**WESTERN STATES SEISMIC POLICY COUNCIL**

**POLICY RECOMMENDATION 17-7**

 **Earthquake Early Warning Systems**

**Policy Recommendation 17-7**

WSSPC recommends the research, development, and implementation of earthquake early warning systems in those states or regions with high seismic risk and a seismic network that can, or can be enhanced to, support an early warning capability. These national and regional-specific systems should include outreach, education, training, management, and ongoing maintenance of the systems.

**Executive Summary**

An earthquake early warning is issued very rapidly following the initiation of an earthquake and provides alerts to people and communities that have not yet experienced ground shaking from the earthquake. Earthquake early warnings are possible because earthquakes produce differing types of waves that travel at different speeds. The faster P waves travel at about 6.5 kilometers per second and are first to arrive at seismic monitoring stations. These P waves contain important information about the size and location of the earthquake. Slower moving S waves (3.5 km per second) arrive after the P waves and cause more intense shaking capable of damage to buildings and infrastructure.

Based on information from the earlier arriving P waves, the expected shaking intensity can be estimated through rapid analysis and alerts can be issued to communities and facilities likely to be impacted by the earthquake. These alerts can be transmitted through high speed telecommunications systems so communities that are distant from the earthquake epicenter but vulnerable to strong motion damage may receive advanced warning prior to the arrival of damaging S waves. Alert times vary from almost no warning in the area nearest the epicenter to 60-80 seconds in areas at some distance from the epicenter. As implied in this description, earthquake early warnings are of greatest benefit to regions distant from the epicenter that may be impacted by ground motions generated by large earthquakes.

**Background**

A nationwide earthquake early warning system was implemented in Japan on October 1, 2007. The system is based on Japan’s extensive and dense seismologic and strong-motion networks that were enhanced following the January 17, 1995 Hanshin-Awaji (Kobe) earthquake. In Japan’s earthquake early warning system, warnings are received through computers, cell phones, the media and signaling devices installed in homes, critical facilities and businesses. Early warnings are used to slow or stop high speed trains (*Shinkansen*), alert drivers of motor vehicles, control elevators (to prevent people being trapped), regulate industrial processes, and notify people at home or work that they should move away from hazards and protect themselves. Limited systems are in place in Mexico, Turkey, Italy, and Greece, and Taiwan.

The United States has monitored scientific and technological developments in other nations, and although it has not yet implemented a fully operational earthquake early warning (EEW) system, the United States Geological Survey (USGS) has supported the development and trial operation of EEW with university partners and the State of California since 2006. Those efforts have resulted in a demonstration system called ShakeAlert that began sending test notifications to selected users in January 2012. While that system has demonstrated the feasibility of earthquake early warning in California, the system is still being tested for reliability and robustness

An EEW system for the U.S. West Coast is being developed within the current operations of the Advanced National Seismic System (ANSS) regional seismic networks: California Integrated Seismic Network (CISN), and the Pacific Northwest Seismic Network (PNSN). This enables USGS/ANSS and its network partners to leverage their substantial investment in sensor networks, data processing centers, and software for earthquake monitoring, and takes advantage of the considerable expertise and experience of current personnel, reducing the cost of implementing EEW by using existing capabilities and facilities.

The California Office of Emergency Services (Cal OES) plans to carry out the provisions of California Senate Bill 438 by developing an Earthquake Early Warning Program business plan including specific cost estimates for each component of the program and a funding plan, identification of funding sources, an outline of the roles and responsibilities of various program participants, and the expected time schedule for completing the system. The business plan will be developed through consultation with program participants, state agencies, departments, boards and commissions, private businesses, postsecondary educational institutions, and subject matter experts. It is anticipated that the plan will be submitted by February 1, 2018 and be used to advise the Director of Cal OES on implementation of the program.

