, which are by far the most effective for seismic safety, are also the most expensive and controversial. In this model, seismic rehabilitation is *imposed* on building owners by government, usually a city council.

The advantages of mandatory strengthening programs are that building departments are in control of the rehabilitation process, can monitor progress, and can enforce compliance with the program.

The disadvantages include: potential economic hardship on owners, unreasonable compliance schedules, and polarization of the community over this mitigation technique.

AutoZone's Memphis Headquarters a "Model for Seismic Design"

One variation of the Voluntary Model of seismic rehabilitation can be found in Memphis.

AutoZone, a major national auto parts and accessories chain, evaluated its original location in a structure that was initially designed as a department store. Seismic performance was explicitly included in the overall rehabilitation evaluation.

After careful deliberation, the company chose to construct a new building in the downtown area because, all things considered, constructing a new building was actually less costly than rehabilitating the old one.

AutoZone's new headquarters is a $27 million, eight-story building that is designed with 24 lead-rubber base isolators, which act as giant seismic "shock absorbers." Thus, the company not only made a major commitment to the revitalization of downtown Memphis, it also demonstrated its resolve to be prepared for a major earthquake.

In the Central U.S., where *damaging* earthquakes are rare, but where exposure is high, it is reasonable to expect that minimum and voluntary programs of seismic rehabilitation will predominate, at least in the short term. However, higher priority needs to be given to innovative strategies for strengthening hazardous buildings. For its part, CUSEC will continue to sponsor demonstration projects, and will initiate a program to provide technical assistance and training to building owners – public and private – who wish to strengthen hazardous buildings, including nonstructural mitigation measures.

At the very minimum, CUSEC and member states should take the lead in preventing the construction of *new* buildings that are potentially hazardous. This means that seismic provisions in building codes must be enforced. In this manner, through a normal process of building replacement, our communities will have fewer hazardous buildings.

CUSEC AND MISSISSIPPI TEAM TO STRENGTHEN LOCAL HOSPITAL

by **Richard Roman**, Centers for Disease Control Liaison to CUSEC

The Northridge earthquake, a magnitude 6.7 that struck on January 17, 1994, once again demonstrated the vulnerability of hospitals and other medical facilities to the effects of earthquakes. A total of 23 hospital sites sustained damage, ranging from extensive structural damage (9) to widespread nonstructural damages (14 hospital sites) Source: California Seismic Safety Commission, "A Compendium of Background Reports on the Northridge Earthquake (FEMA press release, March 12, 1996).

The costs to repair these hospitals is significant. The Federal Emergency Management Agency, for its part, will provide approximately $831 million to repair four damaged hospitals.

The loss of functionality of hospitals and other medical care facilities is a major concern among emergency medical and health officials. Within seconds, earthquakes can cause hundreds if not thousands of casualties, leading to unprecedented demands on medical care facilities. Yet, recent earthquakes have shown just how vulnerable these facilities are to earthquakes. In many respects, a hospital can be viewed as a collection of mechanical, electrical, and structural systems that support very specialized medical services. When these systems and equipment are damaged, the ability to provide medical care in the critical hours (even days) following an earthquake is greatly curtailed. Patients at these damaged hospitals often must be moved to other medical care facilities, further compounding the overall medical response.

CUSEC-Mississippi Hospital Mitigation Project

Recognizing the vulnerability of hospitals to damaging earthquakes, the state of Mississippi, in conjunction with CUSEC, is developing a non-structural mitigation demonstration project for a major Northern Mississippi hospital. Funding for the project is through the Hazard Mitigation Grant Program.

The project has three interrelated components. The first is a demonstration of how to minimize damages to a critical care unit of the selected hospital. The project team selected a critical care unit because this is where the most seriously ill patients are usually housed. The nonstructural mitigation project will feature cost-effective steps that

Summary of Non-structural Damage to Northridge, Olive View, and Holy Cross Medical Centers

Primary Cause of Disruption and Evacuation	Northridge	Olive View	Holy Cross
Broken piping, water leakage	x	x	x
Mechanical equipment damage, lack of HVAC service	x	x	x
Sprinkler and/or other water line breaks, leaks	x	x	x
HVAC equipment anchorage failures	x	x	x
Large oxygen tank base failures, leaning tanks	x	x	x
Toppling of unanchored cabinets and equipment caused localized evacuation for cleanup and repair	x	x	x
Communications failures	x	x	x
Elevator damage	x	x	x
Fire fighting system out	x	x	x
Medical gas failure		x	x
Backup power outage		x	
Water service outage	x	x	x
Gas service outage		x	x
Electrical service outage	x	x	x
Peak ground acceleration, free field	not instrumented	0.91g horizontal 0.60g vertical	not instrumented
Peak building acceleration	not instrumented	2.31g horizontal (roof)	not instrumented

Source: *A Compendium of Background Reports on the Northridge Earthquake for Executive Order w-78-94*; Seismic Safety Commission, State of California, November 9, 1994, p. 183.

can be taken to prevent, or at least reduce damages to respirators, heart monitors, and other life support equipment, and in the process maintain patient medical stability.

The second part of the project is a seismic vulnerability analysis of the hospital, conducted by the University of Mississippi, College of Engineering, Department of Civil Engineering. The analysis will determine how the key structural systems in the hospital will perform in various scenario earthquakes. The engineering study will also include retrofit recommendations to improve the hospital's survivability in future earthquakes.

A video will be produced that documents the entire nonstructural mitigation process. This video will show hospital administrators and others how a modest *front end* investment in mitigation can save the hospital millions of dollars from even a moderate future earthquake.

