Final Report

of the

Missouri Earthquake Insurance Task Force

Missouri Department of Insurance,
Financial Institutions
& Professional Registration

December 19, 2008

Missouri Earthquake Insurance Task Force

On November 19, 2007, Missouri Governor Matt Blunt asked Doug Ommen, then the Director of the Missouri Department of Insurance, Financial Institutions and Professional Registration (DIFP), to lead a new Missouri Earthquake Insurance Task Force. The group's mission was to provide a comprehensive report with recommendations on how to improve structural safety standards, insure private and public infrastructure and promote continued economic growth in areas near the New Madrid fault. The governor named the following members to serve on the commission:

- Sen. Maida Coleman, Missouri Senate, District 5
- Sen. Rob Mayer, Missouri Senate, District 25
- Rep. Billy Pat Wright, Missouri House of Representatives, District 159
- Rep. Terry Swinger, Missouri House of Representatives, District 162
- Jim Boone, St. Louis, Associated General Contractors of St. Louis
- Janis Borges, Columbia, State Farm Insurance Company
- Charlie Brown, Kennett, Missouri Association of Independent Agents
- Charles Burhan, Shaumburg, IL, Liberty Mutual Insurance Group
- Darwin Copeman, Cameron, Cameron Mutual Insurance Company (represented by Richard "Dick" Kline)
- Mimi Garstang, Rolla, State Geologist of the Missouri Department of Natural Resources (subsequently replaced on the Task Force by Joseph Gillman, the new State Geologist)
- Chris Krehmeyer, St. Louis, Beyond Housing, consumer advocate
- Stacy Mansfield, Jackson, Southeast Missouri Homebuilders Association
- Dave Monaghan, Jefferson City, American Family Mutual Insurance Company
- Randy Noland, Maryland Heights, Missouri Association of Building Officials and Inspectors
- William Placht, Union, Missouri Association of Code Administrator
- Theodore Pruess, Hazelwood, Larson Engineering
- Kent Runyan, Columbia, Shelter Mutual Insurance Company
- Bob Schreiber, St. Louis, Auto Club Family Insurance Company
- James Swope, Overland Park, KS, Farmer's Insurance Company (subsequently replaced by Paul Crosetti)
- Mike Voiles, Jefferson City, Farm Bureau
- James Wilkinson, Memphis, TN, Central United States Earthquake Consortium

Task Force Hearings

The task force held four public meetings in 2007 and 2008. The first meeting was held at the Wainwright State Office Building in St. Louis on December 17, 2007. The task force discussed earthquake insurance coverage statistics and trends, and information about the catastrophic insurance market both in Missouri and in other states. In addition, each insurance company representative on the task force reported on his or her company's changes in earthquake insurance coverage and deductibles over the previous 10 years.

The task force held its second meeting on January 18, 2008 at the Missouri Department of Transportation's Management Center in Chesterfield, Missouri. The meeting included presentations on national trends in catastrophic insurance and state programs in California, Louisiana, Illinois and Arkansas. The task force also discussed Senate Bill 877, legislation introduced in the Missouri General Assembly during the 2008 session, which would have created

a "Missouri Catastrophic Fund." And, the task force heard testimony on the effects of adopting building codes as a way of enhancing the disaster-resistance of new buildings, and on retrofitting existing structures as a way of minimizing earthquake damage.

The task force held its third meeting on June 24, 2008, again at the MoDOT Transportation Management Center in Chesterfield, Missouri. The task force heard about the role of reinsurance in the financing of primary insurance for catastrophic events, about the relatively-new Florida Hurricane Catastrophe Fund and more about how building codes can help to reduce the damages of an earthquake. The task force also discussed various options for financing earthquake resistant construction, such as tax increment financing.

The task force held its final meeting on September 17, 2008 in Room B-7 of the Capitol Building in Jefferson City, Missouri. At this meeting, the task force reviewed what it had learned in the prior meetings and provided staff with an outline of suggestions to include in its final report.

Executive Summary - Key Task Force Conclusions:

- The **Earthquake Threat Is Real, as Documented Through Historical Evidence and On-Going Research.**
- **The Earthquake Threat to Missouri Is Significant.**
- **DIFP Should Acquire Proficiency with FEMA's HAZUS Computer Model.**
- **DIFP's Collection of Earthquake Insurance Data Should Be Improved in a Few Key Areas.**
- **Other states have addressed concerns with their catastrophe insurance markets in various ways, such as establishing market assistance plans (MAPs), providing coverage through their property insurance FAIR plans, establishing state earthquake authorities to write primary coverage, and establishing state reinsurance mechanisms to provide reinsurance to the primary insurance marketplace. Any alternative implemented in Missouri should weigh the benefits and limitations experienced by these approaches in fashioning an alternative best-suited to the unique needs of Missouri.**
- **In the Future, Buildings in the Earthquake Zone Should be Built at Least to "Code Standards" Regardless of Whether a Building Code is in Place.**
- **"Mitigation" Techniques Can Reduce Damages for Existing Structures.**
- **Long-Term Planning & Coordination Should Continue, Emphasizing an Expanded Public Information Campaign.**

Background: The Earthquake Threat of the New Madrid Seismic Zone

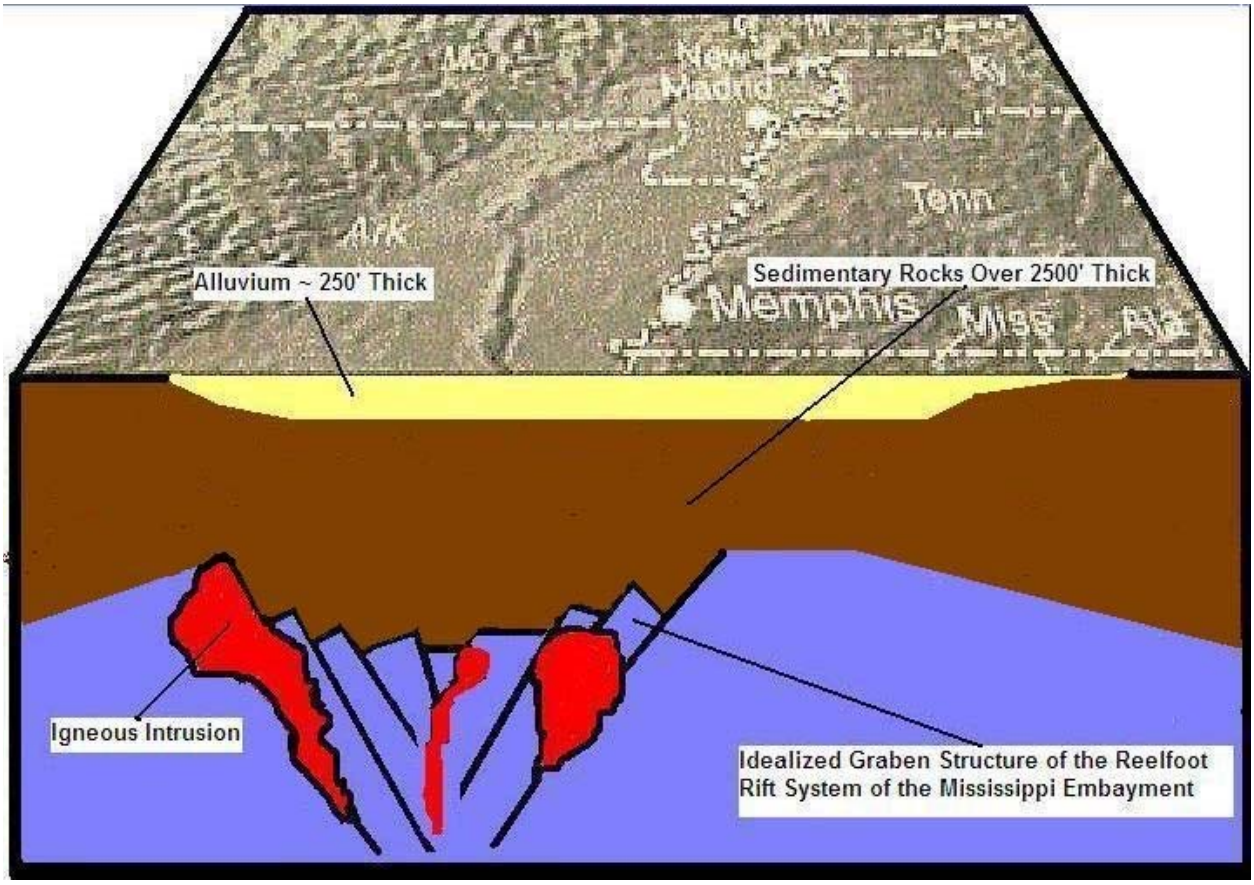
While many Americans are familiar with the earthquake threat faced by the state of California, far fewer are aware of the sizable threat also faced by the mid-continent region near the confluence of the Ohio and Mississippi Rivers. Historical evidence and scientific studies over the past 25 years indicate that this latter region faces a significant earthquake threat. The mid-continent region is the location of two areas of active seismicity, the Wabash Seismic Zone along the border between Illinois and Indiana near the Ohio River, and the New Madrid Seismic Zone (the NMSZ) near the "bootheel" of southeastern Missouri, roughly paralleling the Mississippi River. It is the NMSZ that was of principle concern to the Missouri Earthquake Insurance Task Force.

The causes of earthquakes in the mid-continent region differ from the causes on the West Coast of the United States. It is well established that the West Coast's seismicity is connected to the interactions of two "tectonic plates," which are enormous, slowly-moving regions of the Earth's outer crust. In the case of the West Coast, the North American and the Pacific tectonic plates are grinding against each other at their interface along the 800-mile-long San Andreas Fault in California. The North American plate is moving in a roughly southerly direction, while the Pacific plate is moving north. The two plates do not glide smoothly past one another; rather, irregularities in the rocks create friction, which can accumulate as stress, the potential energy of which is periodically released as an earthquake. Similar areas of inter-plate friction are the source of earthquakes at other places on the planet's surface, such as in Alaska and Japan. Because the plate-against-plate fault lines are frequently visible on the surface of the earth in these regions, the earthquake-causing dynamics of these plate interface earthquakes have been heavily studied by scientists.

In contrast, the New Madrid Seismic Zone is not at the interface of two moving tectonic plates, but rather, lies closer to the middle of the vast North American tectonic plate. In addition, its main components are not visible from the surface, but instead, are buried below the surface under miles of ocean, glacier and river sediments. Nevertheless, geologists have been able to map the subsurface geology using a number of techniques and have constructed the following theory on how the region, and its accompanying earthquakes, developed.

Geologists estimate the earth is roughly 4.5 billion years old. At various times, its surface has been dominated by a single super-continent surrounded by ocean. Roughly 1 billion to 750 million years ago, the single super-continent then dominating the globe was the landmass scientists refer to as "Rodinia." Around 600 million years ago, it began to split apart, and the region that now makes up the continent of North America began to be pulled in opposite directions. Had these "extensional forces" continued, the area from the current Gulf of Mexico to the current NMSZ would have been ripped apart and permanently replaced by an ocean. However, the process seems to have stopped around 500 million years ago, resulting in what is now referred to as a "failed rift." This structure – know by its current label, "the Reelfoot Rift"– includes a central linear drop-down fault segment (or "graben") flanked on either side by uplifts. This rift covers an area approximately 40 miles wide and 180 miles long, and stretches from the Missouri bootheel southwest into Arkansas. At various places within the rift system, large deposits of molten igneous rock have intruded from below. Since its initial formation, the rift has undergone various transformations. At different times, it was covered by water, filled in with marine sediments, raised above water and eroded, covered with water again and, over the

last 100 million years, it was over-topped with additional marine sediments, sediments from glacier run-off, and sediments from the meandering Mississippi River. The illustration below provides a stylized cross-section of the major components of the Reelfoot Rift System, as it is currently understood.

