EARTHQUAKE EMERGENCY HANDBOOK

FOR FIRST RESPONDERS AND INCIDENT COMMANDERS

Responding to and managing an earthquake disaster in a rural environment in the first few days

WSSPC
WESTERN STATES SEISMIC POLICY COUNCIL

INTRODUCTION

This handbook has been created for rural communities with limited resources and is intended to guide response within the first 48 to 72 hours after an earthquake—before State and Federal assistance is available. The assumption is that by 48-72 hours after the event outside support should arrive.

The February 21, 2008 M6.0 Wells, Nevada earthquake provided the impetus for this handbook. The earthquake ruptured a previously unmapped fault and caused significant damage, particularly to unreinforced masonry buildings, in a rural area with limited personnel and resources. The area had no recent history of significant seismic events so emergency responders in the area were not familiar with earthquake hazards and had to learn the basics of earthquake-specific emergency response while responding to the event. The number one "lesson learned" stated in the emergency response section of the Wells earthquake disaster review was the need to develop an earthquake emergency handbook for Incident Commanders in similar situations.

In 2014, the Western States Seismic Policy Council adopted a policy recommending that "an Earthquake Emergency Handbook for first responders and incident commanders be developed." The Western States Seismic Policy Council obtained funding for this handbook from the Federal Emergency Management Agency, Cooperative Agreement 2015-EMW-CA-00213. Principles and guidance in this handbook are intended to protect life, property, and commerce. Terms, concepts, and response may vary from state to state.

Cover Image: Damage to the Bullshead Bar in the Wells historical district from the Wells, Nevada M6 Earthquake February 21, 2008. Photograph by Nick Stake.

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When the Shaking begins:

The following actions should be taken during an earthquake:

- Drop, Cover and Hold On! Drop to the floor; take cover under a sturdy desk, table or other furniture, and hold on to it. Be prepared to move with it. Hold the position until the ground shaking stops and it is safe to move. If that is not possible, seek cover against an interior wall and protect your head and neck with your arms.
- Avoid exterior walls, glass windows, heavy furniture, and overhead equipment or machinery.
- When in a multi-story building, move against an interior wall if you are not near a desk or table. Do not use the elevators.
- Remain alert for structural and nonstructural hazards (nonstructural hazards include furniture, ceiling systems, HVAC systems, chimneys, parapets, etc.).
- When in a crowded store or other public place, move away from display shelves containing objects that could fall. Do not rush for the exit.
- When in a stadium or theater, get below the level of the back of a seat and cover your head and neck with your arms.
- When outdoors, move to a clear area away from trees, signs, buildings, or overhead wires.
- When driving, pull over to the side of the road and stop. Avoid overpasses and power lines. Stay inside the vehicle until the shaking stops.

When The Shaking Stops:

- Account for all personnel and check for life-threatening injuries. Treat life-threatening injuries.
- Remain alert for secondary hazards (these include: hazardous materials spills, fires, dam failures, rock falls, landslides, liquefaction, tsunami, etc.).
- Move response apparatus a safe distance away from buildings and overhead wires.
- A safe distance is beyond the potential collapse zone of a given building (approximately 1.5 times the height of the building). Be aware that should a building collapse, there is the possibility of building elements – such as bricks, concrete masonry units (CMUs), etc. – being thrown further distances and with great force when the sides of the structure hit the ground when falling forward.
- Inspect for and control for any hazards created by damaged utilities such as natural gas, propane, electricity or water.
- Be prepared for aftershocks that may be as strong, or stronger, than the initial shock.
- Conduct a windshield survey to assess potentially damaged areas.

Initial Actions Quick Checklist

- ☐ Establish Incident Command Post/Emergency Operations Center
- ☐ Establish communications
- ☐ Develop a Common Operating Picture/Situational Awareness
    - ☐ Life safety
    - ☐ Fires
    - ☐ Firefighting Water/Potable Water Supply
    - ☐ Damaged buildings
    - ☐ Search and Rescue Needs
    - ☐ Health and Safety Needs
    - ☐ Power
    - ☐ Road status
- ☐ Identify key staff: Operations, Logistics, Planning, Finance, Public Information, Policy Group and Safety Officer
- ☐ Assess other staff resources (fire/medical/rescue)
- ☐ Assess equipment resources (rescue, debris removal, supply movement)
- ☐ Contact local, county or state government

Initial Life Safety Assessment Quick Checklist

- ☐ Damaged Buildings
- ☐ Fires
- ☐ HazMat
- ☐ Natural Gas/Propane
- ☐ Transportation (overpasses, underpasses)
    - ☐ Roads
    - ☐ Railroads
    - ☐ Airports
- ☐ Dams (private, slurry impoundments, livestock ponds) – Consider Evacuation routes
- ☐ Medical patients/Hospitals
- ☐ Nursing homes/Home Healthcare
- ☐ Schools/Day Care Centers
- ☐ Vulnerable populations
- ☐ Agriculture and Livestock
- ☐ Mine collapse
- ☐ Dust
- ☐ Landslides
- ☐ Liquefaction
- ☐ Rock Falls
- ☐ Tsunami or Seiche
- ☐ Aftershocks – Repeat Safety Assessment

AFTER THE EARTHQUAKE

AFTER THE EARTHQUAKE

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Safety Considerations for All at the Incident Scene

In order of priority, the safety objectives for all personnel are:

- Save Lives – The preservation of life is the top objective of emergency managers and first responders and takes precedence over all other considerations.
- Protect Health and Safety – Measures should be taken to mitigate the incident's impact on public health and safety and emergency responders.
- Protect Property – All feasible efforts must be made to protect public and private property and resources, including critical infrastructure from damage during and after the earthquake.

  Fire: Earthquakes can rupture natural gas lines, fuel lines, propane tanks, and hazardous material containers which can ignite and cause fires. In many cases underground water lines which supply hydrants may also be damaged. This may significantly limit the ability to extinguish fires. Tens to hundreds of fires can start and result in conflagrations.

  Buildings: Before entering damaged buildings, perform a safety evaluation on the building. Buildings can be especially hazardous given the potential for aftershocks to occur causing further damage or collapse of the building, falling hazards, and other unforeseen hazards. Considerable judgment must be applied when considering entry into damaged buildings. The Applied Technology Council has assembled guidelines that may be helpful: *https://www.atcouncil.org/pdfs/atc35tb2.pdf*

Safety Zones around Buildings: Barricades should be set up around damaged buildings. A safe distance is at least 1.5 times the height of the building. Barricades will also be needed to block off streets and other unsafe areas.

- **Building Entry Considerations:** Entry into an apparently stable building should not be made until the exterior of the building has been inspected. It is strongly recommended that persons do not enter severely damaged buildings. Entry should only be made for qualified personnel. People entering damaged buildings are at risk because of possible aftershocks.
- **Search and Rescue Considerations:** Search for the injured and rescue of those trapped are among the most important and urgent post-earthquake activities. Those conducting these activities can themselves become victims. Search and rescue personnel, by nature, take higher risks. Those risks can be lessened if time spent in dangerous situations is kept to a minimum and if those involved take precautions. Always walk around the building as part of your assessment. Be aware of falling hazards, such as chimneys, parapets, building appendages, signage, or other building ornamentation. Unless you are on an entry rescue team, medical personnel and their apparatus should remain outside the collapse zone.

Health and Safety: All personnel should take safety precautions which include wearing personal protective equipment (PPE) and respirators to protect against airborne dust and asbestos.

Earthquakes can raise large amounts of dust. Respirators or dust masks may be recommended to protect first responders, personnel working in the damaged areas, and the public, depending on the local hazards. Paper dust masks and household materials such as washcloths, bandannas, and handkerchiefs do not protect people from breathing in asbestos dust or Valley Fever spores.

Be sure to have the correct equipment required to protect against the hazards present.

Asbestos

Asbestos fibers may be released into the air by the disturbance of asbestos containing building materials during an earthquake. A common visual clue which may indicate the presence of asbestos is when older buildings have exposed gas or water pipes which are covered in white-fibrous wrap. To learn more, see: *https://www.epa.gov/asbestos/learn-about-asbestos#exposed*.

