

**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.