Protecting Yourself While Responding to Earthquakes

Safety and Health Awareness for Responders to Earthquakes

1906 San Francisco Earthquake

This training tool is an awareness-level health and safety resource for "skilled support personnel" (SSP) who will participate in an earthquake response and cleanup.

This tool will help workers understand at an awareness level: what an earthquake is, characteristics of an earthquake response, and how to identify and control hazards pertaining to the response and cleanup activities associated with an earthquake.

Trainers may use this tool to aid in the development of an earthquake awareness level course or other awareness level materials (fact-sheets, table-top activities, etc.).

Advanced/Additional Training Required for Those Involved in an Earthquake Response

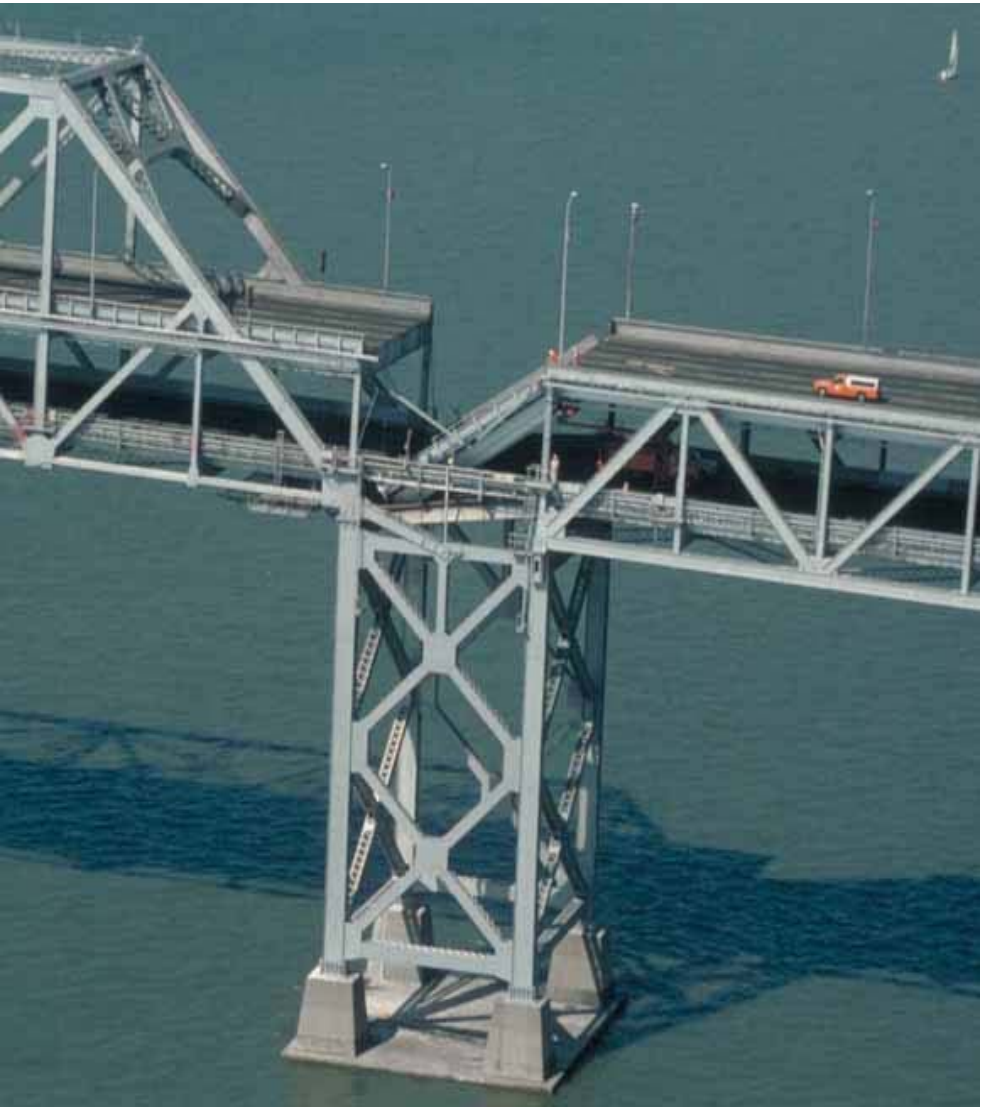
- This training tool does not replace specific fire fighting training, additional duty-specific training, or personal protective equipment (PPE)-specific training requirements.
- Regardless of work scope, there are many topics covered in this awareness training tool that have corresponding Occupational Safety and Health (OSHA) standards—such standards must be met in order to safely and legally perform associated job duties.
- Responders should always keep in mind that when in doubt about the safety of an activity, stop what you are doing. Be sure you are safe before continuing. Don't be a dead hero.

Contact the NIEHS National Clearinghouse for Worker Safety and Health Training (202-331-7733) for information regarding advanced training for earthquake response.

Employer and Worker Responsibilities

Employers and workers have responsibilities under the Occupational Safety and Health (OSH) Act.

- The OSH Act requires employers to provide a safe and healthful workplace, free of recognized hazards, and follow Occupational Safety and Health (OSHA) standards. Employers' responsibilities also include providing training, medical examinations, and recordkeeping.
- Workers must follow the employer's safety and health rules and wear or use all required gear and equipment; follow safe work practices for their job, as directed by their employer; report hazardous conditions to a supervisor; and report hazardous conditions to OSHA if employers do not fix them.