Three of the major health effects associated with asbestos exposure are:

- Lung cancer
- Mesothelioma, a rare form of cancer that is found in the thin lining of the lung, chest and the abdomen and heart
- Asbestosis, a serious progressive, long-term, non-cancer disease of the lungs

Follow state and federal guidance for safe removal of asbestos including using respirators (See OSHA required respirators: *http://www.cdc.gov/niosh/npg/nengapdxe.html*)

Valley Fever (Coccidioidomycosis)

Valley fever is caused by the fungus *Coccidioides immitis* that lives in soil in certain parts of the arid western states. When soil containing the fungus is disturbed, the fungal spores get into the air. When people breathe the spores into their lungs, they may get Valley Fever. Valley Fever is often undiagnosed or misdiagnosed but the consequences may be serious. A map showing endemic areas is here: *http://www.cdc.gov/niosh/topics/valleyfever/images/valley-fever-map.png*

Work should be stopped in dust storms or in high winds, and when digging, continuously wetting the soil will help suppress the spores

from becoming airborne. When exposure to dust is unavoidable, provide NIOSH-approved respiratory protection with particulate filters rated as N95, N99, N100, P100, or HEPA. (Information is from California Department of Public Health *https://www.cdph.ca.gov/programs/hesis/Documents/CocciFact.pdf*

Environmental: Potable water supplies may be disrupted by the earthquake. Until the water supply is confirmed to be safe, advise the public to use bottled water or boil their water.

Establish Emergency Operations Center

Now that the initial actions are started the Incident Commander can locate the Incident Command Post (ICP) or the Emergency Operations Center (EOC) and start to staff it with Key Positions.

Find the right location for an ICP and/or EOC by referring to basic community knowledge/geography. The ICP should be located at or in the immediate vicinity of the incident site and is the focus for the conduct of direct, on-scene control of tactical operations; whereas the EOC can be established as either a virtual or physical location with a focus on supporting on-scene activities by prioritizing activities and allocating available resources. Be aware that aftershocks and secondary hazards may occur. The location of the EOC should be determined prior to

the incident, if possible, and make sure it is in a location that has the following characteristics:

- Location free from other potential hazards (outside of flood zones, dam inundation areas, away from hazardous materials, etc.)
- A safe building
- Adequate space
- Backup power supply
- Communication capabilities (phone lines, radios, and Internet, etc.)
- An ANSI Certified First Aid Kit (at minimum)

Essential Elements of Information

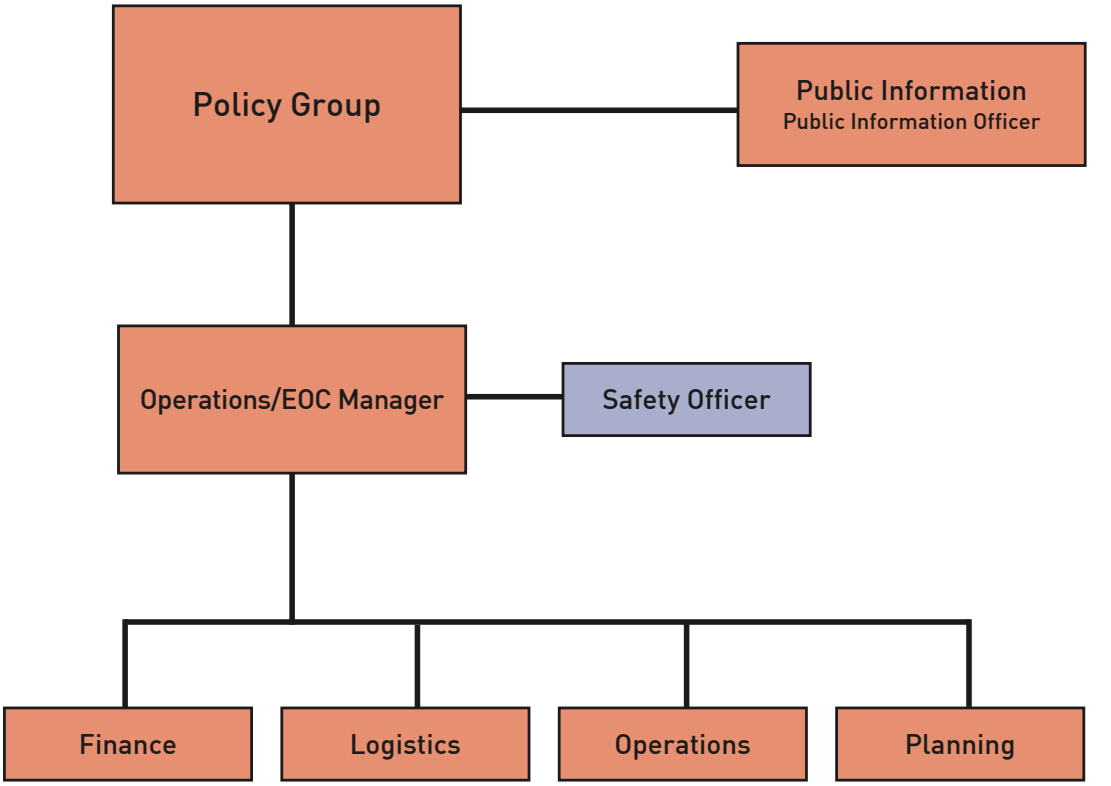
To fully describe and communicate the situation include:

- Number of fatalities
- Number of injuries
- Building damage, partial collapse, total collapse
- Unsafe areas
- Search and Rescue Operations
- Critical Infrastructure, damage assessment, locations and types i.e., road and bridge closures
- Status of communications and other utilities including power, gas, and fuel
- Location/Boundaries/Scope of Incident
- Sheltering Information
- Evacuation boundaries/information

- Incident facilities, types, and locations
- Affected cities/towns/tribes/counties/special districts
- Emergency medical needs/health care facility status
- Toxic areas/chemical spills/airborne/radiological
- Weather forecasts and advisories that may affect public and responder safety
- Distribution or disbursement locations
- Resources on scene and enroute

Maps and charts are helpful to communicate areas of operations, locations of critical facilities, proposed evacuation routes, shelter locations, etc.

Fill Key Staff Positions



1- Operations

Operational objectives govern resource allocation and the response goals during an emergency. These objectives are to:

- Save Lives
- Protect Health and Safety
- Protect Property

The Operations Section:

- Oversees and manages the EOC/ICP
- Assigns Safety Officer
- Checks on Life Safety
- Establishes Secured Areas
- Organizes Building Safety Evaluations
- Establishes Air Operations if needed
- Answers to Policy
- Develops objectives for the incident in cooperation with Planning and Policy

2- Logistics

The Logistics Officer is responsible for completing requests for resources. If local resources are exhausted, resource requests can be made to the County. Any mutual aid agreement can be activated. Requests can be as small as a dump truck or as large as a Search and Rescue Team. Logistics personnel are responsible for:

- Locating facilities
- Supporting Communications

- Providing Medical and Food Services for Responders
- Providing Transportation
- Providing equipment maintenance and fueling
- Providing status of resource requests
- Completing resource requests and escalating beyond the local level if unable to fill requests
- Tracking resources (equipment and personnel hours)
- Discussing prioritization of resource deployment with Operations
- Coordinating donated resources with Voluntary Agencies Active During Disaster
- Managing mobilization and demobilization of resources
- Executing existing Private Sector contracts
- Executing existing contracts and agreements (MOUs and MOAs)

3- Planning

Planning personnel are responsible for collecting, analyzing, and communicating information as part of situational awareness to Operations. Their responsibilities are to:

- Provide support to Incident Commander
- Gather Information
- Plan for the next Operational Period
- Prepare Alternative Strategies and Objectives with Operations

Depending on available staff resources, the planning function may be required to do some or all of the following:

- Coordinate with other agencies to provide a Common Operating Picture (COP)
- Prepare and document Incident Action Plans.
- Prioritize Immediate objectives and goals going forward
- Develop alternate goals and contingency planning
- Coordinate transportation needs with logistics
- Report any significant changes in incident status
- Plan for debris removal issues

4- Finance

Financial personnel are responsible for all financial aspects of the response. Finance coordinates with the Incident Commander, Operations Chief, Logistics Chief, and Policy Group. This includes:

- Tracking costs of emergency operations costs, including resources, personnel, and debris management
- Disbursing funds and adhering to local financial policy
- Tracking and documenting damage to critical infrastructure.
- Tracking the Burn Rate—how fast money is spent during an operational period.
- Advising on pre-qualified contractors

- Tracking employee hours and overtime hours
- Verifying that purchases follow local jurisdiction policy
- Providing payouts to vendors—cutting checks
- Ensuring there are funds available to cover costs
- Addressing fund shortfalls with the Policy Group (Mayor/City Council/elected officials)
- Coordinate with logistics to track volunteers, donated resources, and all in-kind labor, donated equipment, time and resources.
- Providing a daily brief to the Incident Commander/Operations Chief of daily expenditures
- Organizing, filing, and saving ALL paperwork, receipts, and financial records

5- Public Information

The Public Information Officer (PIO) provides important incident information to the Public Commander/Operations Chief who then approves messaging to the public and media. The PIO is the single point of contact for all media inquiries.