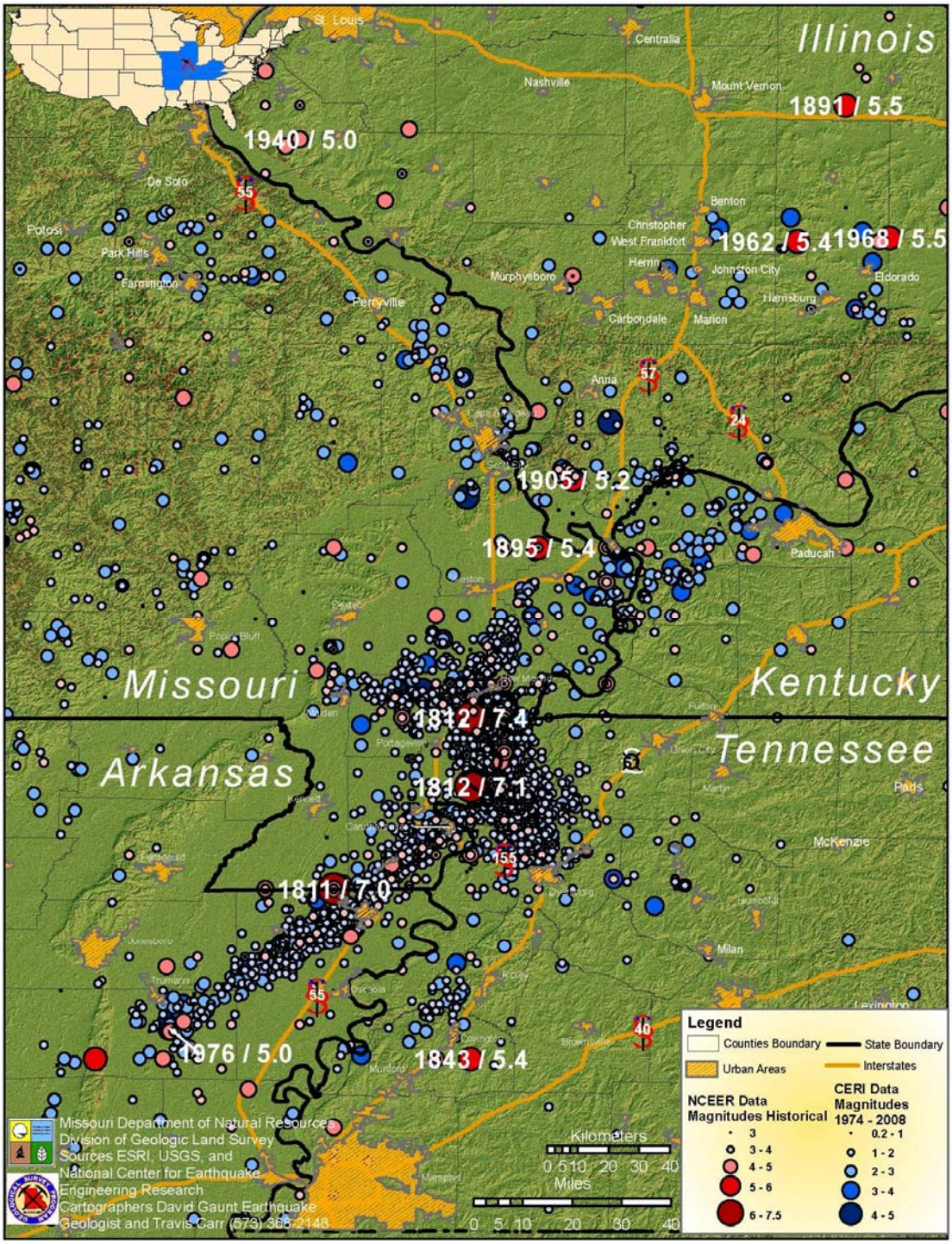


Source: Missouri Department of Natural Resources, Division of Geology & Land Survey.

It is now thought that the fault lines of the original failed rift and the igneous deposits associated with them are related to the area's current seismicity, with the ancient fault lines having been reactivated by compressive stress from the surrounding area.

The New Madrid Seismic Zone is currently "active," with a network of monitoring instruments recording more than 4,000 earthquakes since 1974. The map on the following page shows the distribution of many of these recent events [in blue], plus a number of historical events as well [in red]. Prominent among the latter, historical events are at least three major earthquakes that occurred near the Missouri bootheel in the winter of 1811-1812. While modern seismographs were not then available to record these earthquakes, scientists have looked at historical accounts of their damaging aftereffects and the geological evidence preserved in the soils of the region to estimate their size and destructive power. Based on these analyses, each of these quakes was roughly of magnitude 7 to 7.5, making them the strongest earthquakes felt in the area of the contiguous United States since the arrival of the Europeans. The three main earthquakes occurred on December 16, 1811, January 23, 1812 and February 7, 1812. The last of these had its epicenter near the town of New Madrid, then part of the Louisiana Territory, now part of Missouri; hence the name of the currently active seismic zone. According to a summary by the

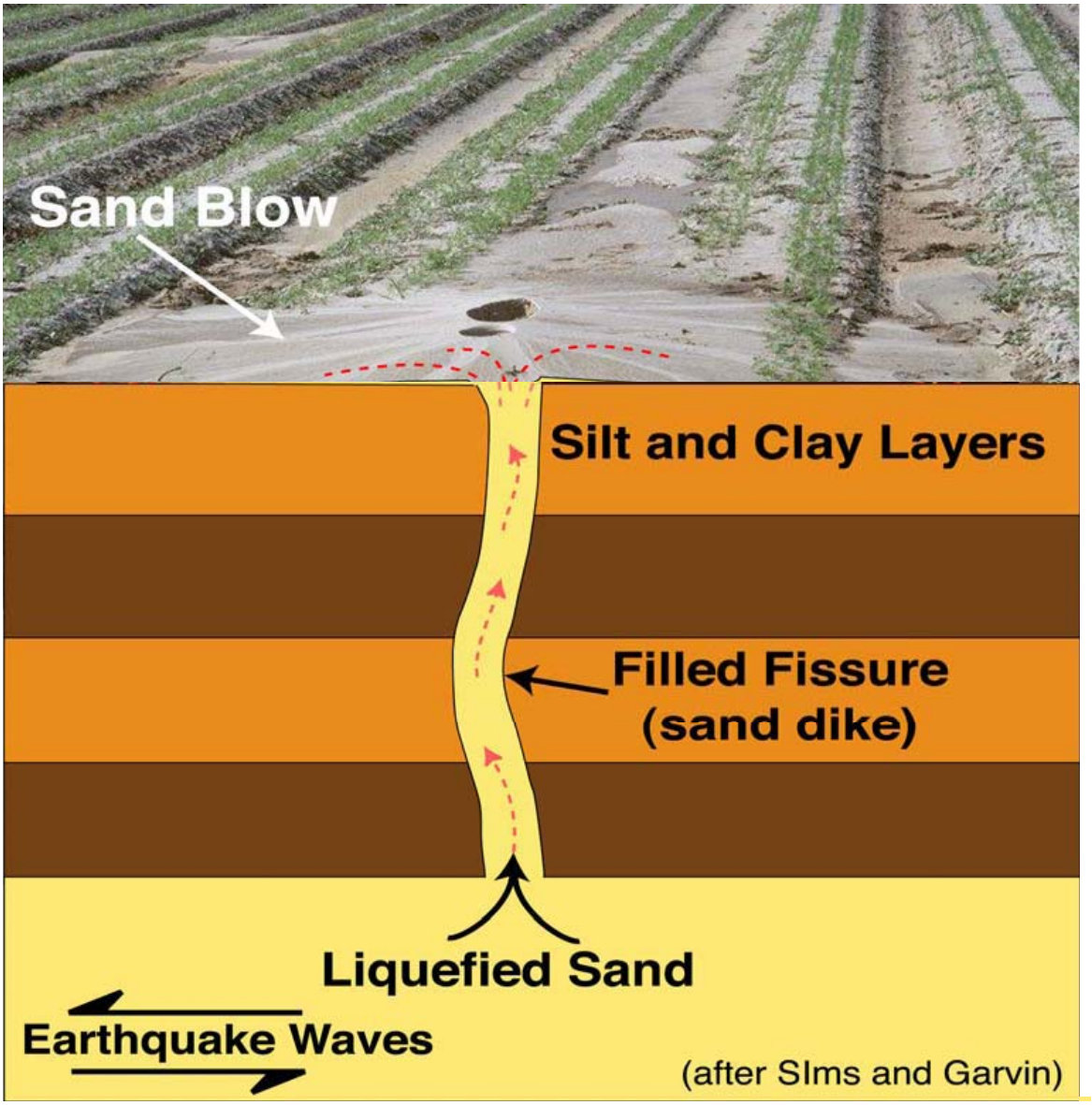
U.S. Geological Survey ("USGS"), in addition to the main quakes, studies have estimated that more than 200 additional moderate to large quakes occurred between December 16, 1811 and March 15, 1812, plus another 1,800 smaller events.



The news reports and diaries of the period have been studied to gauge the power of these tremors. The main three main quakes were felt through much of the land east of the Mississippi

to as far away as Quebec and Maine. The vibrations rang church bells in Boston, 1000 miles away. Huge waves in the Mississippi River overwhelmed some boats and washed others ashore. The small town of Little Prairie had to be abandoned and New Madrid was largely destroyed. Destruction to man-made structures was limited due to the sparse population in the area at that time; nevertheless, according to the USGS, many houses in St. Louis were severely damaged or had their chimneys thrown down.

Geological studies have provided further evidence of the power of these events. At least 221 landslides occurred along the Eastern bluffs of the Mississippi River's alluvial plain. In addition, massive liquefaction occurred wherein the unconsolidated sand and gravel buried beneath muddier river sediments were forced up to the surface, creating so-called "sand blows," (see diagram below) which have the appearance of mini "sand volcanoes."



Source: Sims, J. D. and C. D. Garvin, (1995), "Recurrent Liquefaction Induced by the 1989 Loma Prieta Earthquake and 1990 and 1991 Aftershocks: Implications for Paleoseismicity Studies," Bull. Seis. Soc. Amer., 85, no. 1, 51-65.

Studies have estimated that hundreds of square kilometers were as much as 25%-covered by the liquefied sand that was forced to the surface. Modern aerial photographs readily capture a landscape liberally dotted with the large, light-colored sand deposits produced by these historical sand blows.