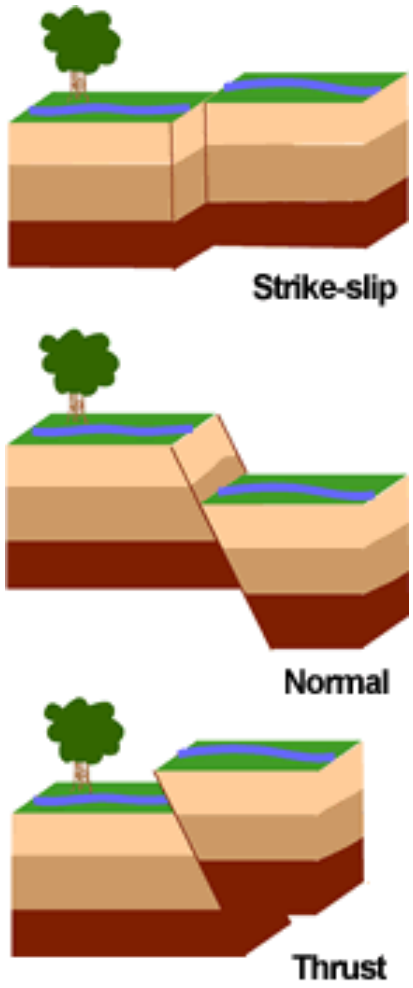
Module 1

Earthquake Basics and General Response Procedures

U.S. Department of Health and Human Services
National Institutes of Health
National Institute of Enviromental Health Sciences

What is an Earthquake?

- An earthquake is a sudden, rapid shaking of the ground caused by the breaking and shifting of rock beneath the earth's surface.
- Earthquakes occur along fault lines.
- Earthquakes have three different shifting patterns (illustrated to the right).
- Earthquakes may occur at any time with little or no advanced warning.
- An earthquake's magnitude or "energy release" is measured on the Moment magnitude (Mw) scale.



What is the Meaning of Earthquake Magnitude?

In 1935, while at the Seismological Laboratory, Charles Richter worked with Beno Gutenberg to develop a rating scale for earthquakes. The scale has become known as the Richter Scale. The scale had the following classifications for earthquakes and their severity:

1. Felt by instruments only
2. Felt by sensitive people and sensitive animals
3. Felt by many people
4. Felt by everyone; pictures fall off of walls
5. Damage
6. Destructive earthquake in populated areas
7. Major earthquake causing serious destruction
8. Total destruction of nearby communities
9. An earthquake more than one 100 million times more powerful than category one

For decades, the Richter Scale proved to be the accepted measurement for earthquakes. In recent years, scientists have begun to use the Moment Magnitude Scale, which is much more precise than the Richter Scale. http://www.ohiohistorycentral.org/entry.php?rec=2666

Where Is an Earthquake Most Likely to Occur in the U.S.?

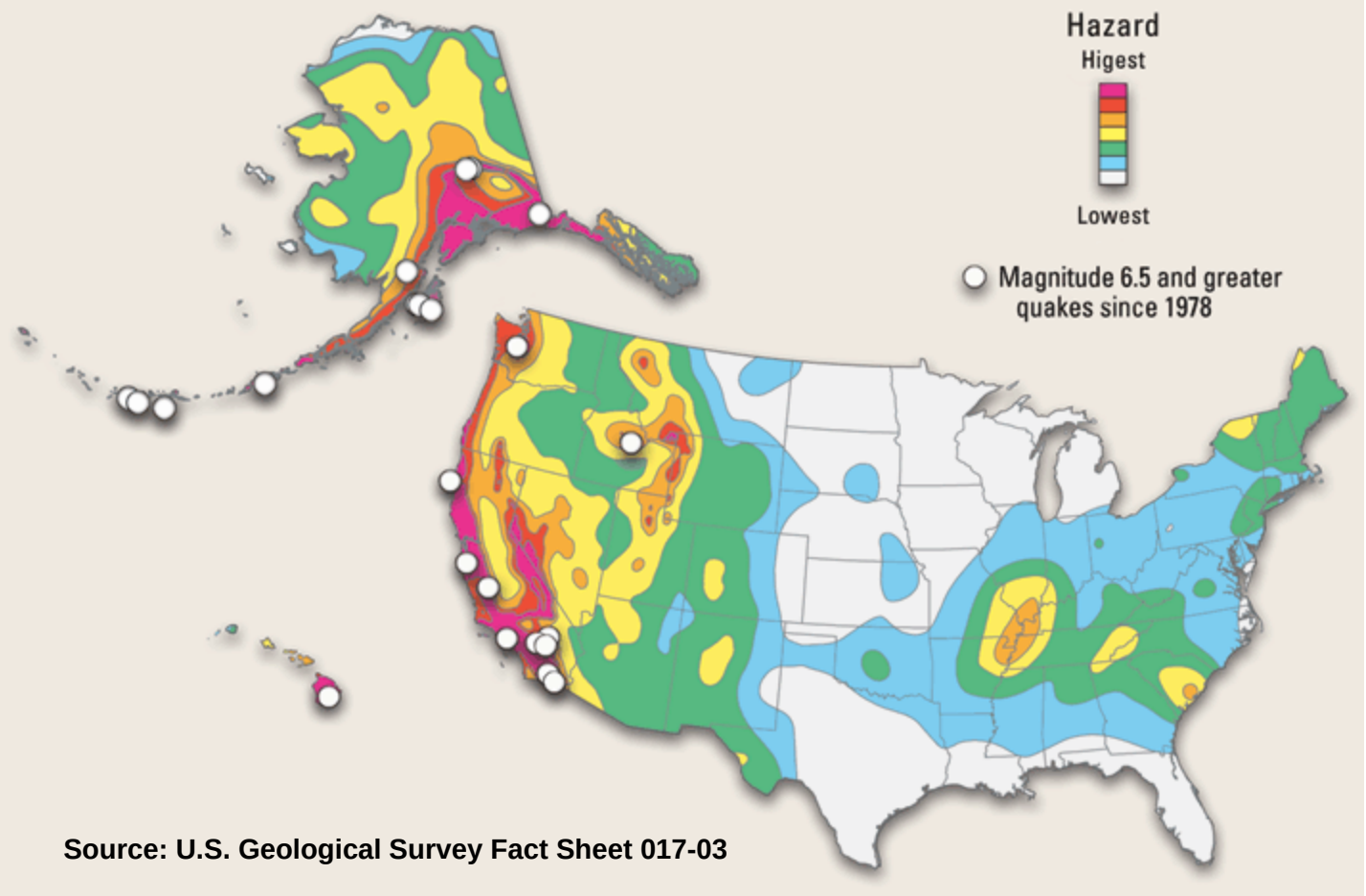
The greatest likelihood of a major earthquake is in:

- The western United States; residents of California face the highest risk
- The New Madrid Fault Zone crosses Missouri, Illinois, Arkansas, Kentucky & Tennessee; four million people along the New Madrid Fault Zone are at risk
- A few pockets on the east coast; for example, Massachusetts, North Carolina, and South Carolina

Fifteen percent of the U.S. population lives in zones of potential major disaster.

San-Andreas Fault

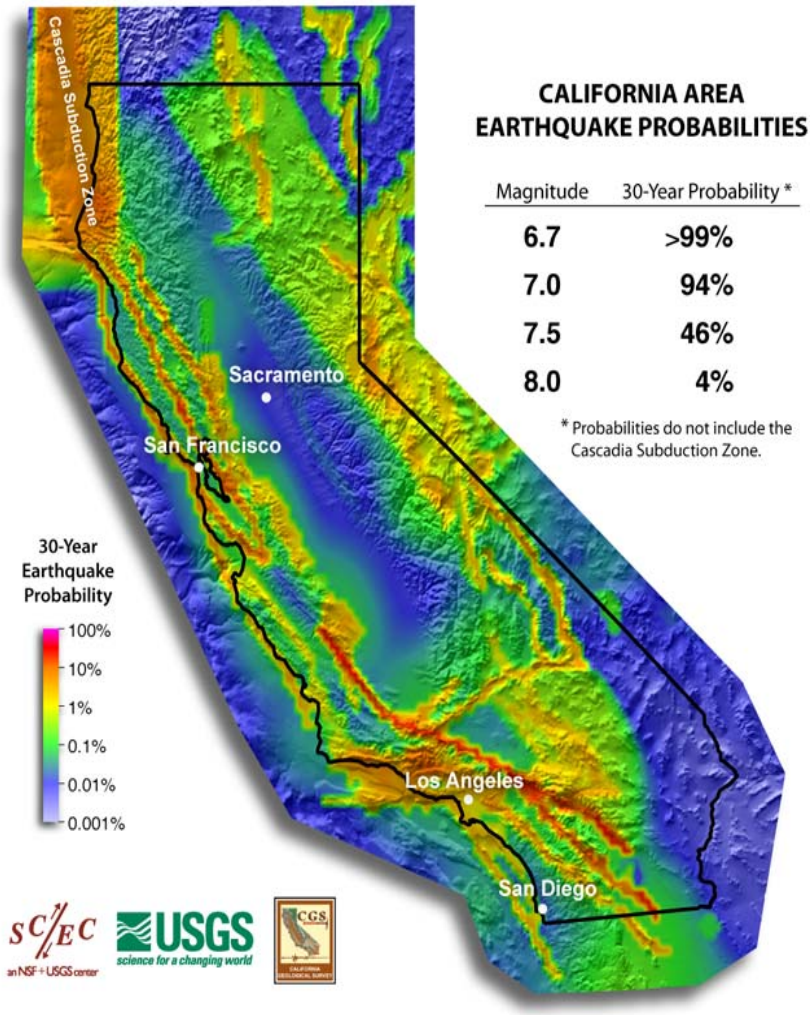
High Risk Earthquake Zones



Source: U.S. Geological Survey Fact Sheet 017-03

The West Coast- a High Risk Area

- A 2007 Uniform California Earthquake Rupture Forecast (UCERF) report states that California has a 99.7% chance (and the San Francisco Bay area a 63% chance) to suffer a 6.7 magnitude or larger earthquake in the next 30 years.



Map of CA Earthquake Probabilities, Major California Faults

Some Hazards in the Aftermath of an Earthquake

- **Earthquakes can cause**:
  - Aftershocks
  - Structures to collapse (buildings, bridges, dams, etc.)
  - Damage to utilities (gas, electric, phone, etc.)
  - Release of hazardous materials
  - Other disasters:
    - **Landslides**
    - **Liquefaction**
    - **Avalanches**
    - **Flash floods**
    - **Fires**
    - **Sea waves (Tidal waves and Tsunamis)**
    - **Seiches**

Are You Prepared for Aftershocks?

What is an aftershock?

- An earthquake that occurs after a previous quake.
- Occurs in the same area as the main quake.
- Is of less magnitude.
- Be aware: an aftershock is an earthquake
  - If you are working, follow appropriate "earthquake" procedures.

Landslides and Avalanches

- A landslide is an abrupt downhill movement of soil and bedrock (in response to gravity).
- Landslides can be triggered by earthquakes or other natural causes.
- Landslides create ground movement from rock falls, deep failure of slopes, and shallow debris flows.
- An avalanche is a flow of snow or rocks down a mountainside.
- Debris may continue to shift as it is removed.
- Debris may contain victims.

