California Earthquake Early Warning Project

Helpful Facts and Frequently Asked Questions

(Sources: CalOES, CISN and USGS)

What is "Earthquake Early Warning?"

Although no one can reliably predict earthquakes, today's technology is now advanced enough to be used to rapidly detect seismic waves as an earthquake begins to happen, calculate the maximum expected shaking, and send alerts to surrounding areas before damaging shaking arrives; this is Earthquake Early Warning.

Why do we need Earthquake Early Warning?

Timely warnings of an earthquake could provide several seconds, and in some cases up to a minute or two, before the arrival of damaging shaking. Even a few seconds can allow time to take protective action such as taking cover in safe locations, stopping elevators and opening doors at the nearest floor, or automatically stopping critical processes to mitigate damages or to enhance public safety.

What efforts are underway to implement an earthquake early warning system?

Cal OES has been tasked with leading a comprehensive effort to bring together experts with decades of scientific research, members of government and private industry, and the latest technology to the table to, finally, get an effective and reliable early warning system online in California.

In September 2013, Governor Jerry Brown signed Senate Bill 135 into law. This was a critical step forward in the overall effort to provide Californians with enough warning that an earthquake capable of producing intense ground shaking has occurred.

Codified as Government Code Section 8587.8, the legislation states that the Cal OES will, in collaboration with the California Institute of Technology (Caltech), the California Geological Survey (CGS), the University of California (UC Berkeley), the United States Geological Survey (USGS), the California Seismic Safety Commission, and other stakeholders, develop a comprehensive statewide earthquake early warning system in California through a public/private partnership.

A major feature of the legislation signed into law by Governor Brown was for California's system to be developed and implemented through a public/private partnership. To accomplish this, by 2016, California must also identify funding for a comprehensive statewide earthquake early warning system other than the State general fund.

What is the strategy for implementing the system in California?

The state is collaborating with a number of institutions, along with public agencies and the private sector, to assess current capabilities and resources to implement a system specific to California's unique needs.

An implementation plan is currently being developed for the ***California Earthquake Early Warning System (CEEWS)*** that will describe the system requirements, minimum standards, management structure, cost estimates and funding sources, and public education guidelines. The implementation plan will constitute a detailed pathway to secure the goal of improving public safety and reducing the damage caused by large California earthquakes.

A series of committees are established to develop the plan. They include:

- A ***Steering Committee*** comprised of public and private stakeholders and subject matter experts to review and provide advice on the progress of the other project committees as they work toward meeting the objectives. The steering committee is comprised of the chairs of the five committees and chaired by an executive level member of Cal OES.

- A ***Stakeholder Liaison Group*** to inform and receive input on the development of the CEEWS external stakeholders and potential users of an earthquake early warning system during CEEWS development.

- A ***Funding Options Committee*** will identify costs and options for system funding that do not identify the state General Fund as one of those sources.

- A ***Standards Committee*** will ensure that the system operates in a timely, reliable and efficient manner.

- A ***Model Committee*** will develop a model that represents a public/private partnership that will operate in a cost effective and reliable manner. The Standards Committee and Model Committee are tasked with developing the system description for earthquake early warning in California.

- A ***Management Committee*** will formalize an organizational structure that incorporates existing roles and responsibilities for seismic monitoring in California.

- An ***Education and Training Committee*** will identify the components of a comprehensive training and education program that addresses the needs of all potential users of an earthquake early warning system.

What has been accomplished since the legislation was enacted?

CalOES has already conducted workshops in northern and southern California, meeting with local, state and federal officials, and the private sector, to make progress on the early warning initiative. Since then, the working committees continue their tasks to: (1) establish recommended performance standards for the system operation, (2) outline how the public and private systems will integrate; (3) describe how the system will be managed once implemented; (4) prepare essential public education material, and; (5) research funding opportunities. In early 2015, the CEEWS Steering Committee will meet to review the working committee accomplishments, which will be summarized in a report on their findings and recommendations.

How will the system be funded?

The system must be sustainable for the long term. That means sustainable funding is needed for the system to become reliable and fully operational. A variety of funding sources will likely need to be leveraged to accomplish this. This may include state and federal funds, grants, subscription services, bond funding, fees for service, and business and industry sponsorships.

What is needed for successful early warning?

The ability to send warning before shaking waves arrive depends on:

- A network of sensors that are densely spaced and close to faults
- Quick, robust telecommunication from sensors
- Computer algorithms for fast evaluation of earthquakes (location, magnitude, potential continued propagation)
- Quick reliable mass notifications
- End user education

What technologies already exist to support earthquake early warning?

California has the foundation for an early warning system through the California Integrated Seismic Network (CISN). CISN is a partnership among Cal OES, the California Geological Survey, the United States Geological Survey, the Caltech Seismological Laboratory and Berkeley Seismological Laboratory, with support from several contributing agencies and organizations. Using real-time information gathered by a network composed of nearly 1,000 seismic stations in Southern and Northern California, CISN provides real-time information to develop maps and other products to help emergency managers deploy resources to help protect lives and property in the areas hardest hit and rapidly determine the magnitude of the damage in order to qualify for federal assistance.