Such sand blows are thought to form only in response to the larger earthquakes, those of magnitude 6.0 and above. As it turns out, they have become a focus of the on-going research to learn more about the pre-historic earthquake history of the NMSZ. While the sand blows from earthquake of the last several hundred years are at the surface of the ground, sand blows of earlier quakes have been covered in the intervening years by a layer of alluvial soil deposited by the meandering Mississippi River. The thicker the over-burden, the older the earthquake represented by the sand blow. Scientists have been able to estimate the approximate age of a number of large earthquakes in the region by using radio-carbon dating of organic materials in the sand blows, as well as dating the age of associated Native American artifacts found at the sites. These studies provide evidence for significant earthquakes in the region circa 900 A.D. and later, circa 1450 A.D. (There is also some evidence to suggest that these were "multiple" events, like the 1811-1812 series, a point which will be discussed later.) These studies suggest that earthquakes strong enough to induce liquefaction (i.e., an earthquake of magnitude 6.0 or greater) occur roughly every 70 to 90 years and larger earthquakes of magnitude 7.0 or greater occur roughly every 250 to 500 years.

Additional paleogeological studies of the region will help establish the magnitude and the approximate dates of the other major earthquakes that have hit the area in even earlier times. Some studies have produced evidence of earthquake circa 300 A.D. and 2350 B.C. Such additional information on prior earthquakes will help clarify whether major earthquakes in the region follow any type of pattern or cycle. Based on what is know today, the USGS and the Center for Earthquake Research and Information ("CERI") of the University of Memphis now estimate the probability of an earthquake of magnitude 6.0 or greater (i.e., large enough to cause serious damage near its epicenter) occurring in the next 50 years to be anywhere from 25 to 40%, while a repeat of the larger1811-1812 earthquakes (magnitude between 7.0 to 7.5) occurring during the next 50 years to be a less-probable 7 to 10%.

However, without a clear understanding of the earthquake process in the region, it is impossible to guarantee that a major earthquake will not happen tomorrow.

Task Force Conclusion

The Earthquake Threat In Missouri Is Real, as Documented Through Historical Evidence and On-Going Research: The evidence from a number of independent sources clearly establishes the existence of the earthquake threat in Missouri. Historical records from the winter of 1811-1812, paleoarcheological evidence of major quakes from prior centuries and the data from modern geologic mapping and seismographic instruments provide substantial support for the notion that the New Madrid Seismic Zone has been the source of massive earthquakes in the recent past and continues to be seismologically active to this day.

The Potential Cost of a Major New Madrid Earthquake

The use of computer modeling has revolutionized the ability to predict the losses associated with natural disasters. One major impetus was Hurricane Andrew, which caused in excess of $45 billion in losses in 1992, leading to the insolvency of 11 insurance companies. One problem insurers recognized after Andrew was the need to spread their insured properties over a wide enough geographic range so that a single hurricane would not present an overwhelming financial burden. This led to the use of computers to analyze the geographic distribution of covered properties and the likely pay-out for a given size hurricane. Such computer modeling was soon used to quantify the effects of other natural disasters, including earthquakes. Several private catastrophe modeling companies have sprung up to provide the insurance industry with such computer modeling programs.

The Federal Emergency Management Agency (FEMA) has developed one such program for use by state and local governments in planning for major disasters. This program, the Hazards U.S - Multi-Hazard or "HAZUS-MH" program was used by the Mid-America Earthquake Center (MAE Center) of the University of Illinois at Urbana-Champagne to estimate the losses due to a major earthquake on 8 central U.S. states, including Missouri. Their report, entitled "Impact of Earthquakes on the Central USA," (hereinafter, the MAE Center Report) was released in September of 2008. The methodology employed by the MAE Center regarding the NMSZ was to model a "worst-case" event for each of the surrounding states, which included moving the "modeled" magnitude 7.7 earthquake along the length of the NMSZ to the point where it would produce the highest damages for the state in question. This model requires detailed information on soil type and thickness and bedrock characteristics to produce accurate estimates of anticipated effects. The MAE Center utilized regional geologic and soils information from the Missouri Department of Natural Resources, Division of Geology and Land Survey (MDNR, DGLS) to modify some of the default settings in the model to reflect the conditions in the mid-continent area, including liquefaction susceptibility, structure inventory updates and advance social impact modeling. The damages resulting from the modeled scenario are sobering:

Modeled Losses (for Missouri): Magnitude 7.7 NMSZ Earthquake

Total Casualties (of some kind)	**15,639**
Total Fatalities	**760**
Total Economic Losses	**$38.7 billion**
Sub-Total Utility Losses	$25.1 billion
Sub-Total Building Losses	$11.8 billion
Sub-Total Transportation Losses	$ 1.7 billion
Total Tons of Debris	**6.0 million tons**
Sub-Total Brick, Wood, Contents	2.9 million tons
Sub-Total Steel and Concrete	3.1 million tons
Persons Displaced	**122,000**
Shelter Space Requires	17.6 million square feet
1st Week's Water Need	1.28 million gallons
1st Week's Ice	2.05 million pounds
1st Week's Food	24 Truckloads (513,828 MREs)

Admittedly, this is a worst-case scenario, based on the occurrence of a magnitude 7.7 earthquake, which, according to the USGS estimates, has a likelihood of occurring within the next 50 years of *less than* 7-10%. But note that the $38.7 billion figure represents only Missouri losses; a major NMSZ earthquake would likely have significant impacts on Tennessee, Kentucky, Illinois and Arkansas. The MAE Center Report repositions the worst-case earthquake in different locations in the NMSZ for each state, but the total economic losses for these eight worst-case models are as follows:

Alabama	$ 1.1 billion
Arkansas	$ 18.9 billion
Illinois	$ 34.1 billion
Indiana	$ 1.4 billion
Kentucky	$ 46.0 billion
Mississippi	$ 9.5 billion
Missouri	$ 38.7 billion
Tennessee	$ 56.6 billion

(Note: As stated in the MAE Center Report: "Though numerous scenarios have been completed, it is important to emphasize that impacts from each scenario *should not* be combined for regional assessment. With each scenario employing a different earthquake (hazard), even within the NMSZ, adding all impacts together represents an event that could not take place. On the other hand, it could be argued that the 1811-1812 earthquakes were three consecutive and potentially damaging events that current modeling tools are *incapable* of representing. Emergency planning, response and recovery decision-makers should weigh these factors in their efforts to balance the potentially conservative and non-conservative assumptions that are inevitable in a large regional study of earthquake impacts such as that described in the current report." [Emphasis added.] From page 88.)

By comparison, the *insured* damages from Hurricane Katrina in 2005 (the largest single natural disaster in recent years) were $45 billion, with an additional $127 billion in federal aid and reconstruction expenditures.

The overall impact of a NMSZ earthquake will be significant. The MAE Center Report provides the following description in its "Discussion and Conclusions" section:

> Critical infrastructure and lifelines will also be heavily damaged and will be out of service after the earthquake for a considerable period of time. Such mass outages are likely to affect a region much larger than the 8 states studied above. Many hospitals nearest to the rupture zone will not be able to care for patients, indicating that those injured during the event will have to be transported outside of the region for medical care. Moreover, pre-earthquake patients will have to be moved out of the area to fully functioning hospitals. It is doubtful that the transportation system will be functioning to a level that allows such mass evacuation. Police and fire services will be severely impaired due to damage to stations throughout the impacted region. Many schools that serve as public shelter will be damaged and unusable after the earthquake. Transportation into and out of the areas near the fault rupture will be difficult if not impossible. Many bridges will be damaged and not passable, airports will be damaged and some ferry facilities and ports will be out of service. The massive loss of functionality of transportation systems

> and facilities will prevent displaced residents from leaving the region and also make it difficult for ground-transported aid workers and relief supplies to access the most heavily damaged areas.
>
> Utility services will be severely disrupted for hundreds of thousands of customers due to extensive facility and pipeline damage. Extended service outages will be highly likely for tens of thousands of customers, making it difficult for them to remain in their homes, even if they are structurally sound after the earthquake. Damage to major natural gas and oil transmission lines will lead to service interruptions that will affect areas as far away as the east coast and New England.
>
> Social impact estimates show that hundreds of thousands of people will be displaced and tens of thousands of people will seek temporary public shelter after a major earthquake on the New Madrid fault. Three successive earthquakes, as in 1811-1812, will generate even more catastrophic impacts. Casualties in the tens of thousands are likely, especially with a southwest segment rupture. Most of these will be minor injuries, though several thousand serious injuries and fatalities are also predicted. In addition, debris generated from this event may reach several hundred thousands tons, which will have to be removed prior to repair and reconstruction efforts. (Pages 88 and 89.)

In addition to helping to quantify the potential impact of a major NMSZ earthquake, the MAE Center Report points out the importance of computer models as long-term planning tools. Over the last few years, DIFP has had some exposure to such models as part of its examination of the premium rates being proposed by insurance companies based on such models. Since it is likely the use of such models will continue for the foreseeable future, the Task Force recommends that DIFP develop a greater understanding of the assumptions, inputs and outputs of such models by becoming trained in the use of the relatively inexpensive HAZUS-MH MR2 program that was the basis for the MAE Center's analysis. This will give DIFP a greater appreciation of the mechanics of the proprietary, third-party models used by the insurance industry, and it may allow DIFP to help advise local Missouri jurisdictions who may be considering using HAZUS for their own disaster preparation initiatives. As a first project, DIFP might consider running the model to simulate the type of moderate earthquake that is more likely to occur in the following couple decades than the worst-case magnitude 7.7 event modeled in the MAE Center Report.; particular attention should be given to the effect of such a moderate quake on the various bootheel counties. Based on the concerns voiced in the MAE Center Report, attention should also be given to the evaluating the adequacy of the current "inventory" for items such as oil and natural gas pipelines, utility power lines and cell phone towers.

Task Force Conclusion

The Earthquake Threat to Missouri Is Significant: While the MAE Center's HAZUS results are based on computer modeling, they nevertheless hint at the enormity, in both social and economic terms, of the potential damage from a major New Madrid earthquake. And, given the region's status as a transportation and infrastructure hub, significant nationwide repercussions would also be likely, as bridges, highways, airports, river ways, pipelines and fiber optic lines were damaged.

DIFP Should Acquire Proficiency with FEMA's HAZUS Computer Model.

Before moving on to the insurance aspects of a New Madrid earthquake, it is important to note a number of points made by the MAE Center regarding the implications of their analysis for future research. Chief among these is the issue of the potential effects of *a series of earthquakes* occurring in succession, one on each of the three identified fault segments of the NMSZ. Current damage assessment, liquefaction, structural fragility and social impact models are based on the occurrence of a single major event. We need to assess both the probabilities of and implications of a second or third earthquake occurring in the NMSZ. Historical information from the 1811 - 1812 series of earthquakes, plus early results from the on-going paleogeological studies in the region, hint that multiple events are a real possibility. In addition, more detailed soil / liquefaction data need to be gathered, updated inventories of key infrastructure components, such as utility distribution networks and cell phone towers, need to be collected, and structural fragility relationships for infrastructure such as chemical plants, communications and electrical towers, need to be developed.

Background: The Challenge of Insuring Against Catastrophic Losses

Ideally, insurable events are both predictable and independent. A predictable event is one in which meaningful probabilities can be assigned regarding the likelihood of an occurrence and the amount of the loss – paid out as claims – should the event occur. Statistically speaking, events become more predictable the more often they occur. Independent events are ones for which the occurrence of one event is unrelated to the occurrence of a second event. Automobile accidents are good examples of ideal insurable events: they happen often so the likelihood of and amount of losses are more predictable, and they only affect a few policyholders at a time, independent of each other.