Landslide 1989 Northridge quake

Landslide in Guerro, Mexico 1989

Avalanche at Mt. Timpanogos

Liquefaction

- The phenomenon of reducing the strength and stiffness of a soil
- Due to shaking and water-saturation, granular material temporarily loses its strength and transforms from soft soils to a liquid.
- May cause structures, such as buildings or bridges, to tilt or sink into the liquefied ground.
- Can create moving areas of “liquid” ground.
- Can undermine structural stability and safety.

Liquefaction results after earthquake in Japan

Liquefaction from 2004 Chuetsu earthquake

Flash Floods

Flash floods:

- Rapid flooding of low-lying areas.
- Flood occurs in less than six hours.

What to do:

- Know the area you are working in.
- Find higher ground.
- Put on a personal floatation device (PFD), if available.
- Do not try to cross rapidly rising water.

Are you at risk?
Have an escape route!

Fires

- Fires caused by earthquake damage are often the leading cause of property damage and casualties.
- Be prepared to encounter fire, and know how to contact fire personnel.
- Debris left from fires may smolder for days to weeks. Be prepared to encounter smoldering debris during cleanup activities.

Fires located in the Marina District, San Francisco, caused by 1989 Loma Prieta earthquake.

Sea Waves and Tsunamis

- Tsunamis are the leading edge of an incoming tide that forms a wave(s) of water that travels up a river or narrow bay against the direction of the current.
- Tsunamis are a series of waves created when a body of water is rapidly displaced.
- Know your location and associated sea wave risk during initial response activities.
- Know your escape route should a sea wave approach.

Aftermath of 2004 Indian Ocean earthquake tsunamis

Risk Factors that Can Increase Damage

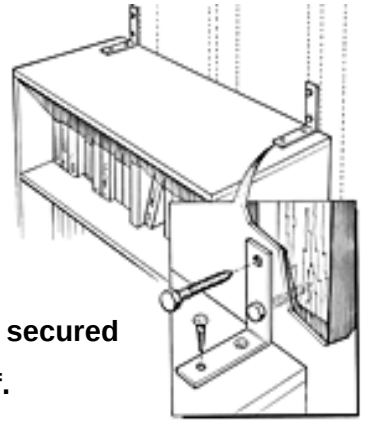
- Areas near fault lines.
- Structures built on unstable soil and rock.
- Structures not built or retrofitted to earthquake-grade standards.
- Brittle materials (such as glass).
- Structures built on steep slopes and areas prone to landslides and liquefaction.

What Can You Do Before an Earthquake?

- Identify potential hazards in homes and workplaces.
- Reduce hazards, where possible.
- Develop a disaster supply kit.
- Structural and nonstructural hazard mitigation.
- Individual preparedness:
  - Gather disaster supplies
  - Develop an emergency plan
  - Identify a safe room

Earthquake Preparedness for the Home

- Develop a home earthquake plan.
- Conduct earthquake drills.
- Develop a plan for reuniting family members.
- Identify an out-of-state family contact.
- Keep supplies on hand.
- Store heavy and breakable objects on low shelves.
- Secure furniture (e.g. bookshelves and water heaters).
- Install flexible pipe.
- Move beds away from windows.
- Move or secure hanging objects over beds, sofas, or chairs.
- Keep shoes and a flashlight under the bed.



Picture of secured bookshelf.

Source: Earthquake Country Alliance

What Can You Do During an Earthquake?

- Drop, cover, and hold.
- If indoors, stay there!
- If outdoors, find a spot away from buildings, trees, streetlights, power lines, and overpasses.
- If in a vehicle, drive to a clear spot and stop.

From USGS: Putting Down Roots In Earthquake Country

What Should You Do After an Earthquake?

- Check the safety of yourself and your family.
- Expect aftershocks.
- If you smell gas, turn it off.
- Extinguish small fires.
- Clean up spills.
- Inspect home for damage.
- Help neighbors.
- Tune to Emergency Alert System (EAS).

Module 2

Controlling Hazards Created by Earthquakes

U.S. Department of Health and Human Services
National Institutes of Health
National Institute of Enviromental Health Sciences

Physical Environment Example: California

- **The Land:**
  - Dense urban development
  - Steep hills
  - Flat and coastal areas
- **The Climate:**
  - Dry
  - Climate varies widely, from Mediterranean to sub-arctic
  - Temperature may vary significantly depending on the area and time of year

National Incident Management System (NIMS)

- NIMS is designed to:
  - Provide a framework for incident management
  - "One mission, one team..."
- Used for ALL types of incidents (floods, fires, hurricanes, nuclear explosions, etc).
- First standardized approach to incident management and response.
- Establishes a uniform set of procedures to be used by all emergency responders (at all levels of government) to conduct response operations.

Core Elements of NIMS

- Incident Command System (ICS)
- Preparedness (planning, training, exercises, qualifications and certifications of all personnel involved in incidents)
- Communications and Information Management
- Joint Information System
- NIMS Integration Center

Incident Command System (ICS)

- The ICS will be used to effectively manage emergency situations, such as earthquakes.
- ICS uses:
  - Unity of command (one person in charge)
  - Span of control to manage personnel (3 - 7 people under one supervisor)
  - Life safety code
  - A modular system to manage resources (a system that can expand and contract with the emergency event)
  - Common terms so everyone understands what is being communicated

Incident Command System Structure

Emergencies in the Field

- Ask what first aid support is available during your briefing and be sure you understand where it is located.
- If the quake hit a densely populated area, understand how that may affect responders requiring medical attention.
- For minor injuries or health concerns go to:
  - Local hospitals or clinics
  - First Aid, EMT, or nurse station
- For serious emergencies call 911
  - Know your exact location
- Notify your supervisor about all injuries and emergencies.