The third component of this project is preparedness and mitigation training for nurses and other health care professionals in the Northern Mississippi region. The premise is that nurses are a valuable and underutilized resource, before and after a disaster. To "harness" this expertise, CUSEC is developing a one-day workshop on earthquake preparedness and mitigation, especially tailored for nurses. Two workshops are planned for 1996.

In summary, the effectiveness of emergency response operations following a major earthquake will depend in large part on the performance and survivability of hospitals and other critical facilities. As FEMA director James Lee Witt has noted, "Improving the performance of acute care hospitals will avoid the need to evacuate patients and will improve post-disaster operations so that these facilities will serve victims when they need assistance most." (FEMA press release, March 12, 1996).

CUSEC and its member states will continue to incorporate mitigation into planning for response and recovery. In the final analysis, the greatest opportunity to improve operational readiness and capability in the Central U.S. is to *strengthen and protect* those critical facilities and systems that we depend on in a major emergency.

Mississippi to Develop a GIS Database of Critical Facilities

The Mississippi Emergency Management Agency is working closely with the GIS Lab at the University of Mississippi Department of Geology to develop a GIS database of facilities critical to emergency response in the event of an earthquake in the northwestern part of the state. Critical facilities to be included in the GIS include:

- fire stations
- police stations
- hospitals, public and private
- schools, K - 12, technical schools, colleges
- state and federally maintained highways
- railroads
- hazardous waste generators and storage locations
- major power transmission lines
- federal, state and county courthouses
- National Guard and Reserve facilities
- designated emergency shelters
- local emergency operations centers
- hotels and motels
- casinos

The development of a GIS database of the above listed critical facilities will require a combination of conversion of existing digital data, digitization of known maps with known locations of critical facilities, and field investigations to locate other facilities of interest.

The GIS database represents an important step in developing an inventory of critical facilities that can be maintained and updated on a routine basis. This information can be used in a number of ways, from pre-designation of hazardous critical facilities for use in mitigation strategies, to post-disaster building inspections in a multi-county region. For more information on this project, contact *Grady Kersh,* at MEMA.

USEFUL PUBLICATIONS

Establishing Programs and Priorities for the Seismic Rehabilitation of Buildings: A Handbook. (FEMA 174/1989). *Available from the FEMA Distribution System, P.O. Box 2012, Jessup, MD 20794. (800) 480-2520.*

The intent of this handbook is to provide nationally applicable guidelines that can be used by local decision-makers in deciding how best to approach the considerable challenge of establishing a program to rehabilitate and strengthen hazardous buildings. While there have been significant developments in the hazard management field since this handbook was published (e.g., FEMA Loss Estimation), the methodology that is described is still a very useful guide for local officials.

NEHRP Handbook for Seismic Rehabilitation of Existing Buildings. (FEMA 172/1992). *Available from the FEMA Distribution System, P.O. Box 2021, Jessup, MD 20794. (800) 480-2520.*

This handbook, a companion to FEMA 174, provides those in the public or private sectors who are interested in seismic rehabilitation with: 1) a general understanding of the common deficiencies in the structural and nonstructural components of existing buildings that cause seismic performance problems;
2) descriptions of some of the techniques that might be used to correct deficiencies for various construction types; and
3) information on the relative merits of alternative techniques. In short, this handbook has some valuable "how to" information, laid out in non-technical terms, that can serve as a useful technical resource for those interested in pursuing seismic rehabilitation.

MITIGATING BUSINESS LOSSES

Recent disasters have shown that a key to community recovery is the ability of businesses – large and small – to resume operations following the disaster. Because of this, an increasing number of communities are examining the feasibility of forming "Business Preparedness Coalitions" that bring together the leadership and expertise of business, emergency preparedness, the engineering and scientific community to develop a partnership approach to reducing the vulnerability of businesses to earthquakes and other hazards. The following article outlines some key elements of a business preparedness and mitigation strategy, with emphasis on small business.

Getting Organized

The starting point for a business preparedness and mitigation strategy is to get organized. There are a number of local organizations that have resources and expertise that can be tapped: local emergency management agency, chambers of commerce, planning and building departments, and merchants associations. Based on recent experience, the success of a Business Preparedness Coalition will depend on at least three factors: 1) Clearly defined objectives; 2) Executive support (government and business sector); and 3) Technical support.

Small Business

The focal point of most business preparedness campaigns is small business, for two fundamental reasons: First, small business (generally defined as 50 employees or less) is very important to the American economy, accounting for over half of private sector output and employment; and 2) these businesses are among the most vulnerable to earthquakes and other hazards. They have few financial reserves to carry them through difficult periods; and they typically lack sophistication about risk and risk management.

A Business Preparedness Coalition can develop a preparedness and mitigation program for small business that is tailored to this group's special problems. A program and strategy could feature at least three elements

Hazards and Risk Analysis

A basic question is: in what ways are small businesses susceptible to losses from earthquakes and other hazards? Recent disasters have shown that small businesses are plagued with several problems: customer and employee access, shipping delays, inventory losses, credit problems, and damages to buildings from which they operate. A hazards and risk analysis needs to take place at two levels: community or regionwide vulnerability; and site specific analysis of the business vulnerability.

"…a key to community recovery is the ability of businesses – large and small – to resume operations following the disaster."

A Business Preparedness Coalition can use the **FEMA-NIBS Loss Estimation** methodology to develop a community-wide risk analysis, starting with an inventory of commercial buildings, ownership, value, type of structure, structural category, occupancy, and nature of business. This information will provide a better picture of the likely impact of various earthquakes on buildings and infrastructure in the Central Business Districts, and a baseline of data to develop preparedness and mitigation options.

Mitigation Options for Small Business

Small businesses have at least three risk reduction strategies that can be pursued.

