The Nevada Earthquake Safety Council is the state's liaison with the Western States Seismic Policy Council. Notably, members of NESC received the WSSPC's "Award in Excellence" in 2002 and 2007 for their efforts implementing the Nevada Educational Seismic Network and in mitigation of fault-related hazards respectively. NESC adopts the WSSPC policies and works to implement them in Nevada.

At its meeting of August 25, 2010, the NESC voted to endorse the Western States Seismic Policy Council's policy recommendations adopted at the annual meeting held in Broomfield, CO. The policies are included below.

WESTERN STATES SEISMIC POLICY COUNCIL
DRAFT POLICY RECOMMENDATION 11-4

Identification and Mitigation of Unreinforced Masonry Structures

DRAFT Policy Recommendation 11-4

Unreinforced masonry bearing wall structures represent one of the greatest life safety hazards and economic burdens to the public during a seismic event. WSSPC recommends each state, province or territory adopt a program to identify the extent of risk that unreinforced masonry structures represent in their communities and develop recommendations which will effectively address the reduction of this hazard.

Background

During earthquakes, unreinforced masonry (URM) structures are vulnerable to catastrophic collapse and represent a significant life safety threat, as occurred in the 2008 Wells, Nevada earthquake. Unreinforced masonry structures are made from brick, hollow clay tile, stone, concrete blocks, or adobe materials that are not strengthened by the addition of steel rods or other bracings. Common building examples include older industrial complexes, schools, mercantile establishments, and private residences.

Also of concern are components of these structures such as walls, unsupported parapets, and fireplace chimneys, which can fall on pedestrians or other people trying to exit a building. The masonry usually is held together with weak mortar and is unable to resist lateral forces. Wall and roof anchorage tend to be inadequate, allowing floors and roofs to separate from the walls and collapse. Historically, this has been a major contributing factor to loss of life in earthquakes throughout the world.

Unreinforced masonry is recognized by the Federal Emergency Management Agency as one of the structural types most prone to failure during an earthquake. A review of the USGS Hazards Program listing earthquakes which generated 1,000 or more deaths since 1900 shows that unreinforced walls are a significant contributing factor in losses to both the financial sector and in human lives.

WSSPC strongly believes that jurisdictions must be proactive to address this threat to their citizens. Legislatively mandated programs and/or local municipally adopted ordinances have proved effective at addressing this risk.

WSSPC recognized that there is a societal cost to the inventory and remediation of unreinforced masonry buildings, but in those areas of high seismicity, failure to address this issue will have chilling effects. In order to minimize the cost and make programs more politically acceptable, the three-stage approach of identifying the population of hazardous buildings, analyzing the risk presented by these buildings, and retrofitting those buildings deemed to be a hazard is recommended.

It is realized that resistance is to be expected when dealing with retroactive ordinances. However, as can be seen by those areas which have adopted fire sprinklers retroactively, versus those which have not, even minimal remediation can yield discernable life saving results. Standardized retrofit concepts for unreinforced masonry structures are available through FEMA publications; however, this in no way negates the need for local engineering analysis and design.

Facilitation and Communication

<u>Implementation</u>

WSSPC recommends that States adopt a program to identify the extent of risk that unreinforced masonry structures represent in a community.

The first phase involves creating an inventory of unreinforced masonry structures and is a relatively low cost process. State and local entities, including school districts, should be responsible for identifying their own URM structures. A review of the locally adopted codes is necessary. All structures built under the Uniform Building Code of 1961 or later should have been reinforced, although this should be verified by field inspections.

Private owners of structures erected prior to the effective date of the 1961 Uniform Building Code should be notified that their buildings may be a potential threat to human health and safety and require professional structural inspection with submittal of the inspection findings to an appropriate agency. This inventory process may take several years, but upon completion a more accurate assessment of a community's risk will be evident.

As a second step, the development of a plan to mitigate this hazard will need to be addressed. Using a multi-pronged approach, including obtaining grant funding when possible, incentives to reduce taxes, possible adjustment of permit application fees, or the providing of design and construction assistance, may make mitigation a more workable option. Neither litigation nor forced abandonment of these structures is desirable. The reduction in occupancy or limitations on use may be an acceptable risk option. Permits issued for the sole purpose of seismic retrofitting should not affect or trigger additional jurisdictional requirements or property tax increases.

Alternate Implementation Plan

WSSPC recommends that each State, province or territory implement the three-phase approach to reducing the risk presented by unreinforced masonry buildings by doing the following:

1. Adopt a legislative initiative requiring the inventory of unreinforced structures within a jurisdiction ;
2. Develop, or cause to have developed, a mitigation plan that identifies hazardous structures and includes a cost benefit analysis; and,
3. Implement a URM structures program through:
   a. Completing mitigation design and retrofit,
   b. Abandoning use of the structure, or
   c. Controlling use and occupancy to minimize the potential risk.