Hierarchy of Controls

- **When dealing with health and safety hazards, try to control them by using the hierarchy of controls:**

Structural Integrity

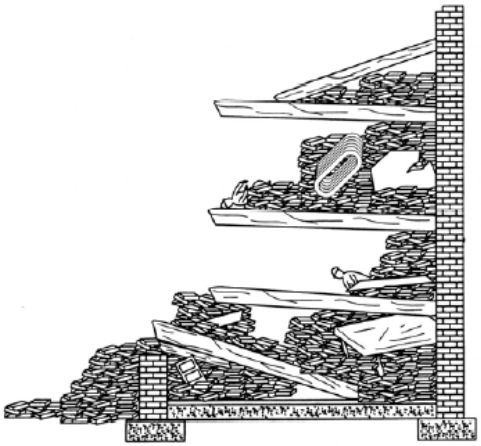
- Earthquakes can severely damage structures, such as buildings, bridges, and dams.
- Never assume that damaged structures or ground are stable; have a registered professional engineer or architect certify that it is safe.
- Assume all stairs, floors, and roofs are unsafe until inspected.
- Look up and be aware of hidden and/or overhead risks.
- Watch out for unstable ground (not firm or firmly fixed) or flooring that could give way and cause entrapment or a fall to a lower level.

Leave immediately if you hear shifting or unusual noises - A COLLAPSE MAY BE OCCURING

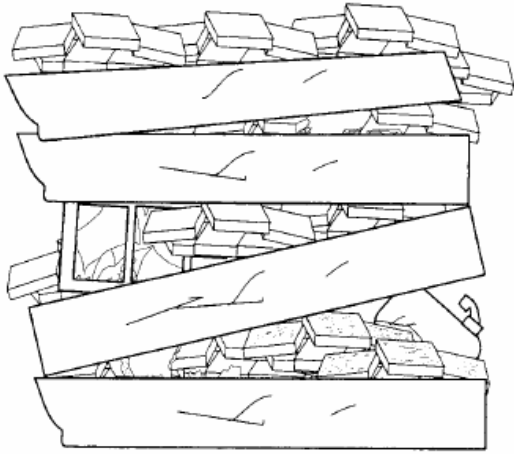
Structural Integrity (continued)

- OSHA requires walls or floor to be shored or braced before demolition, if workers are within structure. (29 CFR Part 1926.850(b))
- Cut off, cap, or control all service utility lines outside the building before demolition work begins. Notify appropriate utility company in advance.
- If it is necessary to maintain any utilities during demolition, such lines shall be temporarily relocated and protected.
- Determine if any hazardous substances have been on the property. Remove any found hazardous substance before demolition.
- Do not cut or remove any structural or load-supporting members on any floor until all stories above such a floor have been demolished and removed.

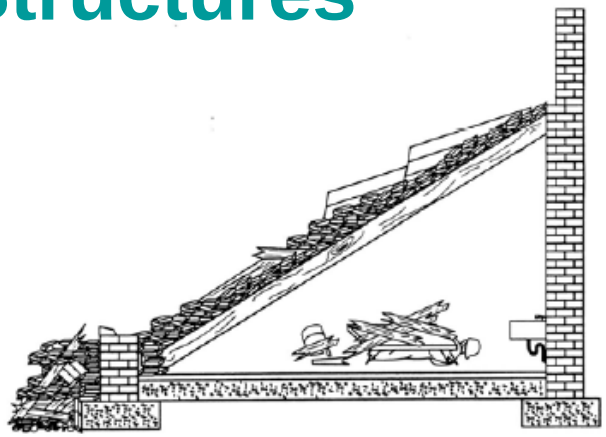
Examples of Unstable Structures



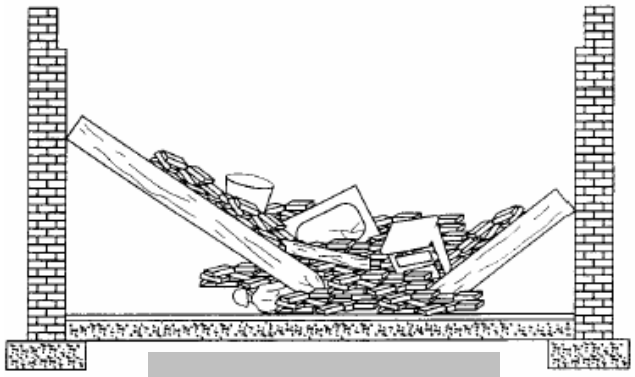
Cantilever



Pancake



Lean to



V-shape

Be aware of fallen debris that has created a natural support for other structures!

Stabilizing Structures

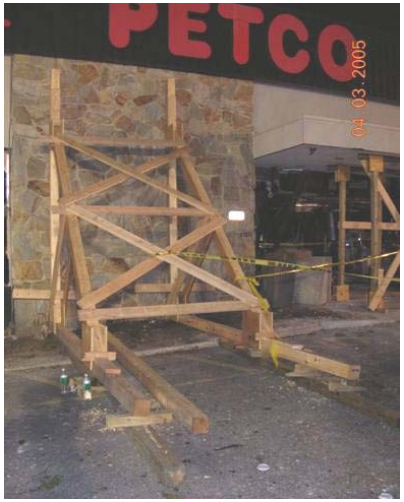
- Stabilizing structures through shoring and bracing, including the risk of heavy equipment, is a highly skilled task.
- Only properly trained personnel should participate in structure stabilization operations.
- Some of the most dangerous work you will encounter is work performed concerning a collapsed or unstable structure.

What Should You Know Before You Stabilize Structures?