1. *Reduce initial losses from earthquakes.* Small businesses can take steps to reduce capital losses from earthquake ground shaking. New buildings can incorporate design features that resist earthquake forces. Existing buildings can be strengthened to do the same. Equipment can be braced or secured. Facilities can be decentralized to reduce the risk of damage to all inventory and production or sales facilities. Businesses can choose to lease facilities or equipment so that, if there is a damaging earthquake, their assets are not at risk.

2. *Increase the probability of being able to continue operations.* Small businesses can take steps to increase the probability they will be able to continue their operations following a damaging earthquake or that they will be able to resume full operations very quickly. For example, businesses can create system redundancy, which may take the form of an inventory of spare parts of equipment. Mutual assistance agreements with other firms can be developed, such as lease agreements for equipment and facilities that guarantee speedy replacement or reduced costs following damage from earthquakes.

3. *Ensuring replacement of lost capital or income.* Some business owners may conclude that, since earthquakes are infrequent, albeit potentially very destructive, it is more cost-effective for them to ensure replacement of lost assets and income through commercial insurance, including both earthquake and business interruption insurance, insofar as coverage is available.

In the final analysis, pre-disaster preparedness and mitigation measures will pay immediate dividends following an earthquake. Damages will be reduced, confusion can be minimized, rebuilding priorities can be established and for the community, economic revitalization can be accelerated.

JACKSON, TENNESSEE TARGETS SMALL BUSINESSES

FEMA's National Small Business Earthquake Outreach Campaign, initiated in 1992, is designed increase small business preparedness and mitigation efforts in high seismic risk areas of the nation. The program provides direct support to interested, eligible local governments to enable them to develop and carry out Business Preparedness campaigns. Campaign materials include: brochure, poster, utility bill stuffer, print advertisement, speaker's kit and video, radio public service announcement, and risk analysis worksheet.

The following article, prepared by **Jill Stevens Johnston**, Center for Earthquake Research and Information, relates how one community in west Tennessee was targeted for a Small Business safety program.

The goal of the Federal Emergency Management Agency was simple: Find a community that could be a pilot for an innovative new campaign to reduce the earthquake risk to a crucial, but inadequately targeted audience in the National Earthquake Hazards Reduction Program – small business.

The project was a new concept for the federal agency – sending staffers into a community to enlist the support of local government, businesses, and emergency management agencies to design a strategy for reducing the damage an earthquake could do to building interiors. With a few guidelines from the agency, and some expert advice readily available to implement the guidelines, the project would be a community-based effort to reduce potential earthquake damage to small businesses, a particularly vulnerable element in any community close to an earthquake source zone.

The National Small Business Earthquake Outreach Campaign was launched officially on the theme, "Don't Be Shocked if an Earthquake Hits Your Business," in Jackson on April 14, 1992. The city wasted no time. Through enthusiastic local support by the Jackson Area Chamber of Commerce, Jackson/Madison County Emergency Management Agency and the Tennessee Emergency Management Agency, local businesses were invited to participate in the campaign that would make Jackson become a national model for small business earthquake hazard reduction.

Each interested business was issued a risk analysis worksheet that involved looking at the work environment and determining the dangerous elements. A series of workshops then demonstrated how simple hardware could be used to fasten hot water heaters to studs in a wall, attach tall bookshelves and filing cabinets to walls, secure computer terminals to desk tops, cover windows to prevent shattering, and prevent cabinets from spilling their contents.

All the materials used in the workshops were available from local stores at a reasonable cost and could be installed with minimal technical expertise. The emphasis in the workshops was on the ease and cost effectiveness of making a business environment safer – a small investment before a disaster, but a big payoff after a disaster occurs.

During the year that followed, many businesses, ranging from day care centers to travel agencies, became earthquake safe, with the result that as a community, Jackson now has a level of preparedness unique to the United States east of California.

Production of a videotape that documents this program in Tennessee has assured that the message will be spread to other communities, a message that Helena, Montana, is listening to very closely, as the newest small community to benefit from the Jackson experience.

BUSINESS OPERATION and RECOVERY CHECKLIST

- ☐ Keep an updated file of supplies, equipment, inventory, a client list and other records most essential to resuming business operations. These should be removed first if you are forced to vacate. Damage may limit or prevent later access. Keep duplicate copies at another location.
- ☐ To qualify for aid, you must supply detailed financial records to substantiate documentation of losses to building(s), equipment, inventory, and operations. Be as prepared as if it were a federal tax audit. Also, maintain a duplicate set of records, photographs, and backup computer disks/tape at another location.
- ☐ Review personal and business insurance to make certain that coverage includes business disruption as well as business property damage.
- ☐ Analyze present space needs. If a disaster forces you to move, are other locations available? Which items are vital to keep the business functioning? What space will they occupy? Which items can be placed in storage?
- ☐ Develop joint plans with customers, suppliers and business neighbors. Contact suppliers to generate contingency plans in a disaster scenario. Work out similar plans with other businesses in the building or area. Become involved in community preparedness.
- ☐ Identify alternate, essential supply and replacement part vendors in case regular vendors are unable to function after a disaster.
- ☐ Prepare for a loss of essential services such as telephone, water, electrical power and gas; plan for backup or alternate systems.
- ☐ Establish prior contacts/arrangements with architects, engineers, planners and contractors.
- ☐ Establish an educational employee awareness plan in order to minimize the complications in business operations that will occur after a disaster.

A PLAN FOR LIFELINES

Lifelines are the public works and utility systems that support our way of life, at home and the workplace. They can be classified under the following five stems: electric power, gas and liquid fuels, telecommunications, transportation, and water supply and sewers.

VULNERABILITY OF LIFELINES

As nearly every damaging earthquake has demonstrated, these lifeline systems are vulnerable to ground shaking and liquefaction (quicksand effect that results from soil failure). With virtually no warning, the sudden release of strains accumulated in a fault system causes a tremendous amount of energy to be dissipated in all directions through the propagation of seismic waves. In the Central U.S., these waves travel through soft sediments, impacting up to ten states. This has major implications for each lifeline system.