Catastrophic risks such as earthquakes are *not* ideal as insurable events because they violate these general principles. They occur very infrequently, making it difficult to predict the likelihood or amount of the potential losses, and they typically affect a large number of policyholders at the same time. Unlike auto insurance, where accidents happen on a daily, even hourly basis, thereby providing a large sample size of events upon which to make predictions, earthquakes of a magnitude large enough to generate claims, especially in the areas near the NMSZ, occur very infrequently. Indeed, even when compared to other forms of catastrophic natural disasters, such as tornados, hail storms and hurricanes, loss-generating NMSZ earthquakes are still rare.

In addition, a major NMSZ earthquake, should it occur, will affect thousands of people at the same time. In the MAE Center analysis of the effects of a magnitude 7.7 earthquake on Missouri, a total of 84,567 single-family, other residential, commercial and industrial structures would be damaged, with 36,891 suffering complete destruction. Similar damage would be suffered in the adjoining states, depending on the location of the quake, meaning that insurance companies would experience multiple large claims at one time.

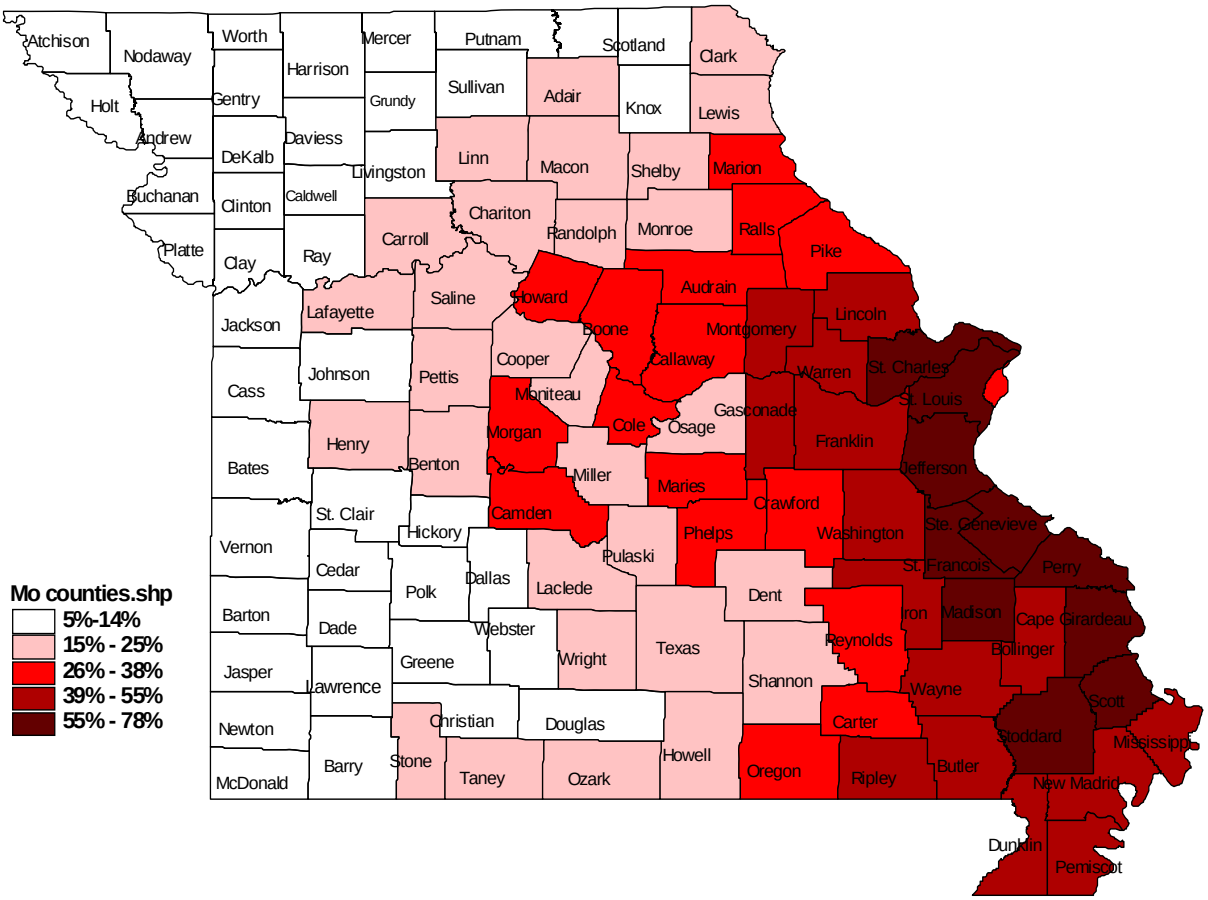
Arguably, the fact that earthquakes are far from "ideal" when it come to their insurability is the reason they present the kind of public policy problem that justifies examination by a special task force. The main tension is between, on the one hand, relying on the private insurance market to provide the insurance coverage and, on the other hand, using some form of public insurance, either as an alternative to the private market or as a supplement to it. When one major insurer

recently withdrew from the Missouri earthquake insurance market, it was a reminder that there have been periods in the recent past, notably in California after the Northridge earthquake, when the private market for earthquake insurance contracted so much that the state created its own, alternative, state-run earthquake insurance mechanism. But, as we will see, Missouri's market remains relatively healthy. As such, the question is whether or not state policymakers need to take any actions now, in advance of a major earthquake event.

Recent Changes To The Earthquake Insurance Market In Missouri

Missouri is the third largest market for earthquake insurance coverage in the United States, after the states of California and Washington. In 2007, Missouri homeowners and business owners spent nearly $80.5 million on earthquake coverage. Currently, 35% of Missouri homes have earthquake insurance coverage. Data collected by the Missouri Department of Insurance, Financial Institutions and Professional Registration (DIFP) indicates the following:

Percent of residential policies with earthquake coverage, 2007

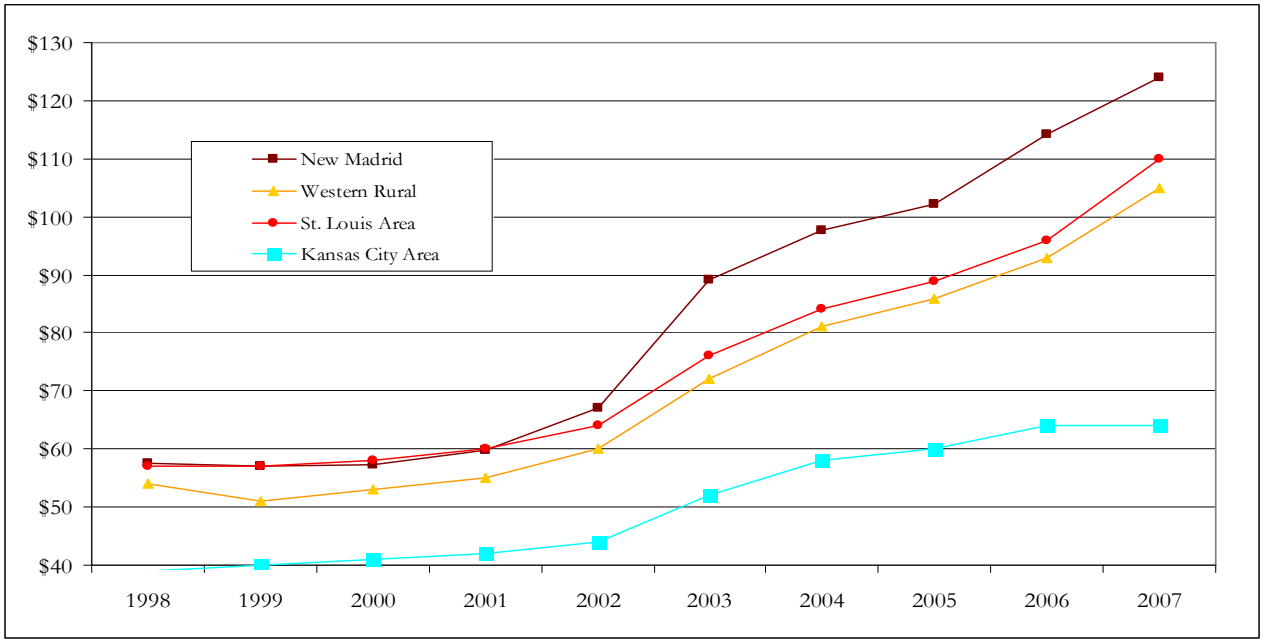


Percent of residential policies with earthquake coverage, 1998-2007

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	% Point Change
New Madrid Area	60.9%	59.3%	60.2%	59.4%	59.0%	57.7%	57.2%	57.1%	53.0%	53.9%	-7.0%
St. Louis & Area Co. s	70.8%	72.1%	71.1%	74.3%	71.7%	70.8%	69.7%	68.3%	64.4%	58.3%	-12.5%
Non-Metro Eastern Mo.	60.9%	60.7%	59.8%	58.6%	58.7%	57.9%	57.1%	56.5%	54.5%	53.8%	-7.1%
Kansas City Area	19.5%	18.9%	17.9%	17.3%	16.3%	15.2%	14.1%	13.5%	12.8%	11.9%	-7.6%
State Wide	44.6%	44.8%	43.6%	43.0%	42.7%	41.7%	40.7%	39.8%	37.7%	35.1%	-9.5%

The Missouri earthquake insurance market has experienced some volatility in recent years. Since 2000, 17groups of insurance companies covering 83,791 residences in Missouri have left the market. Nearly half of this number is attributable to the exit of the Allstate companies from the catastrophe insurance market in 2007. In that same time, 8 different groups of insurance companies began offering earthquake coverage in Missouri and in 2007 they covered 25,498 residences. The total number of residential exposures in Missouri has declined from 670, 968 in 2000 to 610,541 in 2007. Over the last decade, coverage has remained fairly affordable and available, with a relatively steady contraction of the market and a constant upward pressure on prices, as can be seen in the following graph from DIFP statistics:

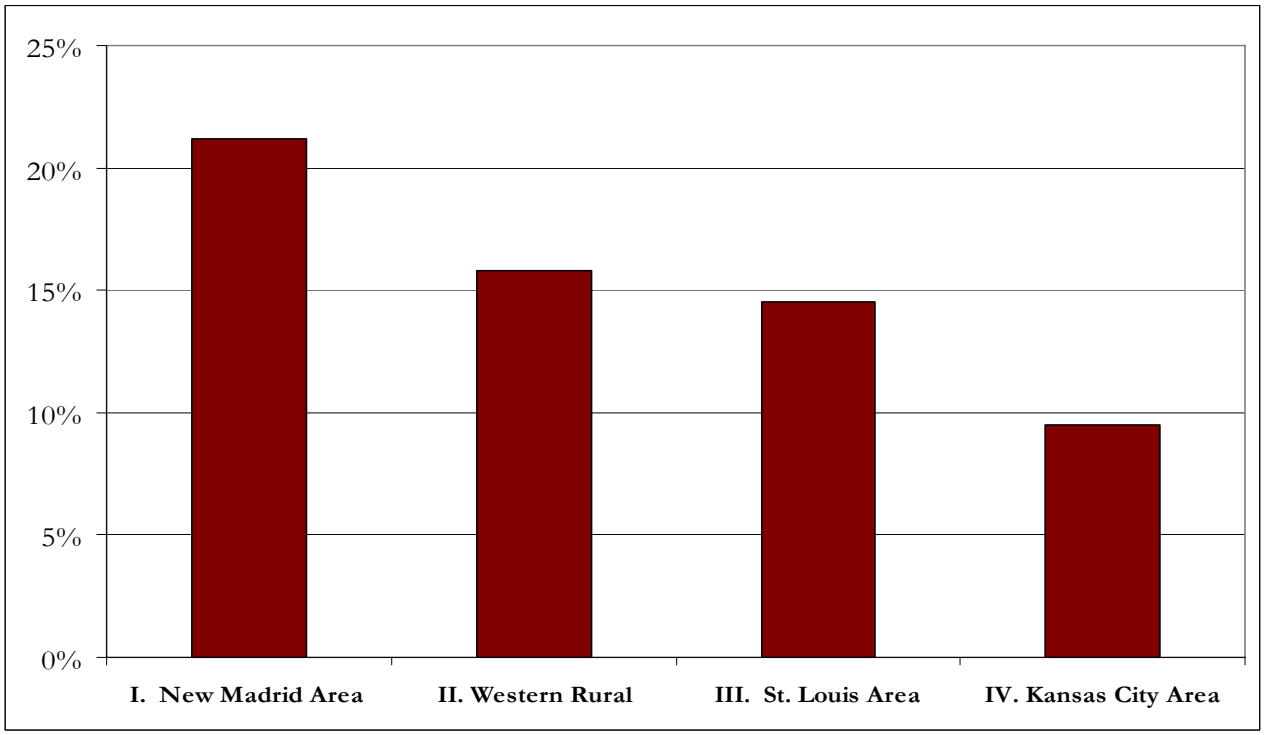
Annual Cost of Earthquake Coverage, 1998 - 2007



As might be expected, the earthquake coverage in those areas most prone to earthquakes is more expensive than elsewhere in the state. Earthquake insurance rates in the bootheel region of the

state, closest to the New Madrid Seismic Zone, have the highest rates, although areas north of the NMSZ along the Mississippi valley are also relatively high, due to the threat of damages associated with the potential for liquefaction of their muddy alluvial soils should an earthquake occur. Among recent rate changes filed with DIFP are increases by one major carrier in the earthquake coverage associated with homeowners insurance in the bootheel region of over 500% for Dunklin, Mississippi, Pemiscot and Scott counties, and roughly 100% increases in 18 other counties, including those in the St. Louis area. In addition, Insurance Services Office, Inc. (ISO) has filed "advisory loss cost" increases for commercial earthquake insurance with DIFP for use by its member insurers of between 17.9% and 48.5% for locations in the bootheel region. (The data from DIFP on the following chart compare the relative cost of earthquake coverage in the state.)

Ratio of Earthquake Premium to Remainder of Residential Policy Premium, 2007



Generally speaking, the statewide average cost is around 50 cents per $1,000. In the bootheel, it is well over $1 per $1,000.

The insurance companies that were represented on the Task Force have taken a variety of actions when it comes to changes in earthquake coverage over the past 10 years. A few companies have raised their minimum deductibles. Some no longer write policies for certain properties nearest the predicted epicenter of an earthquake or refuse to cover older buildings or buildings with masonry construction. One company has moved to more specific underwriting of individual buildings, evaluating structures, soils and other aspects of the property. Several no longer write earthquake coverage at all. However, there are some companies that have not changed their coverage or have only made a few minor changes in the most at-risk locations. Most companies have made some changes to their coverage, but these changes are not uniform from company to company.

While the statistics and graphs presented above indicate the earthquake insurance market is currently being closely monitored by DIFP, the Task Force's investigation revealed a number of areas where this data collection should be expanded to provide a more accurate representation of the market. One area of current interest is the deductible levels associated with coverage. An increase in the deductible level of coverage means that homeowners are essentially "self-insuring" for a greater and greater degree of the risk. In other words, they will pay for a greater share of the losses out of their own pockets. Given the wide range in magnitudes of potential earthquakes, this means homeowners will likely cover the cost of the smaller events themselves, with reimbursement for their insurers coming only with the larger events. While the standard deductible on an earthquake policy used to be 5%, today, it is more likely to be 15 to 20%. Currently DIFP does not collect specific data on the deductible levels of earthquake insurance.

Another, less important "hole" in the data concerns commercial insurance. Currently, DIFP's data collection effort is focused on homeowners insurance. Since commercial operations are critical to the economic viability of a region, it seems prudent to collect earthquake insurance data on these as well, particularly since this information should be readily available from insurers. Similarly, DIFP's data does not capture the earthquake coverage provided through the loosely-regulated excess and surplus lines market (Lloyds of London, etc.). While it is unlikely this is a large portion of the coverage written in Missouri, Task Force members know that some E&S coverage is currently in force.

Another aspect of earthquake insurance not now captured in the DIFP's data collection effort relates to premium credits offered in association with earthquake coverage. Later in the report, the Task Force will discuss methods to improve construction techniques and mitigation measures. One method of encouraging such behaviors is through premium credits granted by insurers. Currently, there is at least one program on file with DIFP by the Insurance Services Office Inc. (ISO) for use by its member insurers designed to give credits to policyholders whose insured property is located in a jurisdiction which has enacted and enforced building code requirements. Currently, DIFP has no way of knowing the extent to which this program, or others that might be developed by individual insurers, are used to promote loss-reduction behaviors on the part of policyholders.

Finally, because much of the area surrounding the NMSZ is rural, it is possible that earthquake insurance coverage is being provided by so-called "county or farm mutuals," insurance entities that are lightly regulated under Missouri's insurance statutes. It is simply unclear at this point in time whether they are providing any significant level of earthquake insurance in the state. As such, the Task Force believes DIFP should conduct an informal survey of these entities to determine their role in the state's overall earthquake insurance market.

Task Force Conclusion

DIFP's Collection of Earthquake Insurance Data Should Be Improved. In order to better monitor the condition of the Missouri's earthquake insurance market, DIFP should collect data on deductible levels, E & S coverage, on commercial insurance and premium credits, in addition to the extensive data currently collected on homeowners insurance. It should also investigate the level of coverage provided by county and farm mutual companies.

Factors Affecting the Viability of the Missouri Earthquake Insurance Market

From the perspective of the Task Force, the preferred method of making earthquake insurance available and affordable to the public is to maintain a viable private insurance market. As the data collected by Missouri's DIFP discussed above indicate, there is currently a working market for this coverage in the state. To the extent carriers have withdrawn from the market, others have replaced them.

The primary factor governing the availability of earthquake insurance in Missouri is the ability of the primary insurers to absorb the losses of an earthquake. According to the MAE Center report, 65% of all direct economic losses can be attributed to utility lifelines. It is unclear at this point how much of this exposure (approximately $25 billion in losses from a 7.7 magnitude quake) is covered by the regulated insurance market. Of the losses suffered due to damage to buildings ($11.8 billion), most would be suffered by single family or other residential structures, according to the MAE Center report. Since, roughly speaking, only half of residences in the at-risk areas are insured, the insurance industry could face losses of around $6 billion in Missouri for a major event. Given the industry's overall loss-absorbing capacity, such a loss is manageable. It becomes more problematic as the number of states with similar losses for the same event are factored into the analysis.

A significant influence on the capacity of the primary insurance industry to take on risk is availability and affordability of reinsurance. Reinsurance is purchased by the primary insurance companies that issue policies to the general public in order to spread their risk, essentially insuring the insurers. About 50% of exposure of catastrophic coverage is now "backed up" by reinsurance. The reinsurance market is global in nature; costly catastrophic events, such as the 9/11 terrorist attacks and Hurricane Katrina, can significantly reduce the loss-absorbing capacity of this global market, temporarily reducing the availability or increasing the price of this coverage. Some smaller insurers indicated that reinsurance covers a comparatively larger portion of their risk because of their limited ability to spread risk across a geographic area. Given the relatively high percentage of coverage typically provided via catastrophic reinsurance, the premium rates charged by reinsurers for this protection can have a significant impact on the final premium rates charged to the public.

Recently, another factor affecting the availability and affordability of earthquake insurance came to light, namely, the decisions of the so-called "ratings agencies" such as A.M. Best and Standard & Poor's. These ratings agencies analyze various insurance company financial data to determine what financial rating "grade" to give each company. These grades can then be used as an evaluation tool by insurance buyers when comparing companies. Due to recent catastrophes, rating organizations have required companies with relatively large catastrophic exposures to significantly increase their financial reserves or face rating downgrades. Increasing reserve requirements therefore reduces an insurer's capacity to write new business, since each new policy must now be backed up by additional reserves

A final factor that can affect the availability and affordability of earthquake coverage that should be mentioned is the previously-discussed level of scientific uncertainty in the computer modeling insurers use to predict losses. This uncertainty makes the market vulnerable to significant

revisions in risk estimates. For example, revised geologic information led at least one modeler to significantly increase the assessed earthquake risk in the St. Louis area. In addition, the development of "loss amplification factors" in catastrophe models, incorporated after Hurricane Katrina, also affect affected earthquake modeling. Some examples of loss amplification factors are civil unrest and prolonged disruption of services. As earthquake science and catastrophe modeling mature, it is possible that additional risks will be identified that put upward pressure on the cost of coverage, thereby reducing availability and affordability.

Current Availability and Affordability in Missouri

If there is a concern on the part of the general public about the state of the earthquake insurance market in Missouri, it would seem (based on the anecdotal experience of the Task Force) to be that some segments of the population are beginning to conclude that the increasing cost of the coverage is no longer worth the benefit of the coverage, given the low probability of an earthquake in the near term. This is perhaps understandable; according to DIFP statistics, while Missourians spent $75.9 million for residential and commercial earthquake coverage in 2006, the losses paid out for that coverage added up to $155,399 or two-tenths of one percent of premium. As the graph at the bottom of page 13 shows, the number of policyholders has seen a moderate but steady decline over the last decade. Insurance agents report that the typical deductible on a policy has gone from 5% in the early 1990s to 20% or 25% today, meaning the policyholder is self-insuring for all of the probable losses of the smaller, more likely quakes. According to DIFP data, the average cost of earthquake coverage sold in conjunction with traditional homeowners coverage for the six-country bootheel region of Missouri has increased from 72 cents per $1000 of coverage in the year 2000 to $1.17 per $1,000 in 2007, an increase of 62%. Thus, to insure a $150,000 house, the typically cost of earthquake coverage in the Missouri portion of the NMSZ would be roughly $175.50, which may or may not be "affordable," depending on how tightly-stretched a particular family's budget is under the circumstances.

From a public policy perspective, given the state's exposure to losses of tens of billions of dollars in the event of major earthquake in the New Madrid Seismic Zone, it makes sense to have as much private insurance as possible to help ameliorate the impact on private citizens. This leads to the question of whether there are workable modifications or alternatives to the current private market for earthquake insurance that might help guarantee the availability and affordability of such coverage.