Assessment

The effectiveness of this policy can be determined by maintaining an inventory of states, provinces and territories with active programs to mitigate the dangers of unreinforced masonry bearing wall structures. By collecting and identifying these individual efforts, WSSPC will provide a clearinghouse of information which can be used to help promote the policy and advocate its use.

The inventory should be administered annually and contain sufficient detail to help identify the types of programs instituted and their effect in the affected regions.

History

WSSPC Policy Recommendation 08-4 was adopted by unanimous vote of the WSSPC membership at the WSSPC Annual Business Meeting April 22, 2008.

WESTERN STATES SEISMIC POLICY COUNCIL
DRAFT POLICY RECOMMENDATION 11-5

Earthquake Information for Incident Commanders

DRAFT Policy Recommendation 11-5

WSSPC recommends that the U.S. federal government, in collaboration with appropriate organizations, develop a standard operating procedure for use by incident commanders in response to an earthquake.

Background

Incident commanders have a valuable tool for dealing with wildfires. The Fireline Handbook was developed by the Incident Operations Standards Working Team of the National Wildfire Coordinating Group, which is sponsored by the U.S. Department of Agriculture, the U.S. Department of Interior, the National Association of State Foresters, the United States Fire Administration, and the Intertribal Timber Council. This handy document is put to good use at essentially all major wildfires. A similar document is needed for major earthquakes, ones that require establishment of an incident command center.

Facilitation and Communication

WSSPC encourages the Federal Emergency Management Agency in the Department of Homeland Security to take the lead in working with other federal agencies to develop a document for earthquake-incident command. This document could be an appendix to the Fireline Handbook or a stand-alone document that incident commanders would have readily available after a major earthquake occurs.

The document should alert incident commanders about issues that are specific to earthquakes and to common issues that arise after earthquakes occur. These include, among others:

- The need to inspect and tag (red, yellow, or green) emergency operations centers and other critical facilities (shelters, fire stations, police stations, hospitals, etc.) as soon as possible;
- The need to inspect and tag all structures (residences, office buildings, businesses, bridges, overpasses, etc.) that were possibly damaged by the earthquake;
- The possibility of needing to re-inspect buildings and other structures after large aftershocks;
- The need to inspect for broken gas lines, leaking or damaged liquefied petroleum gas (propane, etc.) tanks, water lines, electrical lines, and other key parts of the infrastructure that may;
- The need to provide for communication links between the emergency operations center and scientists and engineers who inspect the effects of the earthquake and report through a technical clearinghouse;
- The need to inspect dams, irrigation canals, and other parts of the infrastructure that, if damaged, may cause flooding.

WSSPC offers to help review the document and encourage its use throughout earthquake-prone regions of the world.

Assessment [Needs to be added]

History [To be added upon adoption]

WESTERN STATES SEISMIC POLICY COUNCIL
DRAFT POLICY RECOMMENDATION 11-2

Definitions of Fault Activity for the Basin and Range Province

DRAFT Policy Recommendation 11-2

WSSPC recommends that the following definitions of fault activity be used to categorize potentially hazardous faults in the Basin and Range physiographic province:

Holocene fault – a fault whose movement in the past 10,000 years (11,500 cal yr B.P.) has been large enough to break the ground surface.

Late Quaternary fault – a fault whose movement in the past 130,000 years has been large enough to break the ground surface.

Quaternary fault – a fault whose movement in the past 1,800,000 years has been large enough to break the ground surface.

It should be emphasized that some historical magnitude 6.5 or greater earthquakes that produced surface faulting in the Basin and Range Province occurred on faults that have not been active in the Holocene; furthermore, earthquakes in the Province may occur on faults in all three categories. It is the responsibility of the user to decide what level of earthquake hazard (surface fault rupture and ground shaking) is acceptable for a specific structure or application.

Background

Future large, surface-rupturing earthquakes in the Basin and Range Province most likely will occur on faults that display evidence of prior large surface displacements during Quaternary time. The time when the last major earthquake occurred on a fault and the time interval between the most recent earthquake and earlier earthquakes are factors that influence the probability of when a similar-size earthquake might occur within a given time period. For example, a fault that has a major earthquake on average every 1000 years is more hazardous than one that has a major earthquake on average every 100,000 years. It is up to the user to decide what degree of fault activity is considered "hazardous" and what level of hazard is acceptable. Depending on the intended use of the land (critical facilities, fire stations, hospitals, schools, residences, picnic grounds, etc.), different levels of seismic hazard and risk may be acceptable. In addition, understanding the frequency and size of earthquakes on a fault is critical when deciding whether to build across the fault, and when estimating the probabilities of ground shaking at varying distances from the fault. It should be noted, that historical, damaging, moderate to large (< M 6.5) earthquakes have occurred on faults in the Basin and Range Province which do not have any obvious expression at the ground surface.