CISN is a partnership among:

- Cal OES

- California Geological Survey
- United States Geological Survey
- California Institute of Technology (Caltech) Seismological Laboratory
- UC Berkeley Seismological Laboratory; and
- Supported by several contributing agencies and organizations.

Another technology to be included in the strategy is the "ShakeAlert" prototype Earthquake Early Warning System, which is currently being tested in California. ShakeAlert is built upon existing technology available through the CISN.

What are the benefits of earthquake early warning?

Scientists cannot predict earthquakes, but rapid alerts sent to government officials, first responders and the public about a potentially damaging earthquake could reduce deaths, injuries and property losses.

Timely warnings that a major earthquake is occurring could provide a few seconds to up to two minutes depending on the size of the earthquake and your distance from the epicenter. That is enough time for students, commuters, workers and others to take protective action:

- **Public:** Allow citizens, including school children, to drop, cover, and hold on; turn off stoves, safely stop vehicles.

- **Medical Services:** Allow surgeons, dentists, and others to stop delicate procedures.

- **Emergency Services:** Open firehouse doors, allow personnel to prepare and prioritize response decisions.

- **Businesses and Construction:** Enable personnel to move to safe locations. Elevators could be programmed to stop and open their doors at the nearest floor when an earthquake warning is received could prevent occupants from being stranded. Sensitive equipment could be placed in a safe mode. Chemicals and other hazardous materials could be secured. Production lines could be shut to reduce damage.

- **Transportation:** Automatically trigger the slowing or stopping of trains to avoid derailing. Clear bridge traffic. Inbound aircraft could be automatically advised to divert to other airports.

- **Power Infrastructure:** Help electrical generation facilities to prepare for strong shaking and protect the grid.

How does Earthquake Early Warning work?

The objective of earthquake early warning is to rapidly detect the initiation of an earthquake, estimate the level of ground shaking to be expected, and issue a warning before significant ground shaking

arrives. This can be done by detecting the first energy to radiate from an earthquake, the P-wave energy, which rarely causes damage. Using P-wave information, we first estimate the location and the magnitude of the earthquake. We use this to estimate the anticipated ground shaking across the region to be affected. The method can provide warning before the S-wave, which brings the strong shaking that usually causes most of the damage, arrives.

What determines warning time?

Earthquake early warning can provide seconds to minutes of warning before strong shaking arrives. The amount of warning time depends on the speed of the system and your distance from the event. The speed of the system relies on a dense network to ensure enough sensors are near all possible earthquake sources. A dense network especially helps reduce the "blind zone," within which warning is not possible because the earthquake source is too close for an alert to outpace the seismic waves. To maximize warning time, efforts will need to focus on minimizing delays in data processing and communication, and delivery of alerts.

How can I get Earthquake Early Warning alerts?

The public dissemination of earthquake early warning alerts is part of the long term strategy for this system. However, there are some short term challenges: There are many areas in California where there are not enough seismic stations to recognize and characterize a newly starting earthquake quickly enough for an early warning to be useful; and, people, companies and institutions must know beforehand what they will do when they receive the information. Eventually, earthquake early warning alerts will arrive by all means possible - through email, applets, radio, and television, and by computer-to-computer messages for automatic control of systems like trains and production facilities.

What are the probabilities of an earthquake in California?

In 2008, the Working Group on California Earthquake Probabilities published the *Uniform California Earthquake Rupture Forecast, Version 2 (UCERF 2).* Within this document, scientists conclude it is certain that another major earthquake will occur in California in the coming years.

- **Magnitude 6.7 Event Statewide:** Scientists estimate that the probability of at least one magnitude 6.7 earthquakes somewhere in California within the next 30 years at more than 99 percent. The likelihood of such a quake in the Los Angeles region is estimated to be 67 percent. In the San Francisco Bay Area, the likelihood is estimated to be 63 percent.

- **Magnitude 7.5 Event Statewide:** Scientists also estimated the probability of a magnitude 7.5 quake somewhere in California over the next 30 years at 46 percent. The 30-year probability of a M7.0 earthquake in Southern California is 82 percent and the probability of a M7.5 earthquake is 37 percent. The 30-year probability of a M7.0 earthquake in Northern California at 68 percent and the probability of a M7.5 at 15 percent.

Summary

California has the infrastructure and basic capabilities to support the development of an earthquake early warning system to enhance public safety in the event of a large earthquake. Such a system should build upon the existing earthquake monitoring framework, including CISN, ShakeMap, ShakeAlert prototype and other disaster assessment tools used by emergency managers.

We believe a comprehensive earthquake early warning system will reduce the number of emergency services that need to be provided when disaster strikes. The system would be effective to mitigate the damage and losses to property. A credible and well-funded system will require support from both government and the private sector.

For More Information

Cal OES Earthquake and Tsunami Program
http://bit.ly/quake-warning

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