

## FAQ: Magnitude, Intensity, and ShakeAlert<sup>®</sup>

The **ShakeAlert<sup>®</sup> Earthquake Early Warning system<sup>1</sup>**, operated by the U.S. Geological Survey (USGS), quickly detects significant earthquakes, estimates shaking, and issues ShakeAlert Messages to Technical Partners. Then, Technical Partners, which have entered into a license agreement with the USGS, use this information to deliver alerts that rapidly reach people and trigger automated actions to protect vital systems and infrastructure, potentially seconds before shaking arrives at their location.

The ShakeAlert Earthquake Early Warning system only issues a ShakeAlert Message if certain thresholds in magnitude and intensity are met. The goal is to alert people and systems for weak or greater shaking.

### • What is the difference between earthquake magnitude and intensity?

Magnitude and intensity each measure different aspects of an earthquake.

**Magnitude** measures the amount of energy released from an earthquake. Magnitude is expressed in whole numbers and decimal fractions. For example, an M5.0 is considered a moderate earthquake, and an M6.0 is a strong earthquake. As an estimate of energy, each whole number step in the magnitude scale represents about 32 times more energy released. Consider that M7.0 earthquake releases ~32 times the energy of an M6.0 earthquake and 1,000 times the energy of an M5.0 earthquake.

**Intensity** is what people feel as the seismic waves travel across the surface of the Earth. Your location relative to the earthquake is the main factor that determines the level of shaking you will experience. The type of rock and soil beneath you can also affect the shaking intensity; valleys and unconsolidated sediments tend to amplify shaking.

### Earthquake Magnitude and Energy Released

A single step in the magnitude scale represents a ~32x stronger earthquake (by energy released).

Magnitude 5

Magnitude 6  
32x stronger  
than a Magnitude 5

Magnitude 7  
1000x stronger  
than a Magnitude 5

Magnitude 8  
32,000x stronger  
than a Magnitude 5

Magnitude 9  
1,000,000x stronger  
than a Magnitude 5

ShakeAlert<sup>®</sup>

The USGS [“How Much Bigger...?” Calculator](#) explains the difference between two different magnitude earthquakes in terms of strength and energy released.

In 1935, Charles Richter of the California Institute of Technology introduced the concept of earthquake magnitude and the Richter Scale to measure the size of earthquakes. While some media reports still erroneously refer to the Richter Scale, scientists have developed far more accurate ways to measure earthquakes than were available in the 1930s.

<sup>1</sup>When referring to “system” vs “System,” lowercase “s” refers to the USGS part of the operation (sensors and processing centers), and uppercase “S” refers to the USGS part and the alert delivery Technical Partners (i.e., the entire System).

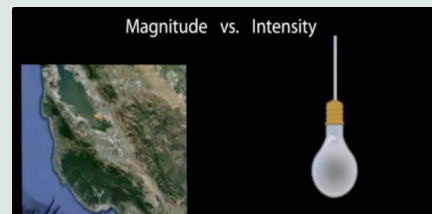
## • What is the Modified Mercalli Intensity Scale?

The Modified Mercalli Intensity (MMI) Scale is composed of increasing levels of intensity that range from imperceptible shaking to catastrophic destruction; levels of intensity are designated by Roman numerals. The MMI Scale does not have a mathematical basis; instead, it is a holistic ranking based on observed effects. The lower range of the MMI scale generally deals with the manner in which the earthquake is felt by people. The higher range considers observed structural damage.

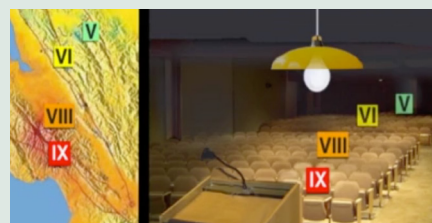
## • How else can we think about magnitude vs. intensity?

Consider the amount of energy and brightness emitted from a lightbulb. For a given earthquake, magnitude is a fixed property and does not change, just like the wattage of a lightbulb. Shaking intensity is like the amount of light received at any spot in the room away from the lightbulb. The closer you are to the lightbulb, the more intense or bright the light is. The farther away from the same lightbulb, the less intense or dim the light is.

For more on magnitude vs. intensity, check out this [animated GIF](#) from the Incorporated Research Institutions for Seismology (IRIS).



Check out this [IRIS animation](#) to better understand what a person experiences relative to earthquake intensity.