A **Holocene** criterion (10,000 years (11,500 cal yr B.P.}) to characterize potential fault activity has significant precedence, principally from its past usage and application in California. For purposes of implementing the Alquist-Priolo Earthquake Fault Zoning Act, the California Code of Regulations defines an active fault as *Holocene Active,* that is, there is evidence of surface rupture within approximately the past 11,000 years, although local governments may use a broader defmition. The *Holocene Active* defmition also has a practical applicability because climate change following the most recent major glaciation has resulted in many recognizable soil horizons and geomorphic surfaces that are used to help date fault activity. Because major historical earthquakes have occurred in the Basin and Range Province on faults that do not show surficial evidence of previous Holocene activity, the Holocene Epoch is too short to span the range of average earthquake recurrence intervals (average earthquake repeat times) on faults in the Province.

A late Quaternary criterion (130,000 years) uses the onset of the Sangamon interglacial period as a datum and spans many of the average fault recurrence intervals in the Basin and Range Province. All but one of the major historical earthquakes in the Province occurred on faults that show evidence of late Quaternary activity.

The **Quaternary** Period (1,800,000 years) represents the onset of a major climatic change to the current cycle of glacial/interglacial intervals, during which most of the surficial alluvial deposits and much of the present landscape in the Basin and Range Province formed. All the major historical earthquakes in the Province have occurred on faults that show evidence of Quaternary-age movement at the surface. A Quaternary criterion encompasses an average recurrence interval for essentially all the faults that might produce future earthquakes.

The Basin and Range Province is a large extensional tectonic domain that contains thousands of normal-slip and strike-slip Quaternary faults involved in contemporary deformation. Large earthquakes in the Province, especially those that are associated with surface rupture, commonly involve multiple, distributed faults, and have occurred on faults that have a wide range in the time since their most recent surface-faulting earthquakes. This tectonic behavior in the Province differs from the more focused, higher slip-rate tectonics of the plate boundary system in western California. These different characteristics may warrant different considerations, such as the activity criterion used when establishing fault setbacks and identifying potential earthquake sources.

The identification of faults that pose an earthquake hazard requires application of a fault-activity criterion to exclude ancient faults that are unlikely to rupture during future earthquakes. This criterion allows society to develop guidelines for identifying potential surface-rupture and ground-motion sources. Two fundamental parameters are needed to characterize fault activity for the purposes of hazard assessments: the amount of displacement that occurred during large, surface-faulting earthquakes and the time interval over which the earthquakes occurred, which in some cases can be expressed as an average recurrence interval between earthquakes. These data are used to calculate the fault's geologic slip rate, which is net displacement divided by the time interval over which the strain accumulated that resulted in displacement. Fault slip rates, typically expressed in mm/yr or m/kyr, provide a quantifiable measure of fault activity; the higher the slip rate, the more active the fault.

There are several examples of Basin and Range Province faults that have had major historic movement, but lacked evidence of Holocene or late Quaternary activity. The most dramatic example of the latter is the 1887 Sonoran earthquake in northern Mexico. Different lines of reasoning suggest that prehistoric surface rupture occurred at least 100,000 to 200,000 years ago (Bull and Pearthree, 1988). The 1954 Fairview Peak, Nevada, earthquake (Bell and others, 2004) is another example of a major historic earthquake on a fault that lacked evidence of Holocene displacement (Pearthree, 1990; Caskey and others, 2004). The 1954 Dixie Valley, Nevada, earthquake occurred on a fault zone that has evidence of Holocene activity, but also ruptured major portions of fault traces that lacked Holocene displacement (Bell and Katzer, 1990). Major earthquakes have occurred on faults that had Holocene displacement as well, such as the 1983 Borah Peak, Idaho, earthquake (flanks and Schwartz, 1987). More than one-half of the major historical earthquakes in the Province produced surface faulting on faults that appear to lack Holocene activity. Thus, the Holocene criterion is a useful but not an complete indicator of where future large earthquakes may occur in the Basin and Range Province.

Prehistoric earthquakes that produced surface ruptures on faults within the Basin and Range Province have a range of recurrence intervals that span from hundreds of years to hundreds of thousands of years. Recurrence intervals of a few thousand to tens of thousands of years are typical. One of the most comprehensive and detailed paleoseismic studies in the Province was undertaken as part of the site characterization of the proposed high-level nuclear waste repository at Yucca Mountain, Nevada. That study revealed that average recurrence intervals for many of the faults at and near Yucca Mountain are between 20,000 and 100,000 years (e.g., Wong and others, 1995). A range of earthquake recurrence intervals can be estimated by considering the typical range of vertical slip rates for faults in the Basin and Range Province (0.01 to 1.0 mm/yr) and typical surface displacements during major earthquakes (1 to 3 m). This yields a range of potential recurrence intervals of 1,000 to 300,000 years.