If possible, establish a specific physical location as a focal point for the coordination and dissemination of information to the public and media. If multiple organizations/agencies are providing information, this location can become a "Joint Information Center" (JIC) where public affairs professionals from organizations involved in incident management

activities work together to provide critical emergency information, crisis communications, and public affairs support.

The media have considerable leeway to report on disasters, preserving the public's right to know about major events. Public agencies should:

- Warn the media of the risks of a disaster site.
- Depending on state and local laws, provide unrestricted access to disaster sites unless responders at the scene reasonably determine that such unrestricted access will interfere with emergency operations, personal safety, or scene security.
- Ensure that those accessing the disaster sites have access to or bring their own Personal Protective Equipment (PPE).
- Consider logging the media in when they enter the scene and out when they leave.

General PIO Responsibilities

The Public Information Officer:

- Coordinates information about the earthquake, secondary hazards, and recovery activities to the public, agencies, and elected officials through media briefings, Joint Information Center releases, press releases, Emergency Alert System (EAS), text messages, social media, and/or door-to-door warnings.
- Ensures that information provided by all sources is authentic and valid.

- Controls rumors by correcting misinformation rapidly.
- Prepares public instructions for identified hazards.

Detailed Earthquake Messages

Earthquake-specific public information should include:

1. *What has happened: Facts should be released as soon as information is confirmed and updated frequently.*
    - Aftershocks
        - Aftershocks will happen, so expect them and continue to be prepared.
        - The larger the initial earthquake, the more aftershocks there will be (see table in Appendix A).
        - Aftershocks can be larger than initial shock.
        - Even small aftershocks may cause new damage, weaken already damaged structures, or push partially damaged infrastructure over to collapse.
        - Do not enter buildings until they have been REINSPECTED after an aftershock, even if they were initially green or yellow tagged.
    - Environmental:
        - Earthquake magnitude, time, location, intensities, updates
        - Road closures and alternate routes

  - Area closures
  - Special instructions (boil drinking water, toxic spills etc.)

- Search and Rescue:
  - Check on your neighbors (immediately post-event)
  - People from out of town will be assisting local officials and helping us
  - Shelter locations for people and animals
  - Medical facilities/triage locations/pharmacies open

- Health and Safety:
  - Lifeline failures and estimated repair: water/sewer/electric/gas etc.
  - Watch the kids!!!
  - Food/water station locations.
  - Only shut off gas if necessary: *(smell or hear gas escaping)*.
    - » If you see or suspect a broken gas line: evacuate the building, call the gas company/911 immediately, and (if it is safe to do so) turn off the gas service shutoff valve.
    - » If leaking gas starts to burn: DO NOT try to put the flame out, evacuate the building, call 911 and your gas company immediately, and (if it is safe to do so) turn off the gas service shutoff valve.

  - Airborne dust may be a biological hazard
    - » Paper dust masks & household materials such as washcloths, bandannas, & handkerchiefs DO NOT protect people from breathing in Asbestos dust or *Coccidioides* spores.
- Structural Damage:
  - Be aware of potentially damaged buildings.
  - Red building placards indicate unsafe buildings. Do NOT Enter!
  - If a building has not been evaluated—IT IS A POTENTIALLY DANGEROUS BUILDING.
  - Avoid damaged buildings (public and private).
  - Report damaged Infrastructure (telephones, power, roads, sewer, water etc.).

2. *What is being done in response?*
   - The public wants to get "back to normal" as soon as possible. Tell people what you are doing to respond, control the situation and restore order.
   - Acknowledge coordination of all available resources.
   - Describe successes and challenges.

3. *What is the expected outcome?*
    - Explain how the process will work, how long it could take and what should be expected.
    - The process will depend upon availability of responding resources and accurate safety assessments.
    - Provide estimates of public service restoration times.
    - Provide estimates when areas will be reopened to the public.
4. *What does it mean to me?*
    - Be cognizant that you are communicating to multiple audiences with different needs.
    - Provide people with information to enhance their safety and address potential concerns they may have.
    - Fear of the unknown is often greater than fear of the facts.

Acknowledging Public Anxiety

People are usually anxious following the strong shaking from an earthquake, especially when they look around and see that shaking reflected in damage. They have a lot of coping and regaining of control to do, and commonly do this through talking rather extensively about the earthquake and aftermath, cleaning up, and assisting in making things right again. Understanding the earthquake and

its effects, estimating the size of aftershocks and learning they can experience them without consequences help folks gain control of the event.

It is important that everyone continue to Drop, Cover, and Hold On during the stronger aftershocks, and to avoid becoming complacent. Leadership by emergency personnel can help this effort.

Communicating to Elected Officials and Policy Makers

Keeping local, state, and federal elected and appointed officials informed about the situation can reduce criticism, minimize confusion and sometimes result in additional resources being provided. When possible, provide quick responses to, and cooperate with, government officials.

6- Policy Group

Policy group sets up a room separate from the Emergency Operations Center and gives direction to Operations who then implements the objectives and goals.

Policy group is key to disaster management because they have the authority to mandate priorities, tasks and objectives to the Incident Commander/ Operations Chief. Often Policy group allows the Incident Command/Operations Chief to control the event; however, it is within Policy's purview to give specific direction and guidance and contribute to the development of objectives for the incident man-

agement. Policy is also responsible for financial support. If a disaster exceeds a community's resources then Policy group provides financial guidance.

Policy Group is responsible to declare a disaster and should provide the necessary documentation.

Additional Essential Elements of Information

What is the Elected Official (Mayor, County Commissioner) going to ask? Essential Elements of Information in addition to the overarching list on page 10 may include:

- Loss of critical equipment (assets/sensitive items)
- On-going missions
- Requests For Assistance (RFAs) from State or other Government agencies that cannot be supported.
- External requests for assistance that will be sent to other states

7- Safety Officer

The Safety Officer's role is to monitor conditions, activities, personnel conditions, and to develop measures to help assure the safety of all personnel. The Safety Officer is a key member of the Command staff and reports directly to the Incident Commander.