- Recognize the multiple hazards associated with stabilizing structures.
- **KNOW HOW TO COMMUNICATE THE HAZARDS**
  - **understand notification procedures**
- Installing and removing structural supports, including shoring and bracing systems, requires engineered plans for each site.
- Establish limited access zones and escape routes before work begins.

How to Reduce Injury at Collapsed Structures

- Engineered shoring and bracing plans are required.
- Ensure all workers are trained and authorized to be in the work area.
- Create a limited access zone around structure to be shored and/or demolished
  - height of structure (ft) + 4(ft).
- Be alert for signs of a secondary collapse.
- Where appropriate use PPE, such as: safety shoes, hard hat, safety glasses, hearing protection and durable work clothes and gloves.



Demolishing Structures

- Only participate in demolition if you are trained to do so - **KNOW THE ASSOCIATED HAZARDS.**
- Engineered demolition plans are required for every project (emergency, fire, escape, etc.).
- A competent person must oversee all work.
- Stop work and report new and/or unexpected hazards (e.g., a hidden gas main is p up).
- Post DANGER signs where imminent hazards exist.

See OSHA 1926 Subpart T, Demolition, for further information

Overhead Hazards and Falling Debris

- Injuries to disaster site workers are often the result of falling materials and debris related to unstable structures, and other compromised surfaces.
- Overhead falling hazards may include:
  - Loose debris
  - Building components
  - Unsecured building contents such as bathtubs, refrigerators, furniture, etc.

Take extra precaution when working in these areas. Follow safe work practices and wear appropriate PPE, such as hard hat, work clothes, safety shoes, gloves, safety glasses, and respirator.

Debris Piles and Unstable Surfaces

- Only walk and work on surfaces you know are stable.
- If post-fire, look for smoldering material on or beneath the surface.
- Look out for hazardous materials.
- Use other ways to get to work surfaces, such as bucket trucks.
- Erect scaffolding and park lift equipment onto stable surfaces, and anchor to stable structures.
- Wear protective equipment provided, including hard hats, safety glasses, leather gloves and safety shoes with slip resistant soles.
- Use fall protection with lifelines tied off to suitable anchorage points, including bucket trucks, whenever possible.
- Watch for fall hazards to other levels.

Fire and Smoldering Debris

- 25% of fire related deaths in the United States are caused by smoldering fires.
- Smoldering debris may remain for weeks and could reignite if combined with combustible materials or if oxygen becomes available (i.e., disturbing debris during cleanup operations).
- Have at least two UL rated 10A-cooling fire extinguishers at every cleanup activity.

Confined Spaces

What is a Confined Space (CS)?

- Space with limited access and egress
- Large enough for bodily entry
- Not designed for occupancy
- Examples: boiler, pit, septic tank, utility vault, well, basement, trench, collapsed structure, and elevator shaft

What hazards make it a permit required CS?

- Oxygen deficiency
- Entrapment
- Engulfment
- Hazardous atmosphere
- Any other recognized, serious health or safety hazard

Your Safety Officer Must Approve Confined Space Entry!!!!

Confined Spaces (continued)

Before you enter a confined space (CS) your supervisor must:

- Make sure you and the attendant are trained.
- Ventilate and monitor surroundings for hazardous atmosphere. For example, use a Combustible Gas Indicator (CGI) to detect and measure airborne concentrations of combustible gases or vapors, and/or a portable Photo Ionization Detector (PID) to detect organic vapors.
- Lock out or tag out all energy sources in the space.
- Issue appropriate PPE, possibly including self-contained breathing apparatus (SCBA).
- Establish barriers to external traffic, such as vehicles and pedestrians.
- Provide ladders or similar equipment for safe entry and exit.
- Provide good communications equipment and alarm systems.
- Have rescue equipment and trained rescue personnel nearby.

If the CS is caused by structural collapse, have space certified safe by a registered professional engineer or architect before you enter!

Urban Search and Rescue (US&R)

- US&R involves the location, rescue (extrication), and initial medical stabilization of victims trapped in confined spaces.
- US&R is part of the Federal Emergency Management Agency (FEMA).
- US&R task force members work in four areas of specialization:
  - Search - to find trapped victims following a disaster;
  - Rescue - helps safely dig victims out of collapsed concrete and metal;
  - Technical - i.e., structural specialists who make rescues safe for the rescuers; and
  - Medical - cares for victims before and after the rescue.
- The role of these task forces is to support state and local emergency responders' efforts to locate victims and manage recovery operations.

Electrical Hazards

- Four main types of electrical injuries seen in disaster cleanups:
  - Electric shock
  - Burns
  - Falls caused by contact with electricity
  - Electrocution
- Avoid working with electricity in wet environments. If this must be done, use equipment approved for wet conditions.
- Electrical cords and outlets must meet OSHA standards.
- Use double insulated tools.
- Use Ground Fault Circuit Interrupters (GFCIs) on all power tools and cords as close to the panel as possible.
- Do not re-energize electrical systems, or use electrical equipment that has been in fire or water, until it has been evaluated by a qualified electrician.

Portable GFCI.

Electrical, Overhead Power Lines, Downed Electrical Wires, Cables

- Treat all power lines and cables as energized until proven otherwise.
- Use appropriately grounded low-voltage equipment.
- Stay clear of downed and damaged electrical lines.

Hazardous Utilities

- Look for overhead power lines and buried power line indicators. Post warning signs.
- Contact utilities for buried power line locations.
- Stay at least 10 feet away from overhead power lines.
- Unless you know otherwise, assume that overhead lines are energized.
- Get the owner/operator of the lines to de-energize and ground lines when working near them.
- Other protective measures include guarding or insulating the lines.
- Use non-conductive wood or fiberglass ladders when working near power lines.