Telecommunications

The Central Mississippi Valley is a major transportation and communications corridor. Telecommunications facilities, such as radio and microwave towers and telephone trunk lines, are fragile, principally because their structural integrity depends on stable ground.

A common occurrence in the telecommunication system during an earthquake is focused overload. A system is not designed to handle calls above its capacity, which is set according to the traffic patterns of each central and toll office. It is not cost-effective to provide full capacity connectivity to all subscribers when the highest demand at peak periods is only a small percentage of full-capacity connectivity. Overload can be minimized by educating the public.

Transportation

The vulnerability of roads, bridges, airports, and rail lines in the Central U.S. is well documented. Bridges and overpasses, in particular, are susceptible to earthquakes, which means that access to and from disaster areas will be impeded.

The consequences of failure in a transportation lifeline due to an earthquake can lead to: 1) Direct loss of life due to collapse or structural failure of the lifeline; 2) Indirect loss of life due to an inability to respond to secondary hazards, such as fires; 3) Delayed recovery operations; 4) Release of hazardous products (e.g., losses from tank cars derailed by track failure); and 5) Losses due to interruption of access (e.g., export losses due to port damage).

Kentucky Retrofits Vulnerable Bridges

By the end of July, 1997, Kentucky will have concluded an aggressive retrofit program that has targeted a total of 77 seismically vulnerable bridges along priority routes in Western Kentucky.

The retrofit program began as a result of a study by the Kentucky Transportation Research Program, entitled "Earthquake Hazard Mitigation of Transportation Facilities," completed in January, 1988. That study examined the vulnerabilities of emergency access routes to each of the 26 westernmost counties of Kentucky. It recommended a list of bridges along critical access routes for retrofitting. The total estimated cost to complete the retrofit is $1 million, eighty percent of which will be federal funds.

Generally, the retrofits consist of the use of steel cables running through bridge piers and tying the spans together. The improvement cannot guarantee a bridge will not fail during an earthquake, but it should help to prevent the loss of spans which might otherwise shake off the piers.

Gas and Liquid Fuel Systems

Gas and liquid fuel systems provide energy for transportation as well as for electric power generation and the production of necessary goods and services, including heating in cold weather. A damaging earthquake in the New Madrid seismic zone could impact the general public in a ten to fifteen state region by the shutdown of oil and gas transmission lines, damage to gas distribution systems, or interruption of electric power generation due to loss of fuel supply. The lack of a fuel source can also pose a serious problem for many industrial facilities. The monetary losses and social disturbance attributable to such a shutdown can be substantial, especially if the disruption in service is for an extended period of time.

Electric Power Systems

The states in the Central U.S. have recent experience with extended power outages due to ice storms. These electric power failures served as a reminder of how interdependent our lifeline systems are.

Electric power systems are the lifelines to other lifelines. Many water systems, for example, are dependent on pumps to maintain pressure. Loss of power can mean a quick drop in water pressure and flow. This can be critical for fire suppression.

Transportation systems, likewise, would be severely affected by the loss of power. Mass transit and traffic signals depend on power. Without power to pump liquid fuels from storage tanks, vehicular transportation would be severely curtailed.

In essence, the pace of recovery following a major earthquake in the Central U.S. will be greatly influenced by the availability of electric power. For this reason, one of CUSEC's priorities has been *electric power stems vulnerability reduction.*

Water and Sewer Systems

A major earthquake in the New Madrid seismic zone could cause extensive damage to water and sewer lifelines. This in turn would have serious effects for several other lifelines and critical facilities.

Fire suppression systems – water loss would greatly increase the risk of conflagration, which is potentially more destructive than the earthquake itself.

Telecommunications systems – water loss could result in the shutdown of cooling systems, which could render computer dependent telecommunications systems inoperable.

Water supplies – water loss could mean that water supplies would have to be trucked in until water systems could be restored. This could also affect businesses.

Sewers – water and power loss could seriously damage sewer systems, causing major public health problems over a

potentially wide area.

In essence, even a moderate earthquake would cause serious damages to lifelines and major disruption across the land. Barge traffic on the river, natural gas and oil pipelines, interstate highways, and power lines all provide essential services, the loss of which would have a significant, long-term impact on the entire Central and Eastern United States.

DEVELOPMENT OF DESIGN GUIDELINES AND STANDARDS

Lifeline vulnerability is a national problem. Because of this, the National Earthquake Hazards Reduction Program (NEHRP) Reauthorization Act requires FEMA and the National Institute of Standards and Technology (NIST) to develop a "plan, including precise timetables and budget estimates, for developing and adopting, in consultation with appropriate private sector organizations, design and construction standards for lifelines."

The Challenge

There is considerable evidence that seismically designed lifelines perform well in earthquakes; the challenge is to develop a consensus on design guidelines and standards. The reason is that the nation's lifeline infrastructure encompasses thousands of individual facilities that are owned, operated, and regulated in distinctly different ways.

Most electric power, gas and liquid fuel, telecommunication, and railroad facilities are *privately* owned and operated. State highways, bridges, and tunnels and federal-aid highways are owned by individual states. Local governments own municipal, county, and parish roads, bridges and tunnels. They and regional authorities own and operate water and sewer, light rail/transit, airports, and ports and harbors.

This has important implications for how mitigation measures – including retrofitting – are applied. In theory, government owned systems should be more readily updated and protected; in practice, funding shortfalls often impede this process (e.g., witness the case for upgrading roads and bridges).

Opportunities in the Central U.S.