APPENDIX A
Understanding Earthquakes

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Understanding Earthquakes

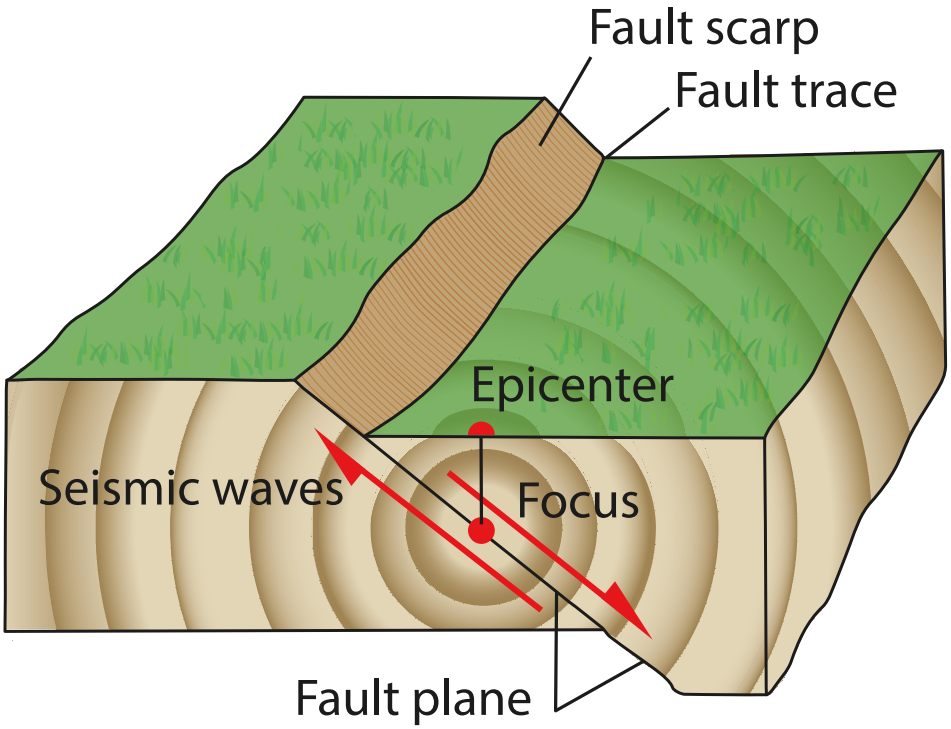
A basic understanding of earthquakes and earthquake terminology will help in understanding the cause and effects of an earthquake disaster and conveying this to others.

An earthquake creates shaking, sometimes violent, that results from a rapid movement underground or explosions from volcanoes. In addition to shaking — the most prevalent effect — the ground can be offset, distorted, or settle, fires can be started, landslides can occur, and large waves can be created in oceans and lakes when earthquakes occur. Earthquakes are almost always groups of events, with one or a few larger events and lots of smaller adjustment events. Earthquakes that occur before the main shock(s) are called ***foreshocks*** and earthquakes that occur after them are called ***aftershocks***.

Most earthquakes occur on ***faults*** — fractures or zones of weakness in the earth — along which movement has occurred. The location on a fault where an earthquake rupture begins underground is called the ***hypocenter*** or ***focus***. The corresponding location directly above the hypocenter on the earth's surface is called the ***epicenter***.

Maps showing known faults may be available from your state geological survey. While many earthquakes occur on known, mapped faults, some earthquakes

occur on faults that are buried beneath the surface (called "blind faults") or even may occur in areas with no known faults.



The above diagram shows an earthquake that starts underground and ruptures along an inclined fault, and some earthquake terminology. During earthquakes of magnitude 5 and larger, the earthquake rupture may continue all the way to the surface, creating visible offsets of the ground. (Referenced from *http://ykonline.yksd.com/distanceedcourses/Courses/EarthScience/lessons/FourthQuarter/Chapter13/13-04/Images/focus.GIF*.)

Earthquake Size and Severity

The size of an earthquake is described by a physical measure, earthquake magnitude, and an impact measure, earthquake intensity.

Earthquake magnitude is the value given by scientists and is related to things like the extent to which a fault was ruptured during the earthquake, how much energy was released by the earthquake, and how hard it was to break the fault. Earthquake magnitude is also related to how much shaking occurs and how widespread that shaking might be. Earthquake magnitudes are commonly portrayed as the size and/or color of dots on an epicenter map (also known as earthquake maps or seismicity map).

There are many names for earthquake magnitude, such as local magnitude, Richter magnitude, and moment magnitude, but they all describe the size of the earthquake. Magnitudes of 0 to 3 are considered microearthquakes, magnitude 4s are small earthquakes, magnitude 5 and 6 are strong to major earthquakes that can do damage to communities, magnitude 7 are large earthquakes that can have extensive damage, and magnitude 8 and 9 are great earthquakes that will have widespread damage.

Earthquake intensity is a description of how the earthquake affected people, buildings, and the ground surface. Earthquake intensity maps show the extent of the effects of an earthquake and can give a scope of a disaster and some intelligence for responding to an earthquake. The scale ranges from I to XII and is given in Roman numerals so it is not confused with earthquake magnitude. This scale is shown in earthquake intensity maps and "Did You Feel It" maps made by the U.S. Geological Survey.

The lower numbers of the intensity scale generally deal with the manner in which the earthquake is felt by people. The higher numbers of the scale are based on observed structural damage. Structural engineers usually contribute information for assigning intensity values of VIII or above. The highest values, intensity XI and XII, describe ground distortion.

By talking to people affected by the quake and observing damage and using this scale, you can begin to get an idea of the severity of an earthquake in a given location. Because of their nature, thrust faults can create large damage zones relative to other types of faults.

Modified Mercalli Intensity Scale (MMI)

The following is an abbreviated description of the levels I through X of Modified Mercalli Intensity Scale:

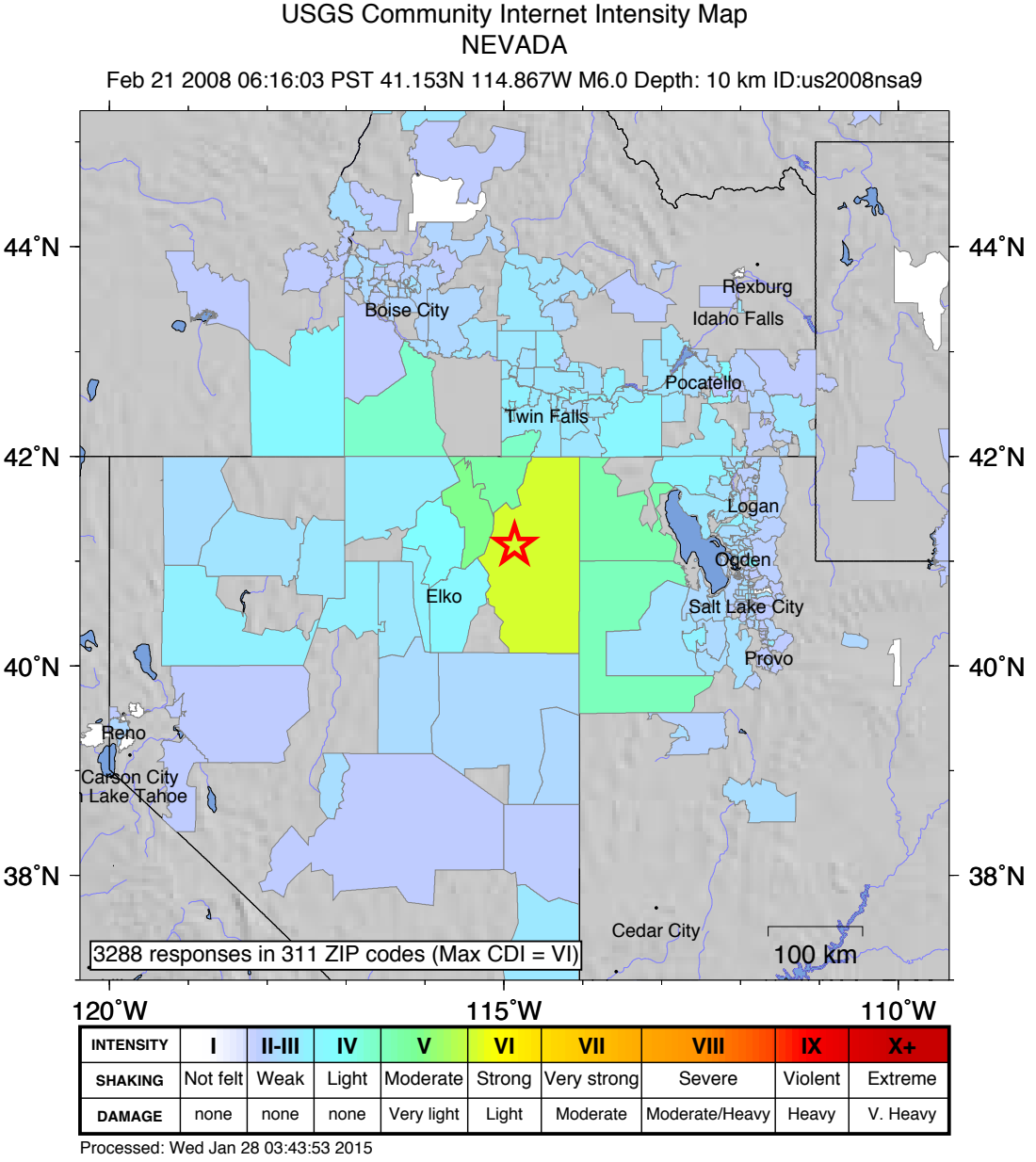
Intensity	Shaking	Description/Damage
I	Not felt	Not felt except by a very few under especially favorable conditions.
II	Weak	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV	Light	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.