Before removing debris, make sure there are no live wires, fuel lines, or chemical lines!

Water Issues

- **Reservoirs**
  - Natural or artificial areas which collect and store water for later use. Created using cement, earth, rock, or a mixture. Once completed a stream flows behind it, eventually filling it to capacity. Reservoir failures can cause widespread flooding to adjacent areas.

Taum Sauk Reservoir Failure

- **Dams**
  - Barriers constructed across waterways to control the flow or raise the level of water. Dam failures are generally catastrophic if the structure is breached or damaged. Main causes of dam failure include spillway design error, geological instability caused by changes to water levels during filling or poor surveying, poor maintenance, especially of outlet pipes, extreme rainfall, and human, computer or design error.

- **Floodgates or Water Gates**
  - Adjustable gates used to control water flow of bodies of water, like reservoirs or levees. May be designed to set spillway crest heights in dams, adjust flow rates in sluices and canals, or stop water flow entirely as part of a levee or storm surge system. Floodgates may also be used to lower the water levels in a main river or canal channels by diverting the flow of water into a flood bypass or detention basin during a flood stage.

Water Issues (continued)

- **Levee or Dike Failures**
  - The most frequent (and dangerous) form of levee failure is a breach. A levee breach occurs when part of the levee actually breaks away, leaving a large opening for water to flood the land protected by the levee. A breach can be a sudden or gradual failure caused either by surface erosion or by a subsurface failure of the levee. Levee breaches are often accompanied by sand or sand boils.

Picture of levee breach

- **Greywater**
  - Greywater, also known as sullage, is non-industrial wastewater generated from domestic processes, such as dish washing, laundry, and bathing. Greywater comprises 50-80% of residential wastewater.

- **Blackwater**
  - Blackwater is water that contains high concentrations of organic waste and pathogens that need to decompose before it can safely be released into the environment. Blackwater includes water from toilets and garbage disposals.

Health and Safety Plans (HASP)

1999 Izmit, Turkey, earthquake

OSHA has set regulations that require Health and Safety Plans (HASP) to protect workers involved in national response operations.* The HASP serves as a guide for employers and workers to follow during their daily operations to prevent the spread of contamination, injury, and death. **Review your HASP before you start work!**

*OSHA, 29 CFR 1910.120, HAZWOPER

HASP (continued)

This document covers some HASP sections that will be used on the worksites during an earthquake response. The site safety section includes general information from several of the HASP sections listed below.

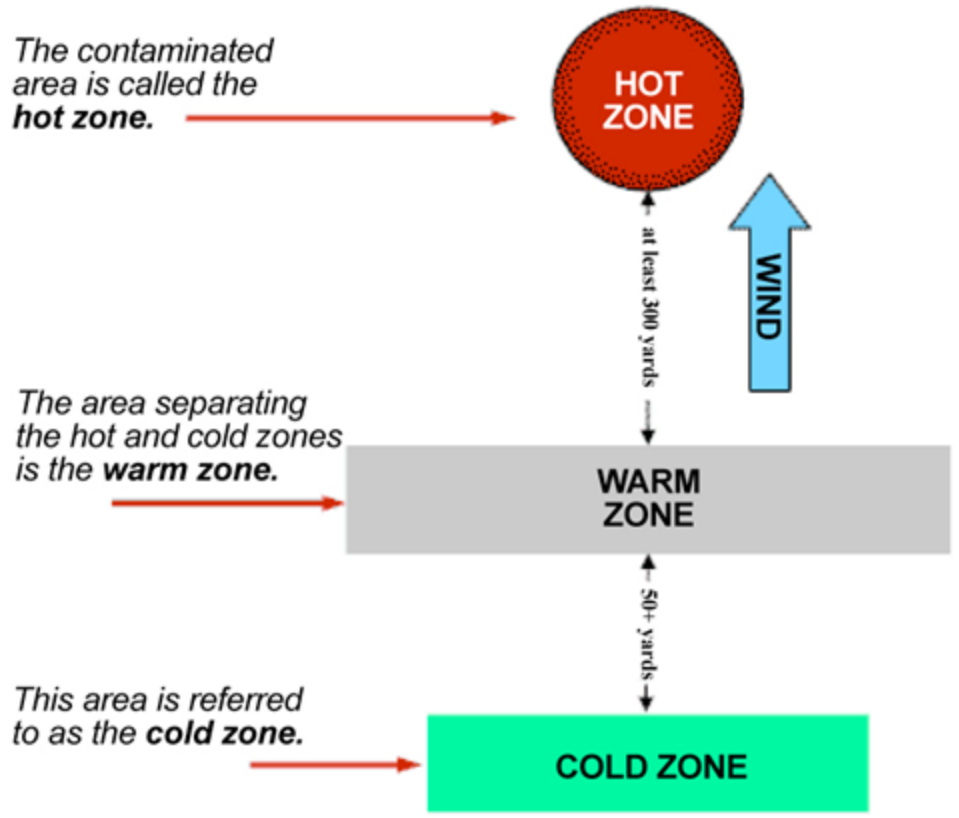
All HASPs must cover <u>all</u> of the following:

- Introduction
- Key Personnel
- Hazard Assessment
- Training
- PPE
- Temperature Extremes
- Medical Surveillance
- Exposure Monitoring and Air Sampling
- Site Control
- Decontamination
- Emergency Response/ Contingency Plan
- Emergency Action Plan
- Confined Space Entry
- Spill Containment

Elements of a Site Specific Safety Plan (SSSP)