## Earthquake Intensity Scale Modified Mercalli Intensity (MMI)

<p>Not felt except by very few.</p> <p><b>I</b> Not Felt</p>	<p>Felt only by a few persons at rest, especially on upper floors of buildings.</p> <p><b>II</b> Weak</p>	<p>Felt indoors, though many people do not recognize it as an earthquake. Standing cars may rock slightly.</p> <p><b>III</b> Weak</p>	<p>Felt indoors by many, outdoors by few. Dishes and windows are disturbed.</p> <p><b>IV</b> Light</p>	<p>Felt by nearly everyone, many awakened if at night. Dishes and windows are broken.</p> <p><b>V</b> Moderate</p>
<p>Felt by all; many frightened. Some heavy furniture moved. Damage is slight.</p> <p><b>VI</b> Strong</p>	<p>Slight to moderate damage in ordinary construction. Some chimneys broken.</p> <p><b>VII</b> Very Strong</p>	<p>Considerable damage to ordinary construction. Chimneys, columns, and walls may fall.</p> <p><b>VIII</b> Severe</p>	<p>Damage is great in substantial buildings, with partial collapse. Buildings shifted off foundations.</p> <p><b>IX</b> Violent</p>	<p>Some well-built wooden structures destroyed; most masonry and structures are destroyed.</p> <p><b>X+</b> Extreme</p>





## • How do magnitude and intensity affect whether you will receive a ShakeAlert-powered alert?

For more understanding about modeling magnitude, check out this [short video](#) from the Incorporated Research Institutions for Seismology (IRIS).

End-users receive ShakeAlert-powered alerts only if certain thresholds for magnitude and shaking intensity are met, as identified below. The ShakeAlert system only issues a ShakeAlert Message if the earthquake is expected to produce weak or greater shaking that can potentially cause damage. It is important to note that not all Technical Partner delivery methods have the same alerting thresholds and may not all activate for a given earthquake.

### Alert Thresholds

#### To Alert People

	Who is Alerted	Magnitude Threshold	Intensity Threshold
 <b>Wireless Emergency Alert (WEA)</b>	General public with WEA-capable devices	5.0+	MMI IV+
 <b>Cell Phone Apps</b>	People who have downloaded a cell phone app	4.5+	MMI III+ (user selectable)
 <b>Android Operating System</b>	Android cell phone users through push notifications	4.5+	MMI III - MMI IV
	Android cell phone users through full-screen takeover	4.5+	MMI V+
 <b>Automated Alerts through Public Address Systems, Lights, Sirens, In-House Apps, etc.</b>	Institutions that use ShakeAlert to alert people to take a protective action	4.0+	MMI III+

#### To Alert Systems and Machines

 <b>Automated "Machine-to-Machine" Alerts</b>	Institutions that use ShakeAlert to automate actions to mitigate damage to vital equipment, systems, and infrastructure	4.0+	MMI III+
--	---	------	----------

**ShakeAlert**

As of June 2021

### REFERENCES AND RESOURCES

Earthquake Intensity- Incorporated Research Institutions for Seismology (IRIS)  
[https://www.iris.edu/hq/inclass/animation/earthquake\\_intensity](https://www.iris.edu/hq/inclass/animation/earthquake_intensity)

Earthquake Magnitude, Energy Release, and Shaking Intensity- US Geological Survey (USGS)  
[https://www.usgs.gov/natural-hazards/earthquake-hazards/science/earthquake-magnitude-energy-release-and-shaking-intensity?qt-science\\_center\\_objects=0#qt-science\\_center\\_objects](https://www.usgs.gov/natural-hazards/earthquake-hazards/science/earthquake-magnitude-energy-release-and-shaking-intensity?qt-science_center_objects=0#qt-science_center_objects)

Modified Mercalli Intensity Scale- US Geological Survey (USGS)  
[https://www.usgs.gov/natural-hazards/earthquake-hazards/science/modified-mercalli-intensity-scale?qt-science\\_center\\_objects=0#qt-science\\_center\\_objects](https://www.usgs.gov/natural-hazards/earthquake-hazards/science/modified-mercalli-intensity-scale?qt-science_center_objects=0#qt-science_center_objects)

Putting Down Roots in Earthquake Country, US Geological Survey (USGS)  
<https://pubs.usgs.gov/gip/2005/15/gip-15.pdf>

ShakeAlert System Alerting Thresholds- US Geological Survey (USGS)  
<https://www.shakealert.org/implementation/shakealert-system-alerting-thresholds/>

Take 2: Magnitude vs. Intensity- Incorporated Research Institutions for Seismology (IRIS)  
[https://www.iris.edu/hq/inclass/animation/take\\_2\\_magnitude\\_vs\\_intensity](https://www.iris.edu/hq/inclass/animation/take_2_magnitude_vs_intensity)

@USGS\_ShakeAlert- Twitter, US Geological Survey (USGS)  
[https://twitter.com/USGS\\_ShakeAlert](https://twitter.com/USGS_ShakeAlert)