V	Moderate	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Very strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	Severe	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Violent	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Extreme	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

Abridged from The Severity of an Earthquake, a U. S. Geological Survey General Interest Publication. U.S. Government Printing Office: 1989-288-913, http://pubs.usgs.gov/gip/earthq4/severitygip.html.

When an earthquake occurs people can log on to the "Did You Feel It" website (*http://earthquake.usgs.gov/data/dyfi/*) to report their observations of damage and shaking. The U.S Geological Survey compiles these into a Community Internet Intensity Map, which can be available on the web immediately following an event.

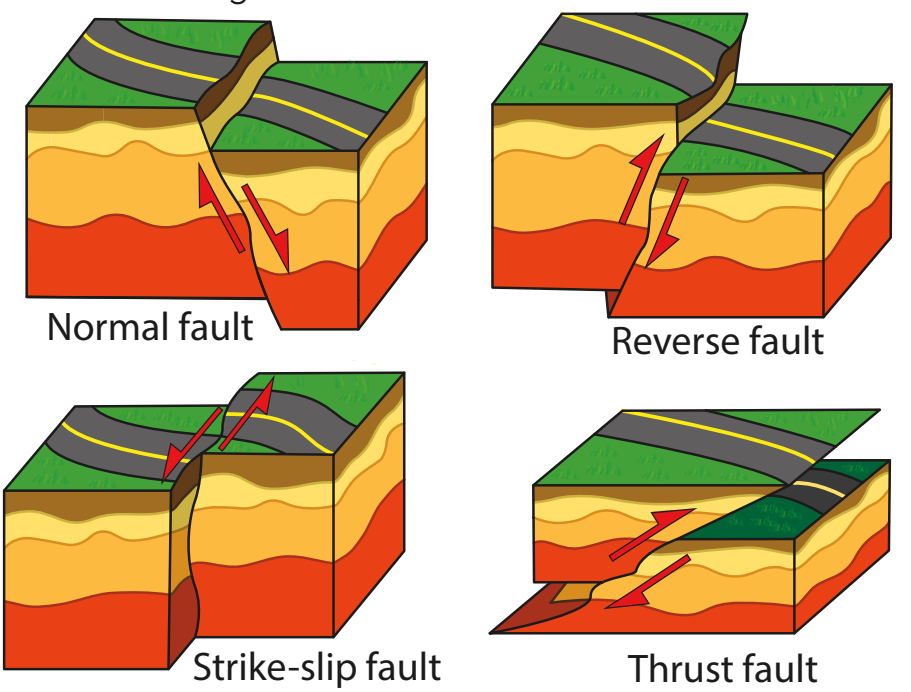
This map shows the extent of the earthquake, which can assist in knowing how much and where response resources might need to go. An example of a Community Internet Intensity Map from the 2008 magnitude 6 Wells, Nevada earthquake is shown in the figure below, which shows the strong shaking was confined to the northeastern part of Nevada.



INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy

Types of earthquake faults

- Faults are described by the type of movement that occurs on them (see figures below).
- The type of movement can have significant consequences as to how much and what type of damage occurs to the built environment.
- Fault movement that is caused by normal, reverse, or thrust faults will be mostly vertical.
- Fault movement caused by a strike-slip fault will be primarily horizontal. Strike-slip offsets are further named for which direction the movement went, to the right or to the left, and are called right-lateral or left-lateral, respectively.
- A thrust fault is a reverse fault that has a fault plane less than 45 degrees.



These diagrams show different kinds of fault movement that can occur during earthquakes and a geologist may use these terms. (Referenced from http://soundwaves.usgs.gov/2009/11/fieldwork2.html.)

When earthquakes have surface rupture, ground offsets will likely mimic these movements – so a pipeline would be offset horizontally during a strike-slip earthquake or vertically during a dip-slip earthquake, unless there is some surface complication.

Seismic Hazards

1. Ground Shaking

Ground shaking during the earthquake creates the most damage, impacting buildings and structures. The violence and duration of shaking are influenced by the size, type, and location of an earthquake and local site and basin effects. In general, the closer a location is to the earthquake, the stronger the shaking is, and the larger the earthquake is, the longer and more severe the shaking will be. During earthquakes, it is common for some locations to shake more and have more damage than others. Local differences in communities are commonly the result of differences in site or geologic characteristics. Solid rock is rigid and is not as easily shaken strongly as softer, looser materials, like an old, filled river channel. Aftershocks can also create threatening and damaging shaking following the main shock.

Virtually all structures are vulnerable to shaking damage, including, but not limited to: buildings of all types, sizes and age of construction; dams, bridges,overpasses, water/gas storage tanks and water towers, gas and utility transmission lines, and cell towers.

Unreinforced masonry buildings **(URM)** of brick, stone, or adobe are particularly susceptible to collapse from shaking. In areas of strong shaking, these are targets for initial surveys for victims and buildings that rescuers and other responders should be mindful of as possible threats to their activities.

Masonry chimneys on homes are easily damaged during moderate and larger earthquakes, creating falling hazards and potential fire hazards.

Bricks, concrete beams and blocks, metal and wood building facades, parapets, or decorative elements can break off and fall, and potentially cause injury, burial, and blockage of entryways.

Serious damage to buildings and infrastructure may not be visible.

Aftershocks may cause additional damage after the initial quake.

Shaking can cause oscillations or sloshes, called "***seiches***", in lakes, reservoirs, and pools, and large waves, called ***tsunamis***, in oceanic settings.

2. Fault Rupture and Movement

Fault rupture refers to movement that breaks the surface of the ground along the fault.

Fault rupture often creates a ***fault scarp*** which disrupts any cultural feature crossing the fault: transportation lines including roads, railroads, and airport runways; utility lines; and buildings. This

rupture can be a narrow, singular feature, or can be a zone of small faults and/or distorted ground that can affect a wider area. There can also be multiple fault traces when earthquakes are complex.

Strike-slip faults move predominantly horizontally – if there is minimal vertical movement roads may be traversable and utilities may still be functional.

Other types of faults that move vertically (normal, reverse, or thrust) may not be traversable.

3. Ground Failures

Landslides and Rock falls: Earthquake triggered landslides can block roads and railroads, dam rivers, slide into reservoirs causing overtopping of dams, and bury infrastructure and homes. Rock falls are commonly created on slopes with loose debris and/or boulders on the surface. When shaking is large enough, rock and boulder falls can injure people, damage buildings, and block roads. Landslides and rock falls can be loosened and made susceptible by initial shaking and be triggered by aftershocks or precipitation.

Liquefaction: Shaking of water saturated sands and silty soils can cause the soil to temporarily "liquefy" and lose its capacity to hold the weight of structures or buried utility/infrastructure lines. Shaking can be stronger in these areas, and damage can be extensive. If moderate to steep slopes liquefy, the soil may flow out for long distances.

Lateral Spreads: Earthquake shaking causes slopes to move laterally, either by sliding or flowing. The slopes that spread by liquefaction are commonly gentle. The ground surface becomes disrupted and uneven as the area that is spreading breaks apart.

Tsunami: Vertical uplift of the sea floor or lake floor from earthquake movement (usually earthquake magnitude 7 or larger), significant landslides, or volcanic eruptions can cause a series of large waves called a tsunami (in the ocean) or (seiche in lakes). These waves can inundate shore areas with deep water, in deadly and devastating ways. These waves also threaten shoreline roadways, infrastructure, and dams.

