Audible Warning for Selected Personnel

Earthquakes threaten 1 in 4 Americans. Earthquakes currently cannot be predicted, but people can act beforehand to reduce the harm when earthquakes occur. One way to do that is to implement earthquake early warning, which refers to a system that rapidly detects earthquakes just after they begin, quickly calculates how strongly the ground will shake, and notifies people or systems just a few kilometers or tens of kilometers from the epicenter before the shaking arrives. With a few seconds' warning, people and systems can take useful protective actions. The next few pages answer key questions for people deciding whether and how to adopt earthquake early warning to issue audible warnings to selected personnel. This material was written by leading earthquake engineers, seismologists, emergency managers, and other pioneers of earthquake early warning, including people who developed, implemented, and use earthquake early warning in real life.

This is one of seven guidelines for different ways to use earthquake early warning. Find the full set at http://www.sparisk.com/pubs/Porter-2020-EEW-Set.pdf

Essence of the Practice

An audible warning is announced either through a radio system to select people carrying a two-way radio, or through the telephone system to select extensions. The warning instructs people to take immediate self-protective action against imminent ground shaking such as drop, cover, and hold on.

A B

Figure 1. Audible warning for selected personnel can be delivered by (A) IP telephones or (B) two-way radios. (Images: A: Geek2003 Creative Commons Attribution-Share Alike 3.0 Unported, B: Evan Forester, public domain)

Context in Which the Use Case Would Work

This use case is intended for workplaces with low enough ambient noise or high enough visibility that personnel can hear or see the alarm. Works in regions with an earthquake early warning network: California, Oregon, Washington, Mexico, Japan, Turkey, Romania, China, Italy, and Taiwan.

Realistic Expectations

Some fraction of users will take self-protective action. In Japan during the 2011 Tohoku earthquake, approximately 75% of people successfully took self-protective actions. Comparable statistics for the U.S. are not yet available. See "potential vulnerabilities" below for reasons some people might not take self-protective action. Expect injuries to be reduced but probably not eliminated through successful self-protective action; efficacy statistics are unavailable.

Clear Behavior

Drop, cover, and hold on, and its alternative context-dependent actions are described in https://www.earthquakecountry.org/step5/. These include instructions for people with disabilities, in bed, in a highrise, in a store, outdoors, driving, in a stadium or theater, near a shore, or below a dam.

Potential Vulnerabilities

The system will not work if radio repeaters have lost power and battery backup has run down. It will not work on telephones without power or telephone connectivity.

The system may fail to send an alarm because of

- An IP phone system can suffer from added latency (longer time to transmit the message) and potential failure of software integration.
- Electric power or Internet connectivity is lost or cut off before the message is received or announced. This potentiality can be somewhat mitigated by the vendor monitoring power and Internet connectivity and alerting end users to loss of power and by providing backup power to the alerting system.
- Prior unnoticed or uncorrected damage to hardware. Constant monitoring by the vendor and following a frequent testing protocol can mitigate this problem.
- Failure to start software. The same monitoring and testing protocols can mitigate this problem.

The warning may or may not arrive long enough in advance of strong shaking because of proximity to the rupture and because of the time it takes for successful self-protective action. If the warning arrives before strong shaking, people may still fail to take self-protective action for any of several reasons. Users may be unable to hear or understand the alarm because of:

- Sleep
- Ambient noise (a crowd, a loud television, etc.)
- Hearing impairment
- Language
- Ambiguous message. All these possibilities can be mitigated to some extent.

Users may be slow to react appropriately because of:

- Unfamiliarity with earthquake early warning
- Lack of drilling or experience
- Checking first to see what everyone else is doing
- Waiting for an authority figure to confirm the message
- Bravado
- Belief that the alarm is a mistake, false alarm, or meant for others

Physical constraints may prevent effective self-protective action because of:

- Mobility impairment
- Crowded or enclosed space (e.g., movie theater lobby, jail cell, toilet stall)
- Prevented or injured by others taking inappropriate action

Users may take inappropriate actions because of

- Misinformation (believing in the triangle of life)
- Obsolete advice (standing in a doorway)

- Panic (such as attempting to run out of the building). Panic can be reduced by greater preparation, such as through regular drills, and possibly through occupants' confidence in the strength of their building.

Implementation Costs

Cost to implement an audible alarm through a radio system: low $10,000s. For an IP phone system, $1,000s. Drilling can involve 1 hour of staff preparation per drill, perhaps annually. Costs to develop a system in-house are unknown.

Hardware and Software Requirements

For a two-way radio system, the user must have such a system, and new hardware is added. For address through an IP phone system, only new software is required.

Training Materials, Requirements, and Frequency of Training

Earthquake Country Alliance provides ample training materials and requirements. See https://www.earthquakecountry.org/step5/. In the US, annual training on ShakeOut day seems to represent the consensus on appropriate frequency. See https://www.shakeout.org/ for information about ShakeOut day.

Maintenance Requirements

Maintain the radio or IP telephone system, perform annual testing, and ensure remote monitoring and system updates from the vendor.

Examples of Past Use

NBC Universal Studios and Cedars-Sinai Medical Center implemented such a system. At Cedars-Sinai, hospital staff were trained on how to react to the alerts and staff have gone through drills (Lin 2020, Healy 2014). For information, contact Early Warning Labs, 1-424-238-0060, Info@EarlyWarningLabs.com.

References

Healy, P. (2014). Private Sector Takes Role in Advancing Quake Early Warning. NBC Los Angeles, September 6, 2014. https://www.nbclosangeles.com/news/private-sector-takes-role-in-advancing-quake-early-warning/93964 [accessed April 28, 2020]

Lin, R.G. II (2020). California's new early warning earthquake app features a shaking countdown. Los Angeles Times, February 12, 2020. https://www.latimes.com/california/story/2020-02-12/californias-new-early-warning-earthquake-app-features-a-shaking-countdown [accessed April 28, 2020]