The process for developing and adopting seismic design guidelines and standards for lifelines will require training, education and the use of demonstration projects to show what can be accomplished by replacing key equipment as part of regular maintenance cycles.

In the Central U.S., CUSEC will continue to take an active role in promoting the adoption of seismic safety measures for lifelines. More specifically, CUSEC will undertake the following:

1) *Improve the utilization of research on seismic design standards for lifelines.* CUSEC will serve as an important link between researchers in the lifeline area – notably the National Center for Earthquake Engineering Research (NCEER) – and practicing engineers, architects, planners, and building officials in the Central U.S. to ensure that the results of the research are put to use to influence local design practices.

2) *Conduct training workshops on technical aspects of vulnerability reduction for lifelines.* CUSEC will work closely with professional associations, such as the Earthquake Engineering Research Institute (EERI), to organize, develop, and conduct training sessions that provide the design and construction professions with the tools and skills that they need to incorporate seismic safety in

CUSEC's New Monograph: Vulnerability of Transportation Systems in the Central United States.

With funding support from the U.S. Department of Transportation, CUSEC has produced a monograph that was written for Federal, State, local officials, and others who have a role and responsibility for transportation mitigation, response and recovery. The monograph is divided into three parts: Part one introduces the reader to the earthquake risk in the Central U.S., the growth and complexity of our nation's transportation system, and the consequences of an earthquake on this network. The second section examines the potential effects of earthquakes on each of the major components of our transportation system: highways and bridges, ports and harbors, railways, and airports. The premise is: *Our nation's transportation network should be viewed as an interdependent system of components (e.g., roads, bridges, tracks, retaining walls, etc.), and the failure of any one component can cause problems or even failure in other parts of the system.*

The final section presents a series of observations and recommendations on the future direction of a national program to reduce the vulnerability of the transportation system to earthquakes and other hazards. Such a program should address Risk Assessment, Mitigation, Response, Recovery and Reconstruction, and the Application of Research and Lessons from previous disasters.

development of lifelines.

3) *Conduct demonstration projects.* Demonstration projects can be a very useful mechanism for showing the "cause and effect" of vulnerability reduction for lifelines. Facility walkdowns (e.g., site visits to utilities) have been successfully utilized in CUSEC training to demonstrate the technical aspects of mitigation.

Electric Utilities Targeted in Technical Workshop

The final workshop in the Electric Utility Mitigation Training series, sponsored by CUSEC and funded by the U.S. Department of Energy, will be held in conjunction with the CUSEC Annual Meeting, November 18-20, 1996, in Memphis.

An interdisciplinary team of engineers and seismologists from Pacific Gas and Electric and TVA will develop and conduct the eight hour workshop, which will be guided by four objectives: 1) To address techniques for raising the awareness of electric utility operations and management personnel about seismic vulnerabilities of their systems; 2) To identify state-of-the-art tools and technologies in reducing earthquake risk, and how they can be applied; 3) To develop and implement a comprehensive, practical, and credible seismic safety program, appropriately structured for each utility; and 4) To form a working partnership of utilities in the region who have learned ways to share experience and expertise to their mutual benefit in addressing earthquake issues. For more information on this workshop, please contact *Jim Wilkinson,* at CUSEC.

USEFUL PUBLICATIONS

Mitigation of Damage to the Built Environment. *Central U.S. Earthquake Consortium, 1993. 215 pp. $100.00 (five volume set) Available from the Central U.S. Earthquake Consortium, 2630 E. Holmes Rd., Memphis, TN 38118; (901) 345-0932; fax: (901) 345-0998.*

This is one of five monographs prepared for the 1993 National Earthquake Conference that focused on earthquake mitigation in the central and eastern United States. Written by a committee of researchers and practitioners in the Lifeline and Building Code field, the monograph sets forth state-of-the-art practices for Highways and Railroads, Ports and Air Transportation Systems, Electric Power and Communications, Gas and Liquid Fuel Systems, and Water and Sewage Systems.

Seismic Vulnerability and Impact of Disruption of Lifelines in the Conterminous United States (ATC-25). *Earthquake Hazard Reduction Series 58, Federal Emergency Management Agency, 1991. FEMA 224. Available from FEMA Distribution Center, P.O. Box 2021, Jessup, MD 20794; (800) 480-2520; fax: (301) 497-6378.*

The purpose of this study was to develop a better understanding of the impact and disruption of lifelines from earthquakes, and to assist in the identification and prioritization of hazard mitigation measures and policies. The study inventoried the transportation systems of highways, bridges, railroads, airports, and ports; energy systems of electric power, gas and liquid fuel transmission; emergency service facilities; and water aqueducts and supply.

THE AMERICAN RED CROSS AND MITIGATION

by **Ken Deutsch**, Associate for Mitigation, ARC

Introduction

The American Red Cross has been at the cutting edge of disaster relief activities for more than one hundred years – helping people prevent, prepare for, respond to, and cope with disasters and other emergencies. Like many organizations and millions of Americans, we are concerned about the skyrocketing social and economic costs of disasters that impose an unaffordable and often unnecessary burden on our people and institutions. Therefore, we are helping to spearhead the nation's efforts to do more to limit the harm disasters do to people, property and the environment.

American Red Cross support for mitigation is not a recent development. On the contrary, as shown below, our roots in mitigation can be traced back to our Congressional Charter which was written in 1905.

*"...to continue and carry on a system of national and international relief in time of peace and apply the same in **mitigating** the sufferings caused by pestilence, famine, fire, floods and other great national calamities, and to devise and carry on measures for **preventing** the same."*

Thus, as a humanitarian organization that is led by thousands of volunteers, and, as a signatory to the Federal Response Plan, we have long recognized that the American Red Cross has an obligation to not only respond where and when we are needed, but also to do all we can to help people from becoming victims. In July of 1992, we embarked on a concerted effort to significantly enhance our ability to deliver timely and effective disaster relief services. We also renewed our commitment to help prevent and mitigate the effects of disasters by cooperating closely with the Federal Emergency Management Agency (FEMA) and other government and non-government organizations to help at-risk people and communities reduce their vulnerability to hazards. Our Board of Governors (BoG) also updated our policy statement that focuses on mitigation.