Aftershocks

An earthquake is rarely a singular event. If there has been a damaging earthquake, another earthquake of similar or greater magnitude can occur within hours or days of the initial quake and numerous aftershocks can be expected.

Magnitude of Main Shock	Expected number of aftershocks in the first week of Magnitude 3 or larger
5	7
6	67
7	670
8	6700

Table from Jeanne Hardebeck, USGS, personal communication.

The table indicates that aftershocks are expected after earthquakes of magnitude 5 and larger and that the number of aftershocks increases with earthquake magnitude.

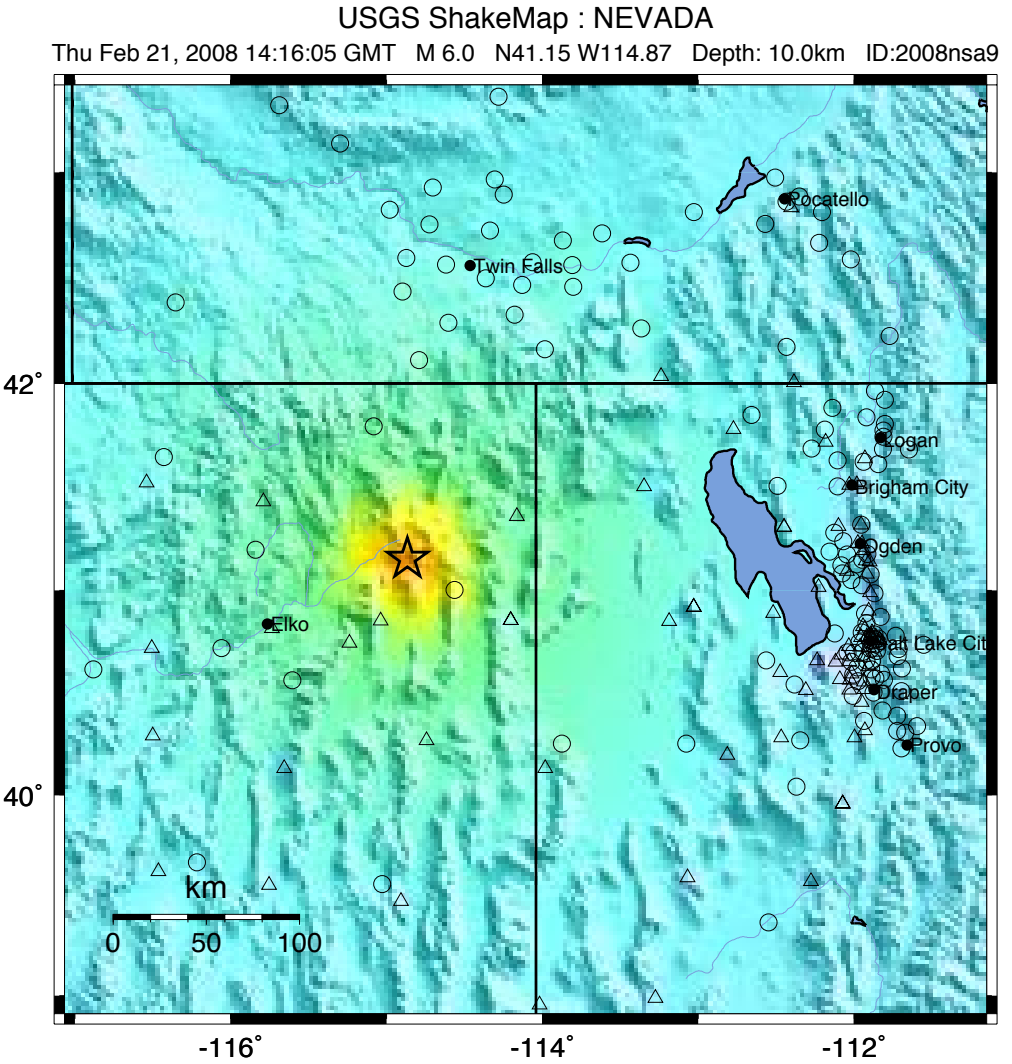
Buildings or infrastructure that has been affected by earthquake shaking may have sustained internal damage or weakening not visible to you, your staff, or inspectors. These buildings may be further damaged or fail in an aftershock. It is critical to keep all but necessary personnel away from areas containing potentially weakened structures to protect you, your staff, residents, and those who have come in to help or observe.

Immediate Earthquake Information Sources

Within approximately 5 minutes of an earthquake, the U.S. Geological Survey (USGS) may have initial information on the size and location available on its website: *http://earthquake.usgs.gov/earthquakes/map/*.

If you have Internet access, you can click on the earthquake and select the "ShakeMap" option. This will provide you with an overview of the expected extent of the affected area as well as the severity of the shaking and may help you target your response prior to receiving actual situational awareness. **Not all earthquakes will have a ShakeMap generated**.

The ShakeMap for the 2008 M6.0 Wells, Nevada earthquake is below. The colors on the map are related to the MMI scale (shown above). This shows that Wells and the area immediately around it were of the most concern for damage from the shaking.



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	*8.1-16*	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Earthquake Myths

- Earthquake weather.
  Earthquakes can happen in any weather conditions and are not in any way related to weather. Likewise, there is no time of day or night when earthquakes are more or less likely.

- Earthquake prediction.
  There are NO ways to predict earthquakes by humans or animals.

- Stand in a doorway.
  Standing in the doorway is not as good as taking cover below a sturdy table. The doorway idea came from when people viewed old collapsed adobe buildings and saw the doorframe still standing. Doors will sway back and forth during earthquakes and there is little to no protection from falling objects.

- Triangle of Life.
  Triangle of Life contradicts the Drop, Cover, and Hold response and should not be followed. It does not offer protection from falling objects, the leading cause of injuries during an earthquake.

APPENDIX B

Pre-Earthquake Preparedness

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Pre-Earthquake Preparedness

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Pre-Earthquake Preparedness and Training

FEMA Training Courses

- IS-29: Public Information Officer Awareness
- IS-100:Introduction to the Incident Command System
- IS-200.B: ICS for Single Resources and Initial Action Incidents
- IS-325: Earthquake Basics: Science, Risk, and Mitigation

For a complete list go to:
https://training.fema.gov/is/crslist.aspx

Pre-Earthquake Preparedness

There may be pre-earthquake opportunities to:

- Develop MOUs and Mutual Aid agreements with other jurisdictions
- Identify resources available from Volunteer Organizations Active in Disaster (VOAD) or other non-profits (to include faith-based)
- Develop "standby" agreements with entities such as Building Code Officials organizations, Structural Engineers, or

the American Institute of Architects to assist in post-event building inspections

- Develop regional debris management plans, with debris collection sites identified, and contracts in place through pre-identified vendors
- Have printed red, yellow, and green building placards available
- Pre-identify a suitable location for ICP/EOC
- Have pre-scripted earthquake messages ready to roll out, such as: what to bring to shelters, the meaning of the colored damage placards, assurances of continuity of government, etc.
- Find out who is your state Earthquake Program Manager and/or State Hazard Mitigation Officer

Supplies to take to the field:

- ☐ This handbook!
- ☐ Completed Contact List (Appendix B)
- ☐ Red/Yellow/Green placards (see Appendix C)
- ☐ PPE: Hard hat/Gloves/Boots/Respirators
- ☐ Communications equipment
- ☐ Caution tape
- ☐ Food/Water
- ☐ First aid kit
- ☐ Camera synced to a GPS unit
- ☐ Hand-held GPS unit
- ☐ Duct Tape
- ☐ Phone/Radio
- ☐ Batteries/chargers
- ☐ Notebook and Record/Receipt folder/envelopes
- ☐ Maps
- ☐ Crescent Wrench
- ☐ (Incident Command System) ICS 209 Forms
- ☐ Other _____

_____

_____

_____

_____

Contact list of officials:

Date of Entry:______	Organization/Department/Position	Name of POC	Phone #	Email
Town / City	Public Works			
	Law Enforcement			
	Fire Department			
	Building Department			
County				
State	Geological Survey			
	Emergency Management			
	Earthquake Program Manager			
	State Hazard Mitigation Officer(SHMO)			
	DOT			
Federal				
Neighboring Cities/Counties				
Tribes				
Private	Utility Company			
	Pipeline Operators			
Non-Profits	Red Cross			

APPENDIX C

Post-Earthquake Building Safety

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Post-Earthquake Building Safety

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Post-Earthquake Building Safety Evaluation

An important activity after an earthquake is to conduct a rapid visual evaluation of buildings which should occur as soon as possible after the earthquake. Buildings also need to be re-evaluated after each aftershock (See Applied Technology Guidelines for entering damaged buildings: https://www.atcouncil.org/pdfs/atc35tb2.pdf. The use of green, yellow and red placards to identify the damage status of a building has long been established. Posting of placards also assists when reviewing a community to determine which structures have or have not been evaluated.