Modifications or Alternatives to the Private Earthquake Insurance Market

Senate Bill 877/House Bill 1918

One alternative has been proposed in the form of legislation before the Missouri General Assembly for a number of years, most recently as Senate Bill 877 and House Bill 1918 from the 2008 legislative session. The proposal would create the Missouri Catastrophe Fund, a state reinsurance mechanism that would reimburse primary insurance companies for earthquake losses that exceed a retention level selected by the insurance company (of 45%, 75% or 90%). The losses paid by the fund would be financed by a variety of sources available to the fund given its status as a "state" entity including: 1) an initial $1,000 payment from each insurer; 2) an actuarially indicated premium appropriate to the insurer's selected retention level; 3) revenue bonds issued after-the-fact if it turns out the premiums collected by the fund are insufficient to

cover the losses due to an earthquake; 4) assessments on property and casualty insurers in case of a deficit; and 5) investment income that would be exempt from federal income taxation. The director would enter into a contract with each insurer promising to reimburse the insurer its losses in excess of selected retention percentage, plus 10% of that amount to cover loss adjustment expenses. In fiscal years in which there were no outstanding obligations of the Fund, the proposal would allow the General Assembly to make an appropriation from the Fund of up to 10% of the investment income of the Fund, to be paid to local or state agencies, public and private educational institutions and non-profit programs, intended to improve catastrophic preparedness.

Proponents of the proposal argue the government needs to put a mechanism in place to spread the risk over time and take proactive steps to pay for a potential event in the future. The Fund would also retain earthquake premiums in-state in an account that would grow over time and be guaranteed to be available in case of an earthquake. The freedom from federal taxes plus the rarity of state damaging earthquakes in Missouri would, with luck, allow the Fund to accumulate a sizable level of resources before a major earthquake. Critics argue one problem would be protecting these monies from use by legislators for non-earthquake insurance purposes, although proponents contend the Fund, if appropriately structured, could avoid this problem.

Florida

The Missouri Catastrophe Fund legislation discussed above was based in significant part on a similar fund now operating in the state of Florida. That fund, known as the Florida Hurricane Catastrophe Fund (FHCF) was created as a result of a contraction of the primary and reinsurance markets that occurred in 1992 as a result of Hurricane Andrew. Its goal is to provide cost-effective reinsurance to the residential property insurers in Florida issuing residential coverage that includes hurricane or wind coverage. The FHCF's claims-paying capacity is set by state statute. According to a federal General Accounting Office report, the reinsurance it provides is one-fourth to one-third the cost of private reinsurance, due to the FHCF's tax-exempt status, its low administrative costs, its non-profit status and its ability to use debt financing of losses. In addition to premium collected from participating insurance companies for the reinsurance provided by the FHCF, the fund can use post-event revenue bonds and assessments on the state's "assessable" insurers (which includes most lines of insurance such as auto insurance, but which excludes other lines such as accident and health, workers' compensation and federal flood insurance). The assessments are paid by policyholders, collected by the insurance companies and capped at 6% of premium.

According to the Florida State Board of Administration, as of August 2, 2007, $3.7 billion had been paid for 2004 hurricane losses for Hurricanes Charley, Frances, Ivan, and Jeanne, and $4.1 billion had been paid to participating insurers for 2005 hurricane losses from Hurricanes Dennis, Katrina, Rita, and Wilma; 99.9% of the 2005 hurricane losses were from Hurricane Wilma. Also, the state issued revenue bonds in the amount $1.35 billion to pay for the 2005 hurricane season shortfall and issued $2.8 billion pre-event notes to provide liquidity for the 2006 and future hurricane seasons. This indicates a major concern with the FHCF: that its financing mechanism can be hard-pressed to keep up with the losses associated with multiple major hurricanes in a single season.

Critics of the FHCF argue the fund violates a basic concept of insurance by concentrating the risks rather than spreading them. Only Floridians are assessed for Florida hurricane losses. Traditional private reinsurers, on the other hand, can spread the risk throughout the world. The private sector can also access new capital markets, while the only sources of capital for the FHCF are low front end premiums, high back end assessments, revenue bonds and purchase of reinsurance. Critics also argue that Florida reversed the normal sequence of transferring risk; in the normal insurance process, risk is transferred from the insured to the insurer. In Florida however, as the result of the FHCF's pass-through assessments on P&C policyholders, insurers look to their insureds as their reinsurers. Such assessments apply to premiums for automobile and commercial risks, risks that may have no exposure to hurricanes. Also, residents in Northern Florida feel they are subsidizing those in the south, where most of the storm damage occurs.

California

In 1994 the magnitude 6.7 Northridge earthquake caused nearly $18 billion in damage in the Los Angeles area. Shortly after this earthquake, 90% of insurers stopped writing earthquake insurance in California. To insure this risk, the state of California created the California Earthquake Authority (CEA) in 1996. The CEA is a state-backed insurance pool that covers residential properties. It is funded by premiums paid by its customers, contributions from and assessments on participating insurance companies, borrowed funds, reinsurance, and returns on invested funds. The average annual premium for earthquake coverage is $500, with ranges up to $3,000. The CEA's basic coverage is through a bare-bones "minipolicy," which covers only: 1) dwelling coverage limited to the insured value on the home as stated on the companion homeowner's policy, 2) $5,000 in personal property coverage, and 3) $1,500 for additional living expenses or loss of use of the property. No coverage is provided for patios, swimming pools or attached structures. Higher limits can be purchased for contents and living expenses. The CEA's total claims-paying capacity now exceeds $8 billion. Even with this coverage available, fewer and fewer property owners have been purchasing earthquake coverage. According to the California Department of Insurance, 33% of homes were covered by earthquake insurance in 1996, but in 2006 just 12% of homes maintained coverage. Roughly 10% are covered by the CEA, with the rest covered by private insurers who are able to select the risks they underwrite.

Arkansas

Arkansas passed legislation in 1999 that created the Market Assistance Program (MAP). It assists policyholders in purchasing residential earthquake coverage in the private market. The MAP has assisted about 8,000 policyholders and has a current exposure of $688 million. Any financially sound insurer with proper personnel and experience can participate in the MAP, but currently the only participant is a surplus lines insurer through a Lloyd's syndicate. Access to the plan requires participating insurers to write underlying personal lines property policies, and they must give 90 days notice to withdraw from the program.

In addition, the Arkansas Earthquake Authority was also created in 1999 in response to concerns from both insurers and policymakers about the magnitude of individual company exposure. The authority can only write policies when there are no insurers writing through the MAP. The authority can also write policies when MAP rates are: 1) substantially higher than rates the authority could offer; 2) it is in the best interest of citizens; and 3) upon concurrence of the

Senate and House insurance committees. Because the MAP has an active insurer participating, the authority has not been activated.

State FAIR Plans

As a result of the urban unrest in the late 1960s and early 1970s, residential property insurance was hard to find in certain city neighborhoods. As a result, many states created Fair Access to Insurance Requirements Plans (so-called FAIR Plans) which provided limited property insurance coverage in these areas. These plans act as a "safety net," making some level of coverage available to policyholders who cannot find coverage through normal channels. Coverage is financed by premiums paid by the insureds, but any deficits that are incurred are distributed through the insurance industry via assessments. Insurance industry representatives serve on the board of directors of the Plan.

Four states in the Midwest – Illinois, Indiana, Kentucky and Ohio – now offer earthquake coverage as part of their FAIR Plans' coverage. The number of policyholders who purchase this option in each of those states is limited: 630, 15, 917 and 363, respectively. As part of its investigation of the earthquake issue, the Task Force, through DIFP, discussed with the Missouri FAIR Plan whether it too should consider offering earthquake insurance. The issue was initially presented to the FAIR Plan Board of Directors at its September Board meeting and was assigned to a sub-committee for further study.

The potential benefits of using the FAIR Plan are that it would provide a market of last resort for earthquake coverage and would provide a way to distribute any deficits. However, because FAIR Plans are created by state statutes, one issue will be whether the enabling legislation of Missouri's FAIR Plan (at Sections 379.810, et al., RSMo) is flexible enough to permit it to offer such coverage. There are other issues as well, such as the fact that the Missouri Plan does not currently offer typical "replacement cost" homeowner's coverage, and provides policy limits which are less than the cost of many modern homes. Hence, amendatory legislation might be needed to allow the Missouri FAIR Plan to function as an effective safety net, should one be deemed necessary.

Louisiana

Louisiana has a $100 million incentive fund to encourage insurance companies to enter the residual market and write business in the state. The fund has surplus requirements so that eligible companies are well-capitalized to handle claims.

National Legislation

The Homeowners Defense Act of 2007 (H.R. 3355) establishes a completely voluntary federal/state consortium to leverage economies of scale and the diversification of the type and location of catastrophic risks to achieve reinsurance costs lower than those available to states independently. It also creates a federal loan program to provide post-event financing to qualified state reinsurance programs while those programs accumulate capital sufficient to pay their reasonably anticipated reinsurance losses. State catastrophic reinsurance programs must satisfy specific requirements, including reinsuring all personal residential lines of insurance and only risks in the state deemed truly catastrophic by the Treasury Secretary, before they can qualify for

the consortium and loan programs. This bill passed in the House of Representatives on November 7, 2007 and awaits a hearing in the Senate.

Task Force Evaluation of Alternatives

As indicated earlier, the most recent data gathered by DIFP indicates that Missouri still has a considerable private market for earthquake insurance. The question is whether the state needs to take any actions now, to modify this market or create an alternative to it, to prepare for the losses likely to result from a major earthquake in the future.

The experience in other states has been that dramatic changes tend to occur only *after* a major disaster followed by a subsequent failure of the private marketplace. Before the major disaster, public policy makers will find it difficult to focus the time and resources on a problem, albeit, a significant one, that may or may not occur, given the fact that they will already have an agenda full of issues demanding immediate attention. This may be an even larger problem with mid-continent earthquakes, since the problem is not widely understood and since no major earthquake has occurred in recent memory.

The insurance alternatives discussed above cover a wide spectrum, from market assistance plans that provide a very limited level of assistance to an existing insurance market, to the California and Florida programs, wherein the state essentially takes over a significant portion of the market. While they differ widely in their details, each represents a response by policymakers to a crisis that existed in a particular state at a particular point in time. Different circumstances will compel different policy decisions. Rather than recommending that Missouri adopt any particular modifications to its insurance market at this time, the Task Force has instead discussed the alternatives that have been tried by others, and has tried to note the benefits and limitations of each approach in this report. Which approach, if any, is selected is up to the state's elected representatives.

Of course, Missouri is not limited to trying something already tried elsewhere, nor is it limited to trying only one approach. For example, at its last meeting, the Task Force discussed a "phased" approach to any changes to the earthquake insurance market. Phase I would be to have DIFP continue to monitor the market, with the expanded data collection previously discussed. Phase II would be to institute a Market Assistance Plan should the Director of DIFP make an official "finding" that the availability or affordability of earthquake insurance had reached a crisis point. Phase III would be to set up a new, state-run earthquake insurance pooling arrangement (unless the existing Missouri FAIR Plan determines that it already has the statutory authority to function as such an arrangement *and* its Board votes to take on this responsibility). However, Phase III would be undertaken *only after* a MAP had been given a chance to work and had been shown to be unable to provide the coverage demanded by the public. The caveat to this three-phase approach would involve discussions on a multi-state and federal level for a regional or national disaster response program. The Task Force believes Missouri should participate in any such discussions, since a disaster financing approach which spreads the risk beyond the borders of the individual states makes theoretical sense. Just what, if anything, will be developed on a multi-state or federal level remains to be seen.