*"The American Red Cross will advocate programs and legislation which **mitigate** disaster damage and loss of life, such as the adoption of land use regulations, improved building codes and appropriate construction standards..."*

Over the last eighteen months, we have worked closely with FEMA to help develop the soon-to-be released *National Mitigation Strategy* that will chart a course for America to devote more time, resources and energy on actions and measures that prevent disasters or significantly reduce the severity of their destructive effects. We have also initiated a significant parallel effort to define, develop and sustain a comprehensive mitigation strategy that is appropriate for the American Red Cross. Therefore, we are currently meeting with a number of regional FEMA and state emergency management officials and representatives from our local chapters to get first-hand information about ongoing state and local mitigation programs as well as to identify other actions we can take to help minimize the devastation caused by disasters.

Current American Red Cross Mitigation Activities

While there is much more to be done, the Red Cross is already engaged in activities that support mitigation and help save lives and property. Our efforts include:

Promoting Mitigation Awareness and Mobilizing Support for Mitigation by making community presentations and by providing awareness and education information, before disasters strike, to raise the public's awareness of the risks they face and show them ways to minimize those risks. We also include mitigation in some of our Community Disaster Education (CDE) materials. For example, the highly successful "*Against the Wind*" video and brochure, developed in a partnership with FEMA and other organiza-

tions, show people living in hurricane and wind-prone areas the actions necessary to prevent or reduce wind damage. Another is "*Repairing Your Flooded Home*" that was used extensively during the California, Virginia, and Louisiana floods, as well as those that struck the Northeast following the "Blizzard of 1996," and the ones that recently caused so much devastation in the Northwest. This booklet describes methods of repairing flooded homes in ways that prevent or minimize future damage.

Serving as Advocates for Mitigation at the Local, State, Regional, and National Levels by supporting actions and efforts that reduce the vulnerability of people to disasters. For example, we serve on a number of state and local mitigation committees or task groups that are charged with building and sustaining support for mitigation and that coordinate specific mitigation actions and programs.

Helping Identify Resources to Support Mitigation Following Disasters by providing casework assistance to identify resources to pay for mitigation actions such as elevating appliances, elevating and/or relocating homes, and purchasing flood insurance.

Serving on the Federal Mitigation Task Force to help promote nation-wide mitigation awareness and encourage mitigation actions. This task force consists primarily of signatories of the Federal Response Plan and other organizations involved in mitigation or disaster preparedness, response, and recovery actions. Also, we are working with the Central U.S. Earthquake Consortium (CUSEC), the American Society of Civil Engineers (ASCE), the Insurance Institute for Property Loss Reduction (IIPLR), and many other organizations that support mitigation to pursue common mitigation goals and objectives.

Supporting the United Nations "International Decade for Natural Disaster Reduction" by sharing mitigation information with the International Federation of Red Cross and Red Crescent Societies.

Contributing to the Development, Promulgation and Implementation of the National Mitigation Strategy by providing substantive input, promoting mitigation awareness (within the American Red Cross and the public sector), and investigating ways to make more meaningful contributions to mitigation at the national, state and local levels.

Co-sponsoring FEMA's Biennial National Mitigation Conferences by helping plan and organize them, presenting information on current and planned Red Cross mitigation activities, and by orchestrating and serving on panels that focus on ways to build public support for mitigation and encourage mitigation actions.

Serving on the Mitigation Committee of the 1996 National Hurricane Conference to highlight the need for and importance of mitigation as well as to share mitigation success stories and strategies.

The Challenge

Despite all of the actions by the American Red Cross and other members of the emergency management community to improve preparedness efforts and expand response and recovery capabilities, the costs of disasters continue to sharply escalate and exact an enormous toll on people, property and the environment. This disturbing and costly pattern will undoubtedly continue unless more is done, before disasters strike, to prevent their occurrence or substantially reduce their effects.

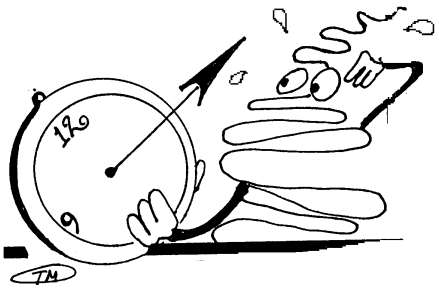
Although mitigation has been around a long time as a concept, it has yet to be fully embraced as a practice. And, like many people, we in the American Red Cross believe that it will not be unless and until the public fully understands the risks they face, the significant benefits of mitigation, as well as the severe consequences and enormous costs of inaction. In other words, mitigation will fully take hold only when an informed public is convinced that it is necessary and feasible; that it reaps large, long-term dividends; and, that failing to mitigate is both unaffordable and unacceptable. Then and only then, will America begin to break the vicious, costly and destructive disaster-rebuild-disaster cycle.

Next Steps

To ensure we in the American Red Cross continue to do our part to reduce disaster damage, injuries and loss of life, we plan to establish to a mitigation task force in 1996 to chart a course for our future roles in mitigation. This task force will thoroughly examine the extent and effectiveness of our current mitigation activities and identify other things we can do to make even more meaningful contributions to this important endeavor.