➤A green placard indicates the structure has received a rapid visual evaluation and is safe for continued occupancy.

INSPECTED

LAWFUL OCCUPANCY PERMITTED

This structure has been inspected (as indicated below) and no apparent structural hazard has been found.

☐ **Inspected Exterior Only**

☐ **Inspected Exterior and Interior**

Report any unsafe condition to local authorities; reinspection may be required.

Inspector Comments:

_____

_____

_____

_____

Facility Name and Address:

_____

_____

_____

Date _____

Time _____

(**Caution:** Aftershocks since inspection may increase damage and risk.)

This facility was inspected under emergency conditions for:

_____

(Jurisdiction)

Inspector ID / Agency

_____

_____

_____

Do Not Remove, Alter, or Cover this Placard until Authorized by Governing Authority

Green (Inspected) Placard:
https://www.atcouncil.org/pdfs/iplacard.pdf

➢A yellow placard is used when the structure is not safe for occupancy, but the building is not in danger of imminent collapse. With appropriate oversight, this allows for individuals to remove retail stock, perishables, personal effects, and other assets. The posting of a yellow placard should never be construed as permitting occupancy without additional evaluation or remediation.

RESTRICTED USE

Caution: This structure has been inspected and found to be damaged as described below:

_____
_____
_____
_____

Entry, occupancy, and lawful use are restricted as indicated below:

☐ Do not enter the following areas: _____
_____

☐ Brief entry allowed for access to contents: _____
_____

☐ Other restrictions: _____
_____

Facility name and address:

_____
_____
_____

Date _____

Time _____

(**Caution:** Aftershocks since inspection may increase damage and risk.)

This facility was inspected under emergency conditions for:

_____
(Jurisdiction)

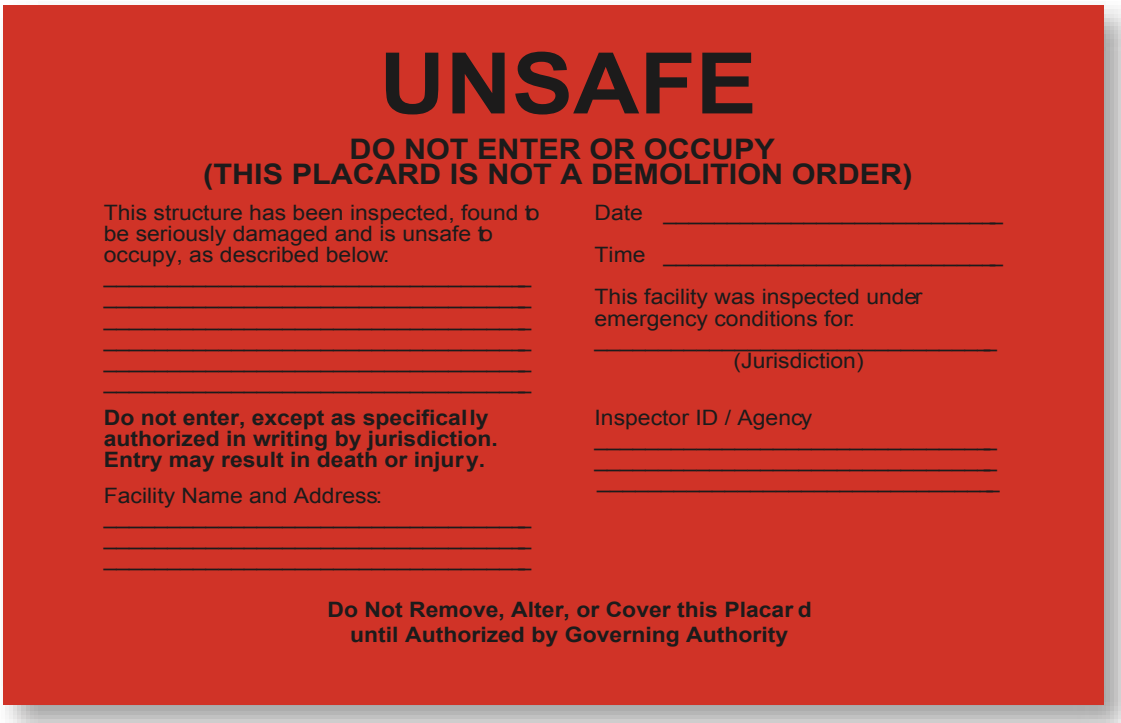
Inspector ID / Agency

_____
_____
_____

Do Not Remove, Alter, or Cover this Placar d until Authorized by Governing Authority

Yellow (Restricted Use) Placard:
https://www.atcouncil.org/pdfs/mplacard.pdf

➤Red placards indicate buildings are in imminent danger and should not be entered into for any reason other than to initiate proper shoring and/or demolition. Tall buildings that have a red posting may require establishing an additional clear space barrier to protect the public.



UNSAFE

DO NOT ENTER OR OCCUPY
(THIS PLACARD IS NOT A DEMOLITION ORDER)

This structure has been inspected, found to be seriously damaged and is unsafe to occupy, as described below:

_____
_____
_____
_____
_____
_____

Do not enter, except as specifically authorized in writing by jurisdiction. Entry may result in death or injury.

Facility Name and Address:

_____
_____
_____

Date _____

Time _____

This facility was inspected under emergency conditions for:

_____
(Jurisdiction)

Inspector ID / Agency

_____
_____
_____

Do Not Remove, Alter, or Cover this Placard until Authorized by Governing Authority

Red (Unsafe) Placard:
https://www.atcouncil.org/pdfs/uplacard.pdf

The ATC-20-2 revised Rapid Evaluation Safety Assessment Form and placards are available online to print for free at: *https://www.atcouncil.org*.

ATC-20 Rapid Evaluation Safety Assessment Form

Inspection

Inspector ID: _____ Inspection date and time: _____ ☐ AM ☐ PM

Affiliation: _____ Areas inspected: ☐ Exterior only ☐ Exterior and interior

Building Description

Building name: _____

Address: _____

_____

Building contact/phone: _____

Number of stories above ground: _____ below ground: _____

Approx. "Footprint area" (square feet): _____

Number of residential units: _____

Number of residential units not habitable: _____

Type of Construction

☐ Wood frame ☐ Concrete shear wall

☐ Steel frame ☐ Unreinforced masonry

☐ Tilt-up concrete ☐ Reinforced masonry

☐ Concrete frame ☐ Other: _____

Primary Occupancy

☐ Dwelling ☐ Commercial ☐ Government

☐ Other residential ☐ Offices ☐ Historic

☐ Public assembly ☐ Industrial ☐ School

☐ Emergency services ☐ Other: _____

Evaluation

Investigate the building for the conditions below and check the appropriate column.

Observed Conditions:	Minor/None	Moderate	Severe
Collapse, partial collapse, or building off foundation	☐	☐	☐
Building or story leaning	☐	☐	☐
Racking damage to walls, other structural damage	☐	☐	☐
Chimney, parapet, or other falling hazard	☐	☐	☐
Ground slope movement or cracking	☐	☐	☐
Other (specify) _____	☐	☐	☐

Estimated Building Damage (excluding contents)

☐ None

☐ 0–1%

☐ 1–10%

☐ 10–30%

☐ 30–60%

☐ 60–100%

☐ 100%

Comments: _____

_____

Posting

Choose a posting based on the evaluation and team judgment. *Severe* conditions endangering the overall building are grounds for an Unsafe posting. Localized *Severe* and overall *Moderate* conditions may allow a Restricted Use posting. Post INSPECTED placard at main entrance. Post RESTRICTED USE and UNSAFE placards at all entrances.