Funding is a key constraint on the timeline for implementation of the California Earthquake Early Warning System and warning systems in other high risk areas of the country. In addition, policy, management structure, user applications, cybersecurity, and public education and training will impact the implementation of earthquake early warning. Although earthquake early warning systems should not be imposed at the expense of hazard education and preparedness activities, and other mitigation programs, earthquake early warning systems have the potential to save lives and reduce financial losses. Those states that have urban populations and infrastructure vulnerable to major earthquakes as well as modern digital seismic networks may consider earthquake early warning as another useful tool for addressing the earthquake hazard. Earthquakes are often described as hazards without warnings, but seismic-network-based early warning systems could provide an alert with sufficient time to implement life safety actions, infrastructure protection, and rapid mitigation of potential damage and disruption.

**Internal Section:**

**Facilitation and Communication**

WSSPC recommends that its members establish state level working groups on earthquake early warning that include interested stakeholders, including social and physical scientists, engineers, emergency managers, private sector partners, and end users. These working groups would serve in several capacities: to support efforts for continued research and development; to support expansion to other regions; to serve as clearinghouses of information on this new technology and as bodies of experts who are able to speak on the subject at scientific and emergency management meetings; to assess the need for regional seismic network enhancement or upgrades to support earthquake early warning; to identify local areas within states where earthquake early warning system deployment is feasible or functions to which early warning could be applied; to address the broader policy issues of the organization and management of an earthquake early warning system; and, to serve as advocates for earthquake early warning before legislative bodies, the media and the public.

Earthquake early warning technical prerequisites include appropriate station density coverage, modern digital seismic stations, real-time telemetry from stations to a central processing site, algorithms to rapidly analyze an evolving seismic sequence, and a means to communicate warnings to users. High sample-rate GPS and other rapid analysis technologies are an essential component of EEW systems. Within the EEW working groups, earth science representatives must take the lead in assessing existing networks and recommending modifications, as necessary, to support an earthquake early warning capability. Scientists and engineers within the working groups will be essential in developing proposals to funding agencies to implement network enhancements that will facilitate the development of earthquake early warning systems. It should also be noted that enhancements to regional networks and the Advanced National Seismic System (ANSS) will yield benefits in addition to earthquake early warning capability, benefits that include more rapid and accurate earthquake source information and ShakeMaps.

Given resource limitations and considerations, choices may be required regarding where an earthquake early warning system will be deployed, including what processes or functions may be affected. In most cases, earthquake early warning systems will be deployed where the largest number of people can potentially be protected and in areas that include critical community infrastructure and sensitive manufacturing operations.

Earthquake early warning systems involve far more than the technical capacity to issue early warnings, so working groups should provide a forum for discussions of how an early warning system will operate and be managed. Basic questions include: what agency will have lead responsibility for the system? What will be the division of labor between science agencies, seismic network operators, emergency management organizations, private consultants and others? How will issues of legal authorities and liabilities be managed? The working groups should include both scientists and emergency managers who can speak on behalf of the technology at scientific meetings and meetings of emergency services personnel, and can provide clear and cogent explanations of the operations and products of an earthquake early warning system to the media and public.

Finally, the working groups should think geographically and strategically about implementation of earthquake early warning systems by developing a long-term plan that includes integrating and leveraging EEW facilities. This may include cost sharing and leveraging of technical and financial assets.

**Assessment**

The primary measure of the success of this Policy Recommendation will be the number of WSSPC members that form earthquake early warning working groups. A periodic assessment should be made to determine whether working groups have been formed and whether early warning systems are being considered. WSSPC will post information on state efforts to implement earthquake early warning systems on the WSSPC website.

**History**

WSSPC Policy Recommendation 17-7 was originally adopted as WSSPC Policy Recommendation 10-9 by unanimous voice vote of the WSSPC members at the July 9, 2010 Annual Business Meeting in Broomfield, Colorado. It was revised and re-adopted as WSSPC Policy Recommendation 14-7 by unanimous voice vote of the WSSPC members at the July 21, 2014 Annual Business Meeting in Anchorage, Alaska. It was revised and re-adopted as WSSPC Policy Recommendation 17-7 by unanimous voice vote of the WSSPC members at the April 28, 2017 Annual Business Meeting in Oklahoma City, Oklahoma.