[Note: On the issue of Phase II – the establishment of a Market Assistance Plan – the goal would be to provide a mechanism to link up potential policyholders with insurers actively writing

earthquake coverage. Perhaps the simplest mechanism is to collect a list of contact information on potential buyers that can be accessed by insurance companies. This has been done in Missouri for years with the residual market for workers' compensation insurance by providing a so-called "take-out list" to the industry of all the employers currently insured in the Missouri work comp residual market. In another approach, the Missouri Department of Insurance set aside a portion of its official web site for a list of insurers actively writing medical malpractice insurance, which can be accessed by medical professionals seeking coverage. A more complex approach is the one used in Arkansas, discussed above. One suggestion DIFP would offer is to make it clear to potential policyholders, in whatever option is selected, whether any insurers listed are traditional insurers (who are fully regulated by DIFP) or are excess and surplus lines insurers (who operate under a much more limited degree of regulation).]

Because Missouri still has an active earthquake insurance market, there is less pressure to make changes to its insurance market at the present point in time. As such, the state has the opportunity to carefully weigh the positive and negative experience of the other states and craft an approach that works best for its own unique set of circumstance. This is particularly true since the Task Force believes there is a more effective approach to addressing the threat of earthquake losses than after-the-fact insurance, namely, building stronger buildings before-the-fact, through the enforcement of building codes. (See next section.)

Task Force Conclusion

Other states have addressed concerns with their catastrophe insurance markets in various ways, such as establishing market assistance plans (MAPs), providing coverage through their property insurance FAIR plans, establishing state earthquake authorities to write primary coverage, and establishing state reinsurance mechanisms to provide reinsurance to the primary insurance marketplace. Any alternative implemented in Missouri should weigh the benefits and limitations experienced by these approaches in fashioning an alternative best-suited to the unique needs of Missouri.

Building Code Options

Based on the testimony received by the Task Force, by far, the best proactive approach to Missouri's earthquake threat is constructing stronger buildings. It has been known for some time that different types of buildings perform differently in earthquakes. For example, wood frame houses perform relatively well, partly because they are more flexible but mostly because they are far lighter in weight. On the other hand, unreinforced masonry structures tend to perform relatively poorly.

The experience of what works and what does not has been incorporated over time into the standards contained in the nation's various building codes. For example, the International Code Council (ICC) develops building codes used to guide the construction of residential and commercial buildings. According to the Institute for Building & Home Safety (IBHS), recent cost/benefit studies have shown that for every additional dollar spent in natural hazard vulnerability reduction measures, there is a long-term savings of between 3 and 16 dollars.

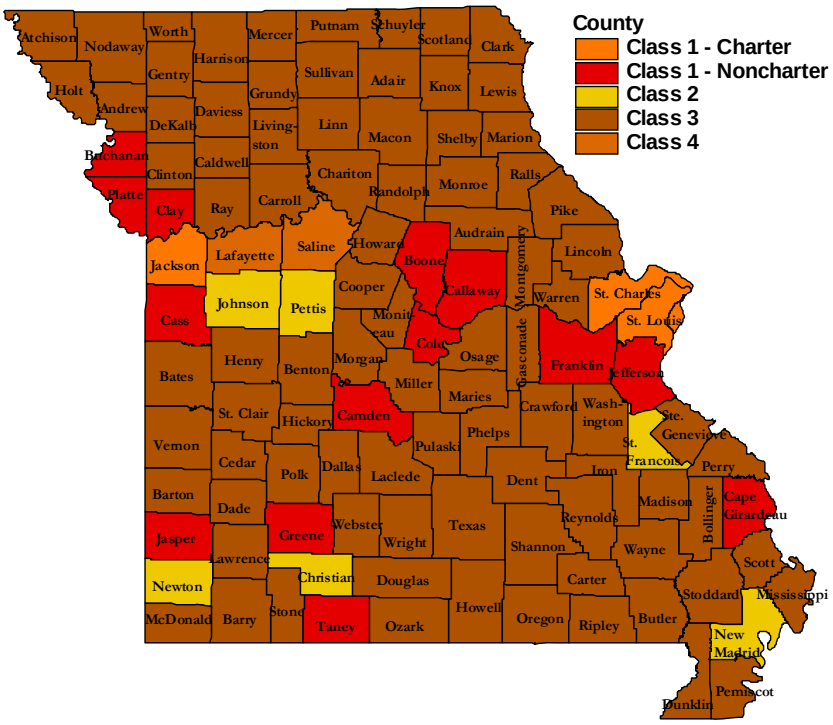
Buildings built to the International Building Code (IBC) or the International Residential Code (IRC) are engineered to prevent a total collapse of the building and thus minimize loss of life in the event of a major earthquake. The ICC also develops property maintenance codes for existing buildings and publishes guides on structural and nonstructural retrofits, such as securing heavy objects and hanging fixtures, and supporting walls, floors, foundations, etc. Retrofits, especially those that are structural in nature, may be cost-prohibitive.

Building Codes are complex, highly-technical documents written for design and construction professionals, and cover a number of topics beyond earthquake tolerance (e.g., fire safety). But, the basic concept regarding earthquakes can be stated in laymen's terms: construct the building so that the lateral load (side-to-side stress) of the earthquake is transferred by the structure through a lateral load pathway, from the roof to the walls, from the walls to the floor, from the floor to the foundation. To transfer this stress, all the components of the structure must be firmly connected to each other. The various elements of the structure should be as solid as possible, avoiding large, unreinforced openings.

Often, these basic concepts can be incorporated into buildings relatively simply, if done during construction. For example, metal straps or connectors can attach the roof beams to the side walls, and metal bolts, inserted into the concrete of a foundation before it dries can be used later to anchor the side walls to the foundation. A variety of supplemental strengthening techniques are available for different building materials and different building components. For example, large openings, like garage doors can be reinforced, as can ancillary structures, such as chimneys. One estimate which the Task Force received on this issue was that, in general, the cost of these additional measures during construction of a building might be an additional 10% of the cost of the structure, but, because the cost of the structure (i.e., the weight-bearing elements of the building) are only 10% of the total cost of the building, the additional safety measures add only around 1% to the final cost.

In the experience of the engineering community, these types of structural enhancements make a major difference in the ability of buildings to withstand the forces of natural disaster like earthquakes. For example, California has been enforcing higher building standards for years. The recent magnitude 5.4 earthquake centered near the Chino Hills area of San Bernardino County did little damage to populated areas, reportedly due to the strict building codes in the area updated in response to the 1997 6.7 magnitude Northridge earthquake. The experience in Florida is similar: structures built to the strict codes enacted since Hurricane Andrew in 1992 have survived the subsequent hurricanes far better than pre-Andrew construction.

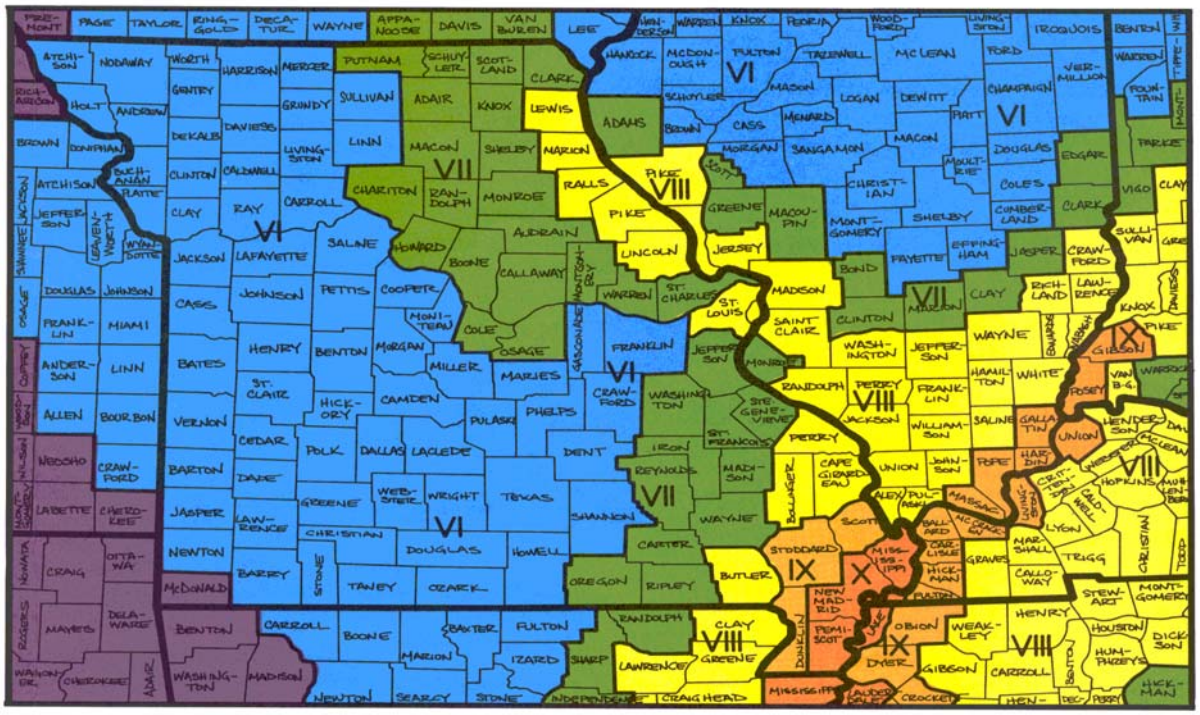
As stated, Florida enacted a statewide building code following Andrew. South Carolina and Louisiana have also adopted statewide codes in response to hurricanes. California has a Building Standards Commission which oversees the various local codes adopted in that state. Missouri, however, does not have a statewide building code and past attempts to adopt such a code have failed in the Missouri General Assembly. Provisions of Chapter 64 of the Revised Statutes authorize all counties of the first and second class to adopt such measures, but as the map of Missouri's first, second, third and fourth class counties on the following page indicates, many of the counties in the Missouri bootheel, near the NMSZ, are third class counties that do not fall under this authorization.



Missouri has, however, enacted a more "targeted" provision to require local jurisdictions to adopt seismic designs standards for new construction. These provisions are found at Sections 319.200 to 319.207, RSMo. They require each city, town, village or county, that can expect a ground shaking equivalent to a Modified Mercalli of VII or above for a magnitude 7.6 earthquake along the New Madrid Fault, to adopt an order or ordinance on new construction, additions or alterations of existing structures to comply with the seismic design and construction standards of "the building officials and code administrators code or of the uniform building code." The green, yellow, light orange, and dark orange counties on the top map on the following page are those that would be expected to experience the specified degree of shaking under these statutes.

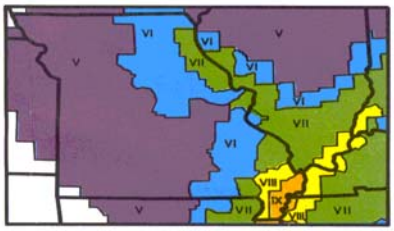
One member of the Task Force familiar with the bootheel region indicated there is a high degree of seismic awareness *and* code enforcement in those communities large enough to be able to finance a full-time code enforcement office. The problem is that the smaller, more-rural areas cannot afford such an enforcement mechanism. Absent an outside funding source, it is hard to see such communities enforcing building codes. Federal funding has been discussed in this regard, but currently FEMA does not allow pre-earthquake grants for such purposes. A new federal grant program through the Department of Housing and Urban Development (HR 4461) passed the House in July, but this bill would require communities to provide matching funds for the grants, with those of a population of less than 20,000 providing a 12.5% match. The Task Force encourages the appropriate state agencies to seek any grant monies available for code enforcement, and to lobby for any modifications to current federal programs that would make such monies available.