☐ **INSPECTED** (Green placard) ☐ **RESTRICTED USE** (Yellow placard) ☐ **UNSAFE** (Red placard)

Record any use and entry restrictions exactly as written on placard: _____

_____

_____

Further Actions Check the boxes below only if further actions are needed.

☐ Barricades needed in the following areas: _____

_____

☐ Detailed Evaluation recommended: ☐ Structural ☐ Geotechnical ☐ Other: _____

☐ Other recommendations: _____

Comments: _____

_____

KEY TERMS & REFERENCES

KEY TERMS & REFERENCES

APPENDIX D

Key Terms and References

Aftershocks. Earthquakes that follow the largest shock of an earthquake sequence. They are smaller than the "main shock" and can occur over a period of weeks, months, or years. In general, the larger the main shock, the larger and more numerous the aftershocks and the longer they will continue.

Emergency Operations Center (EOC). The central command and control facility responsible for carrying out the emergency preparedness and emergency/disaster management functions at a strategic level during an emergency, and ensuring the continuity of operation of a company, political subdivision or other organization. In most EOC's there is one individual in charge, and that is the Emergency Manager.

Epicenter. The point on the Earth's surface that is directly above where the earthquake begins at depth.

Fault. A fracture or crack in the earth along which movement has occurred.

Fault Rupture. The area of earth through which fault movement occurs during an earthquake. For large quakes, the section of the fault that ruptures may be several hundred miles in length. Ruptures may or may not extend to the ground surface.

Fault Scarp. A steep, linear break or slope formed where a fault ruptures the ground surface.

Incident Command Post (ICP). According to National Incident Management System (NIMS), and the Incident Command System (ICS) it is one of five predesignated temporary facilities and signifies the physical location of the tactical-level, on-scene incident command and management organization. It is typically comprised of the Incident Commander and immediate staff and may include other designated incident management officials and responders from Federal, State, local, and tribal agencies, as well as private-sector, nongovernmental, and volunteer organizations.

Intensity. A measure of ground shaking describing the local severity of an earthquake in terms of its effects on Earth's surface and on humans and their structures. The Modified Mercalli Intensity scale, which uses Roman numerals, is commonly used.

Landslide. A mass movement of soil, mud, and/or rock down a slope.

Liquefaction. The process that occurs when an earthquake shakes wet sands, silts, or gravels until it behaves like a liquid, allowing sand to "boil up" to the surface, buildings to sink, or sloping ground to move.

Magnitude (M). A number that represents the size of an earthquake, as determined from seismographic observations. An increase of one unit of magnitude (for example, from 4.6 to 5.6) corresponds approximately to a thirty two-fold increase in energy released. A two-unit increase in magnitude – for example, from 4.7 to 6.7 – represents a thousand fold increase in energy. Quakes smaller than magnitude 2.5 generally are not felt by humans.

Main shock. Possibly the largest quake of an earthquake sequence, preceded by smaller foreshocks, and commonly followed by aftershocks.

Normal Fault. An inclined fault along which the upper side moves downward relative to the lower side.

Parapet. A wall-like barrier at the edge of a roof.

Retrofit. Strengthening an existing structure to improve its resistance to the effects of earthquakes.

Reverse fault. An inclined fault above which the upper side moves upward relative to the lower side.

Seiche. Waves "sloshing" in a lake as a result of earthquake ground shaking.

Seismic hazard. The potential for damaging effects caused by earthquakes. The level of hazard depends on the magnitude and the frequency of likely quakes, the distance from the causative, and geologic conditions at a site.

Seismic risk. The chance of injury, damage, or loss resulting from seismic hazards. There is no risk, even in a region of high seismic hazard, if there are no people or property that could be injured or damaged by a quake.

Seismograph. A sensitive instrument that detects and records seismic waves generated by an earthquake.

ShakeMap. A map showing the intensities experienced from an earthquake.

Strike-slip fault. A generally near-vertical fault along which the two sides move horizontally past each other. The most famous example is California's San Andreas fault.

Surface faulting (surface fault rupture). Propagation of an earthquake-generating fault rupture to the surface, displacing the surface and forming a fault scarp.

Thrust fault. A reverse fault with a dip of 45 degrees or less.

Tsunami. An unusually large series of sea waves produced by an earthquake, landslide, or undersea volcanic eruption. An earthquake of magnitude 7 or greater is usually required to create a tsunami.

Unreinforced Masonry Buildings (URM). Buildings with masonry bearing walls that have no steel reinforcement. Floors, roofs, and internal partitions are usually made of wood and are generally not connected to the bearing walls. This building type is very vulnerable to collapse in an earthquake.

References: *http://earthquake.usgs.gov/learn/glossary/*

URM Definition: Association of Bay Area Governments. *http://abag.ca.gov/bayarea/eqmaps/shelpop/typ2_f.html*

Additional References

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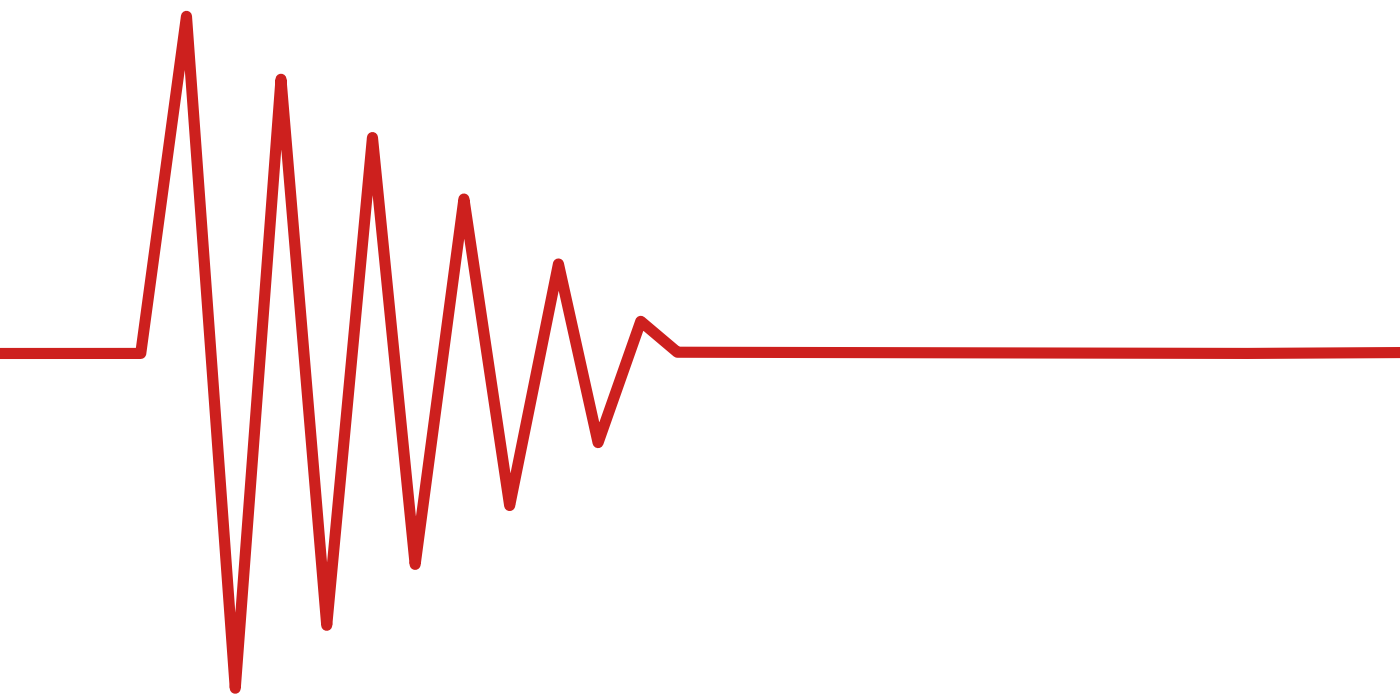

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