Elapsed time since the most recent large earthquake and average earthquake recurrence intervals are important parameters needed when determining fault activity levels and earthquake hazard. They should be evaluated along with other considerations related to levels of acceptable hazard and cost/benefit ratios when evaluating earthquake risk for a specific purpose.

Facilitation and Communication

WSSPC recommends that government agencies, regulators, and owners consider these fault-activity definitions when determining which faults are hazardous for specific facilities or purposes. For some facility types, active fault defmitions are contained in state and federal regulations. Such regulations commonly use different defmitions of fault activity based on the societal importance of the facility being built. Definitions that include less active faults or require more restrictive mitigation measures are typically used for critical facilities where the effect of the facility's failure has grave consequences.

When assessing the impact of future earthquakes, factors to consider are the type of facility and its societal importance; level of acceptable risk; goals, costs, and benefits of risk reduction; and geologic practicality of applying the definition. An example of the latter is found in areas of the Basin and Range Province where widespread latest Pleistocene pluvial lake or glacial deposits facilitate the use of a Holocene criterion, but where the use of a late Quaternary criterion may be impractical because the evidence of activity on some faults of that age is buried by younger deposits. The expense of risk-reduction measures must be balanced against the probability of earthquake occurrence and the resulting risk to society in terms of public safety and potential economic loss. Use of these three broad fault-activity definitions (Holocene, late Quaternary, Quaternary) aid in choosing the appropriate activity class for a proposed facility. It is ultimately up to the regulator and owner to decide how the hazard should be categorized and addressed, although uniform treatment among Basin and Range Province states is desirable.

Assessment

The success of this Policy Recommendation can be assessed based on the use of the definitions by states and local governments in regulations and ordinances. Utah, Colorado, and Clark County, Nevada have adopted these definitions in an earlier version of this WSSPC Policy Recommendation. A periodic re-evaluation of these and other federal, state, and local entities should be made to determine the extent to which these definitions are being incorporated into future seismic-hazard rules, regulations, and guidelines.

References

Bell, J.W., Caskey, S.J., Ramelli, A.R., and Guerrier, 2004, Pattern and timing of faulting in the central Nevada seismic belt and paleoseismic evidence for prior belt-like behavior: Bulletin of the Seismological Society of America, v. 94, no. 4, p. 1229-1254.

Bell, J.W., and Katzer, T., 1990, Timing of late Quaternary faulting in the 1954 Dixie Valley earthquake area, central Nevada: Geology, v. 18, p. 622-625.

Bull, W.B., and Pearthree, P.A., 1988, Frequency and size of Quaternary surface ruptures of the Pitaycachi fault, northeastern Sonora, Mexico: Bulletin of the Seismological Society of America, v. 78, p. 956-978.

Caskey, S.J., Bell, J.W., Wesnousky, S.G., and Ramelli, A.R., 2004, Historical surface faulting and paleoseismology in the area of the 1954 Rainbow Mountain-Stillwater sequence, central Nevada: Bulletin of the Seismological Society of America, v. 94, no. 4, p. 1255-1275.

Hanks, T.C. and Schwartz, D.P., 1987, Morphologic dating of the pre-1983 fault scarp on the Lost River fault at Doublespring Pass Road, Custer County, Idaho: Bulletin of the Seismological Society of America, v. 77, p. 837-846.

Pearthree, P.A., 1990, Geomorphic analysis of young faulting and fault behavior in central Nevada: Tucson, University of Arizona, PhD. Dissertation, 212 p.

Wong, I.G., Pezzopane, S.K., Menges, C.M., Green, R.K., and Quittmeyer, R.C., 1995, Probabilistic seismic hazard analysis of the exploration studies facility at Yucca Mountain, in Methods of seismic hazards evaluation, Focus '95: American Nuclear Society, Proceedings Volume, September 18-20, 1995, p. 51-63.

History

WSSPC Policy Recommendation 08-2 was first adopted in 1997 as WSSPC Policy Recommendation 97-1. It was reviewed and re-adopted as WSSPC Policy Recommendation 02-3 by unanimous vote of the WSSPC membership at the Annual Business Meeting September 18, 2002. It was reviewed, revised, and re-adopted as WSSPC Policy Recommendation 05-2 by unanimous vote of the WSSPC membership at the WSSPC Annual Business Meeting September 12, 2005. It was reviewed, revised, and re-adopted as WSSPC Policy Recommendation 08-2 by unanimous vote of the WSSPC membership at the WSSPC Annual Business Meeting April 22, 2008.