SUMMARY

The significant devastation and loss of life and property caused by recent disasters underscore the urgency and importance for our nation to take a much more proactive and sustained approach to prevent disasters and minimize their effects. Just as the American Red Cross has done so effectively for many years in helping people prevent, prepare for, and respond to, and cope with disasters, we believe that by fully supporting the *National Mitigation Strategy*, we can build on our proud tradition of helping make people and communities safer from disasters. As Henry Ford said, "Nothing, nothing is more important than an idea whose time has come." We believe the time for mitigation has indeed come and that our slogan "HELP CAN'T WAIT" means the American Red Cross will not only continue to be there after disasters strike, but also, that we must do everything we can to help people and communities from becoming victims.



SOURCES OF INFORMATION AND TECHNICAL ASSISTANCE

The following is a partial listing of sources of information and technical assistance for earthquake risk assessment and mitigation.

Member States

Arkansas Office of Emergency Services
P.O. Box 758, Conway, AR 72033. *Dan Cicirello*, (501) 329-5601; fax: (501) 327-8047.

Arkansas Geological Commission
Vardelle Parham Geology Center, 3815 W. Roosevelt Road, Little Rock, AR 72204. *Bill Bush*, (501) 663-9714; fax: (501) 663-7360.

Illinois Emergency Management Agency
110 E. Adams Street, Springfield, IL 62706. *Tom Zimmerman*, (217) 782-4448; fax: (217) 782-2589.

Illinois State Geological Survey
121 Natural Resources Building, 615 East Peabody Drive, Room 121, Champaign, IL 61820. *Bob Bauer*, (217) 244-2394; fax: (217) 244-0029.

Indiana State Emergency Management Agency
302 W. Washington Street, E-208, Indianapolis, IN 46204. *John Steel*, (317) 233-6519; fax: (317) 232-4987.

Indiana Geological Survey
611 N. Walnut Grove, Bloomington, IN 47405. *Norman Hester*, (812) 855-9350; fax: (812) 855-2862.

Kentucky Disaster and Emergency Services
Boone Center, EOC Building, Frankfort, KY 40601. *Mike Lynch*, (502) 564-8628; fax: (502) 564-8614. e-mail mlynch@kydes.dma.state.ky.us

Kentucky Geological Survey
228 Mining and Mineral Resources Building, Lexington, KY 40506-0107. *John D. Kiefer*, (606) 257-5500; fax: (606) 257-1147.

Mississippi Emergency Management Agency
1410 Riverside Drive, Jackson, MS 39202. *Grady Kersh*, (601) 352-9100; fax: (601) 352-8314. e-mail mema@mema.state.ms.us

Office of Geology
Mississippi Department of Environmental Quality, P.O. Box 20307, Jackson, MS 39289-1307 *Cragin Knox*, (601) 961-5503; fax: (601) 961-5521.

Missouri Emergency Management Agency
2302 Militia Drive, Jefferson City, MO 65101. *Ed Gray*, (314) 526-9131; fax: (314) 634-7966.

Missouri Geological Survey
P.O. Box 250, Rolla, MO 65401, *James Williams*, (573) 368-2101; fax: (573) 368-2111.

Tennessee Emergency Management
3041 Sidco Drive, Nashville, TN 37204. *Cecil Whaley*, (615) 741-0640; fax: (615) 242-9635.

Tennessee Division of Geology
Department of Environment and Conservation, 401 Church Street, Life and Casulty Tower, Nashville, TN 37243-0445. *Ronald Zurawski*, (615) 532-1500; fax: (615) 532-0231.

Associate Members

Alabama Emergency Management Agency
P.O. Box Drawer 2160, Clanton, AL 35045-5160. *Dave White,* (205) 280-2204; fax: (205) 280-2493.

Georgia Emergency Management Agency
P.O. Box 18055, Atlanta, GA. *James Wilbanks*, 30316-0055. (404) 635-7011; fax: (404) 635-7205.

Georgia Geological Survey
19 Martin Luther King Jr. Dr. SW, Atlanta, GA 30334. *Dave White*, (404) 656-3241; fax: (404) 651-9425.

Iowa Emergency Management Division
Hoover State Office Building, Level A, Des Moines, IA 50319-0113. *Alphonso Eason*, (515) 281-6057; fax: (515) 281-7539.

Louisiana Office of Emergency Preparedness
P.O. Box 44217, Baton Rouge, LA 70804. *Brett Kriger*, (504) 342-1570; fax: (504) 342-5471.

Louisiana Geological Survey
P.O. Box G, University Station, Baton Rouge, LA 70893. *Bill Marsallis*, (504) 388-5320; fax: (504) 388-5328.

Nebraska Emergency Management Agency
1300 Military Road, Lincoln, NE 68508. *Dennis Kumm*, (402) 471-7213; fax: (402) 471-7433.

Nebraska Geological Survey
University of Nebraska, 113 Nebraska Hall, Lincoln, NE 68588-0517. *Perry Wigley*, (402) 472-3471; fax: (402) 472-2410.

North Carolina Division of Emergency Management
116 West Jones Street Raleigh, NC 27603-1335. *Will Brothers*, (919) 733-3627; fax: (919) 733-0795.

North Carolina Div. of Land Resources Dept. of Environmental Health and Natural Resources
P.O. Box 27687, Raleigh, NC 27687. *Charles Gardner*, (919) 733-3833; fax: (919) 733-4407.

Ohio Emergency Management Agency
2855 W. Granville Road, Columbus, OH 43235-2206. *Candice Sherry*, (614) 889-7172: fax: (614) 889-7183.

Division of Geological Survey
Ohio Dept. of Natural Resources
4383 Fountain Square Drive, Columbus, OH 43224-1362. *Thomas Berg*, (614) 265-6576; fax: (614) 447-1918.

Oklahoma Civil Emergency Management Agency
P.O. Box 53365, Oklahoma City, OK 73152. *Larry Brewer*, (405) 521-2481; fax: (405) 521-4053.