PROJECTED EARTHQUAKE INTENSITIES



This map shows the highest projected Modified Mercalli intensities by county from a potential magnitude – 7.6 earthquake whose epicenter could be anywhere along the length of the New Madrid seismic zone.

6.7

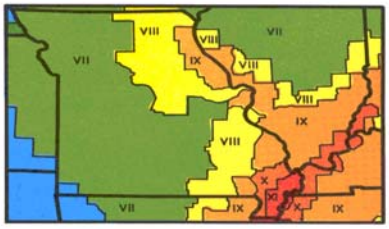


This map shows the highest projected Modified Mercalli intensities by county from a potential magnitude – 6.7 earthquake whose epicenter could be anywhere along the length of the New Madrid seismic zone.

7.6

This map shows the highest projected Modified Mercalli intensities by county from a potential magnitude – 8.6 earthquake whose epicenter could be anywhere along the length of the New Madrid seismic zone.

8.6



Regardless of whether Building Code Enforcement is in place in a particular jurisdiction that is at-risk for earthquake, the Task Force believes new construction in the locality *should nevertheless* be built to code standards, and stakeholders should encourage that level of construction. One method of encouraging such construction might be through the use of premium credits for earthquake insurance. As mentioned above in the section of this report on DIFP data collection, ISO currently has on file with DIFP a program that would grant credits to insureds living in jurisdictions that enforce building codes. Interestingly, credits are also available under this program (the so-call Building Code Enforcement grading Scale or BCEGS) for structures not in such jurisdictions that are nevertheless built to such standards. Perhaps insurance companies could be encouraged to adopt such programs and insurance agents, building contractors and private individuals planning new construction, could be made aware the

available credits. While the dollar value of the credits themselves would not be large, the existence of such credits might be enough to have those in the midst of planning a new structure give consideration to building to higher standards.

Another possibility is to integrate disaster-resistant design with other, modern features, such as energy efficiency and lower-maintenance, all as part of a "package" designed to produce a higher-value structure that will likely have higher future resale value, greater ease of insurability, lower operating costs, etc. One group currently encouraging such an approach is the Institute for Building & Home Safety, whose "Fortified Home" initiative seeks to promote designs that are resistant to multiple types of environmental threats. (In some respects, this advances the idea one step further, to one of building "beyond" code standards.) Rather than relying on the force of law to motivate stronger construction, perhaps such concepts can be "marketed" to future home buyers in such a way that they begin to *demand* such construction, after having been educated that ultimately, improved safety is in their long-term physical and financial interest.

Finally, innovative new approaches developed by engineering science and technology deserve mention. Research is currently under way to produce stronger, more resilient building materials and structural designs. These new techniques can now be built on the large mechanical "shake tables" set up at a number of research labs. These are devices designed to simulate the shaking motions of a strong earthquake in a controlled, laboratory setting. In this way, scientists and engineers can study what techniques work best in withstanding the forces of an earthquake. Work is also under way on new approaches to construction methodology, such as factory construction of modular housing components, which might provide ways to produce higher-quality building components more cheaply.

Task Force Conclusion

Regardless of whether a building code is in place in a particular Missouri jurisdiction, stakeholders should encourage new buildings to be built "to code standards" or better, to make them more resistant to damages from natural disasters like earthquakes.

(Note: Consideration should be given to updating the specific language used in Section 319.200, RSMo. The building codes referenced are no longer the standard codes used in Missouri and the Mercalli-index shaking levels used should be replaced by the types of ground acceleration values used in modern building codes.)

Using "Mitigation" Techniques on Existing Structures

While it is the opinion of the Task Force that "building to code standards" is Missouri's best long-term solution to the threat of earthquakes, that still leaves the matter of the state's current, "built" environments, which the MAE Center's HAZUS report values at $334 billion dollars. Based on the current probabilities, while most of this built environment will likely have been replaced in the several hundred years before the next "great" earthquake, much of it will still be in place by the time the next smaller (but more probable) "damaging" earthquake occurs.

For existing structures, the main options are "retrofit" and "mitigation." "Retrofit" refers to the often difficult and expensive process of taking an existing structure and "bringing it up to code" while retaining as much of structure as possible. Frequently, the costs of a thorough retrofit are prohibitively expensive, and are used on only the highest value buildings or those with special historical significance.

"Mitigation" refers to the much-less-ambitious approach of making a number of smaller improvements to a building's contents or components that will help lessen the damages that will occur during a natural disaster. Such smaller changes can often be undertaken by homeowners themselves, without special tools or materials; where special tools and materials are required, they can be made available through hardware stores, local outreach programs or special "co-ops."

The classic example of an earthquake damage mitigation technique is strapping an upright, natural-gas-powered hot water heater to the wall to prevent it from tipping over in an earthquake, thereby causing the gas line supplying the heater to snap, causing a gas leak that can lead to a post-earthquake fire. Flexible metal straps are wrapped part of the way around the outside of the heater and then fastened to the nearest wall (or walls) to provide additional support. Other examples of earthquake mitigation techniques include attaching fasteners between the backs of bookcases and the walls they sit next to, anchoring expensive electronic devices to the furniture to prevent them from being shaken off onto the floor and special polymer sheeting applied to windows to lessen the danger of flying glass fragments.

As (relatively) simple as these mitigation techniques are, they can be very important in the context of minimizing the losses experienced due to an earthquake. For example, most houses in Missouri are the type of flexible wood frame construction that performs well in moderate earthquakes. Brick veneers may crack and fall away from such houses, but the wooden, load-bearing structures usually perform fairly well. In such cases, damages are actually experienced by the non-structural components (like utility connections and lighting fixtures) and by the contents (mostly, furniture and appliances). The dollar value of such damages can add up quickly in an era of high-tech devices, a fact which takes on added importance if the devices are not covered by homeowners insurance or are covered by earthquake insurance which has a high deductible (meaning policyholders pay the first 15%, 20% or 25% of damages themselves, out of pocket).

Self-help mitigation techniques that can be undertaken by homeowners or small business owners are a perfect topic for public information campaigns and outreach programs. They are simple to explain, they lend themselves well to visual examples and they frequently require no special expertise, materials or tools to implement. The Task Force believes they should be encouraged as part of any public awareness strategy. Strong consideration should also be given to financial incentives to help motivate people to actually take the time and effort to implement these proactive, "self-help" preventive measures. Such incentives could come in various forms, for example, free materials made available thru corporate goodwill donations via outreach programs or sales tax exemptions on specified mitigation hardware. States such as Florida and South Carolina offer substantial income tax credits or property tax abatements for specified mitigation efforts. Premium credits on insurance might also be an option, to the extent insurers are able to verify evidence that the mitigation steps have actually been taken (such as through purchase

receipts on mitigation hardware). The option of "tax increment financing" was also discussed by the Task Force.

Task Force Conclusion

"Mitigation" Techniques Can Reduce Damages for Existing Structures and Should Be Encouraged.

Public Awareness

Missouri is fast approaching the bicentennial of the great earthquakes of the winter of 1811-1812. The Earthquake Insurance Task Force believes the state should use that anniversary as an opportunity for heightening public understanding of the exposure to the threat of earthquakes and various resources available to deal with that threat.

Over the last 25 years, the NMSZ and other mid-continent earthquake zones have been receiving gradually increasing attention from the scientific and emergency planning communities in the various states, as well as the federal government. For example, per Missouri state statute (Section 256.175, RSMo), the Missouri Department of Natural Resources (MDNR, DGLS) is designated as the "lead technical agency in the state to conduct studies" relative to prediction of earthquake impacts. To further this goal MDNR, DGLS is actively participating in efforts to provide detailed geologic mapping of the St. Louis area as part of the St. Louis Area Earthquake Hazard Mapping Project. This project will produce urban seismic hazard maps that differ from the USGS national seismic hazard maps in that they are higher resolution and they account for the effects of the shallow rocks, sediments, and topography on earthquake ground shaking. The efforts will show the spatially variable likelihood of ground failure (such as landslide or soil liquefaction), by combining the potential of materials to lose strength or fail when shaken and the level of shaking expected.

In addition, a major FEMA-led effort has been underway since 2006 to improve the coordination of a response to a New Madrid earthquake. Known as "the New Madrid Seismic Zone Catastrophic Planning Project," the effort is designed to bring together representatives from federal, state and local planning and emergency response organizations, business, industry and volunteer organizations, research organizations and earthquake experts, all for the purpose of developing more detailed response plans for the different portions of the Midwest, plans which will then be integrated into an overall national plan for responding to a NMSZ earthquake. Participants are developing the plans at scenario-based workshops set up to tap the expertise of the people who have actual experience responding to disasters. The plans developed at these workshops will then be tested in a series of state, and regional exercises in 2009 and 2010, culminating in a "major command exercise" in the bicentennial year of 2011. Missouri participants held two workshops in October and there is a "statewide" workshop scheduled for March of 2009.

Likewise, other events are being planned to recognize the bicentennial, including conferences, workshops and public outreach events. The Central US Earthquake Consortium (CUSEC) is providing the staff support and coordination for a steering committee for organizations interested

in developing such programs. Missouri state government is participating on the steering committee through representatives from SEMA and MDNR's DGLS.

The Task Force recommends that other elements of Missouri's state government treat the approach of 1811-1812 bicentennial as an opportunity to first, build awareness of the earthquake threat, but then, secondly, to move beyond mere awareness to actual proactive behaviors to help prepare for such an event. We have three years before the December 2011 anniversary of the first major New Madrid event. We should use to that time to gradually increase awareness and improve readiness.

Specifically, DIFP should review the information sources that are currently available and provide an overview of these sources on its departmental web site. This is needed because of the confusing proliferation of organizations in the earthquake and disaster preparedness communities with sometimes over-lapping areas of interest and/or responsibilities. A non-exhaustive list would include: MDNR, DGLS, FEMA, NEHRP, SEMA, the USGS, the MAE Center, CUSEC, the Missouri Seismic Safety Commission, CERI, the EERI, the IBHS, ISO, and so forth. To the uninitiated, this can be an intimidating organizational landscape to navigate, and DIFP could provide a road map.

In addition, DIFP should consider adopting the best ideas from other information sources for Missouri's public information campaign. For example, DIFP staff noted that one mitigation site listed the likely cost of the materials needed to complete particular mitigation projects. This is the type of practical information needed by consumers when trying to make an informed decision on which, if any, mitigation efforts to pursue. It could be supplemented with a list the tools needed and the time typically necessary to complete the task.

In their research, DIFP staffers were made aware (by the Missouri Film Commission) of at least one DVD that is available from the History Channel on the NMSZ earthquake threat; there may be others. Such materials could supplement web-based or printed materials and could be used in class rooms. (A FEMA consultant observed that one of best methods to disseminate information to the general public is to make sure it gets to precocious 3rd graders, since soon thereafter, everyone will have heard about it.) Clearly, there are many possibilities for increasing public awareness.

Task Force Conclusion

Long-Term Planning & Coordination Should Continue, Emphasizing an Expanded Public Information Campaign.