Oklahoma Geological Survey
100 East Boyd, Room N-131, Norman, OK 73019-0628. *Jim Lawson*, (405) 325-3031; fax: (405) 325-3180.

South Carolina Emergency Preparedness Division
1429 Senate Street, Columbia, SC 29201. *Tammie Dreher*, (803) 734-8020; fax: (803) 734-8062.

South Carolina Geological Survey
5 Geology Road, Columbia, SC 29210-9998. *C.W. (Bill) Clendenin* (803) 896-7702; fax: (803) 896-7695.

Virginia Department of Emergency Services
310 Turner Road, Richmond, VA 23225-6491. *Addison Slayton*, (804) 674-2499; fax: (804) 674-2490.

Non-Government Organizations

American Red Cross (ARC)
Disaster Services, National Headquarters, 615 N. Asaph St., Alexandria, VA 22314, *Ken Deutsch Associate for Mitigation,* (703) 206-8631.

Building Seismic Safety Council (BSSC)
1201 L Street, NW
Washington, DC 20005.
Jim Smith, Executive Director, (202) 289-7800.

Center for Earthquake Research and Information (CERI)
University of Memphis, 3890 Central Avenue, Memphis, TN 38152
James Dorman, Director;
Jill Johnston, Manager, Seismic Resource Center, (901) 678-2007.

Disaster Research Center (DRC)
University of Delaware
Newark, DE 19716, *Joanne Nigg, Director,* (302) 831-6618; fax: (302) 831-2091.

Earthquake Engineering Research Institute (EERI)
499 14th Street, Suite 320, Oakland, CA 94612-1902. *Susan Tubbesing, Executive Director,* (510) 451-0905; fax: (510) 451-5411.
Alan Scott, President, New Madrid Chapter, (314) 726-1771; fax (314) 726-5355.

Insurance Institute for Property Loss Reduction (IIPLR)
73 Tremont Street, Suite 510, Boston, MA 02108-3910, *Eugene LeComte, President and CEO,* (617) 722-0200; fax (617) 722-0202.

National Center for Earthquake Engineering Research (NCEER)
State University of New York at Buffalo, Red Jacket Quadrangle, Box 610025, Buffalo, NY 14261-0025. *George Lee, Director, Patricia Ann Coty, Manager, Information Services.* (716) 645-3391; fax (716) 645-3399.

New England States Emergency Consortium (NESEC)
607 North Ave., Suite 16
Wakefield, MA 01880, *Ed Fratto, Executive Director,* (617) 224-9876; fax (617) 224-4350.

Southern Building Code Congress International
900 Montclair Road
Birmingham, AL 35213-1206
*Rick Vognild, Director/Technical Service*s, (205) 591-1853; fax (205) 592-7001.

Going on-line in the Central U.S.

http://gandalf.ceri.memphis.edu/~cusec/index.html
CUSEC

http://www.state.il.us/iema
Illinois Emergency Management Agency

http://www.igis.uiuc.edu/isgsroot/isgshome/isgshome.html
Illinois State Geological Survey

http://www.ai.org/sema/index.html
Indiana State Emergency Management Agency

http://www.state.ky.us/agencies/military/des.htm
Kentucky Office of Disaster and Emergency Services

http://www.state.mo.us/sema/semapage.htm
Missouri Emergency Management Agency

http://www.eas.slu.edu/SeismicSafety
Missouri Seismic Safety Commission

http://www.State.va.us/des/des.html
Virginia Emergency Management Agency

http://www.eas.slu.edu/Earthquake_Center/earthquakecenter.html
Saint Louis University Earthquake Center

http://www.ceri.memphis.edu
Center for Earthquake Research and Information

http://gandalf.ceri.memphis.edu/~rond/psn
Public Seismic Network

Western States Seismic Policy Council
121 2nd St., 4th Floor
San Francisco, CA 94105
Steven Ganz, Executive Director, (415) 974-6422; fax (415) 974-1747.
e-mail wsspc@slip.net

CONFERENCES AND TRAINING

EVENT	DATE	LOCATION
• Building Code Training (see page 12)	June 5-6	Greenville, SC
• Western States Seismic Policy Council Conf. Info: (415) 974-6422	Sept. 18-21	Polson, MT
• Emergency Planning in Utility Operations Info: CUSEC	Sept. 23	St. Louis

EVENT	DATE	LOCATION
• EERI Technical Seminar (see page 16)	Sept. 25-26	Memphis
• CUSEC Annual Meeting (see page 2)	Nov. 18-20	Memphis
• ASCE International Conf. and Expo on Natural Disaster Reduction	Dec. 3-5	Washington, DC
• EERI Annual Meeting	Feb. 12-15, 1997	Austin, TX

• ***For more information on training please contact CUSEC Headquarters or the Earthquake Program Manager with your State Emergency Management Agency.***

The **Central United States Earthquake Consortium** is a not-for-profit corporation established as a partnership with the Federal government and the seven member states: Arkansas, Illinois, Indiana, Kentucky, Mississippi, Missouri and Tennessee; and ten associate member states: Alabama, Georgia, Iowa, Louisiana, South Carolina, North Carolina, Ohio, Oklahoma, Nebraska and Virginia. The Federal Emergency Management Agency provides the basic funding for the organization.

CUSEC's purpose is to help reduce deaths, injuries, damage to property and economic losses resulting from earthquakes occurring in the central United States. Basic program goals include: improving public awareness and education, mitigating the effects of earthquakes, coordinating multi-state planning for preparedness, response and recovery; and encouraging research in all aspects of earthquake hazard reduction. CUSEC supports the International Decade for Natural Disaster Reduction.

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Elaine Clyburn.....**Red Cross Liaison**
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