- Responsibility/Key Line Personnel
- Identification of Competent/Qualified Persons
- Scope of Work Evaluation
- Hazard/Risk/Exposure Assessment
- Control Measures
- Periodic Inspections
- Daily Safety Planner
- Compliance
- Written Progressive Disciplinary Program
- Hazard Correction
- Training and Instruction
- Project Site Orientation
- Employee Communication System
- Record Keeping
- Accident/ Exposure Investigation
- Emergency Action Plan
- Site-specific Medical Emergency Plan
- Hazard Communication Plan
- Worker training and instruction check lists

Site Control



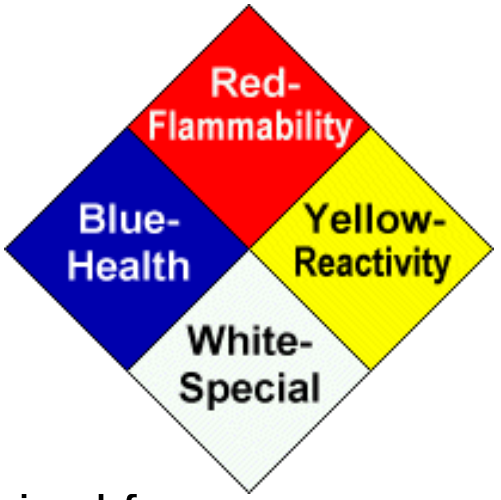
- Site control consists of the following components:
  - Control zones (see image to left)
  - HASP
  - Communication
  - Emergency plan
  - Site map
  - Use of “buddy system”

Hazardous Materials that May be Associated with Commercial and Residential Debris

- Asbestos
- Ash
- Compressed gas cylinders and propane cylinders
- Gasoline cans (& other fuel containers)
- Bulk chemicals & chemical containers
- Lead acid batteries
- Paints and thinners
- Bulk pesticides
- Bulk fertilizers
- Moldy materials
- Munitions
- Laboratory equipment
- Lead
- Electrical transformers
- Air conditioners
- Large metal appliances & equipment
- Automobiles
- Transformers
- Other particulate matter

Hazardous Materials and Hazard Communication

- The Earthquake may have dislodged or damaged tanks, drums, pipes, and equipment that may contain hazardous materials.
- Do not handle unidentified or damaged containers; report these to your supervisor.
- Understand Material Safety Data Sheets (MSDS), and follow as appropriate.
- NFPA 704M warning labels may also be useful in the field.
- Specific Hazard Communication training is required for any potential chemicals with which you may come in contact.



Special Rules for Respirators

- Make sure you are medically cleared to wear your chosen respirator.
- Make sure you received the required training.
- Make sure you are fit tested for your respirator.
- Inspect your respirator each time you put it on and take it off.
- Perform a user seal check each time you put it on.
- Clean your elastomeric respirator at least once a day in accordance with the manufacturer's recommendations.
- Store elastomeric respirators in a clean bag.
- If your respirator becomes damaged or fails to function, stop work and retrieve a new one.

OSHA respiratory protection standard, 29 CFR 1910.134

You May Encounter Victims

- During response and cleanup, you may encounter trapped victims.
- Some may be alive.
- The longer it takes to reach a trapped person, the lower their chance of survival.
- Be prepared that you may find deceased bodies or body parts.

From U.K. Fire Service Search and Rescue Team Structural Collapse

Bloodborne Hazards

- Use disposable nitrile or similar gloves when handling human remains or assisting those with injuries.
- Replace gloves if punctured or torn.
- Do not handle human remains or assist those with injuries if you have skin cuts or punctures.
- Use goggles, or face shield and mask, when handling human remains, i.e., recovering the deceased. Make sure to wear a respirator.
- Transport human remains in closed, leak-proof, labeled containers.

OSHA Blood Borne Pathogen Standard: 29 CFR 1910.1030

Flying Debris and Material Handling

- Wear personal protective equipment, including hard hats, safety shoes, eye glasses, and work gloves.
- Do not walk under or through areas where cranes and other heavy equipment are being used to lift objects.
- Make sure that you have an up-to-date tetanus immunization.

Carbon Monoxide (CO) Exposure

Carbon Monoxide has no warning properties; it is a colorless, odorless gas!

- **CO may be present with:**
  - Any activity using gasoline, diesel, or propane-powered machinery
  - Work near operating equipment
  - Debris reduction sites
  - Work near hot work (cutting, welding), especially in confined spaces
- **To control CO exposures:**
  - Wear CO monitoring equipment
  - Do not use gas/diesel powered equipment indoors or in enclosed areas
  - Use forced air ventilation (e.g., blower)

Symptoms: Headache, dizziness, drowsiness, or nausea progressing to vomiting and loss of consciousness. Prolonged or high exposure can lead to coma or death. If you experience any of these symptoms where CO may be present, **LEAVE THE AREA IMMEDIATELY.**

Portable Generators

Hazards include:

- Carbon monoxide poisoning
- Electrocution from backfeed

- If it is necessary to use a portable generator, follow manufacturer's recommendations and specifications:
  - Use a qualified electrician to assist in installation and start-up activities
  - If using gasoline- and diesel-powered portable generators, switch the main breaker or fuse on the service panel to the "off" position before starting the generator
  - Do not use on or in wet surfaces
  - Do not operate in rain unless the generator can be kept dry
  - When refueling, turn off and wait for motor to cool, or use appropriate funnel to prevent spills onto hot engine
  - Do not use indoors or in temporary or permanent shelter

Ergonomics

Ergonomics is arranging work environment and task methods to reduce injury and fatigue in workers. An example is using roller conveyors on which objects can slide to eliminate unnecessary lifting.

To help prevent injury during an earthquake response, if possible:

- Use proper machinery to assist in lifting materials
- If proper equipment is not available, use teams of two or more to move bulky objects
- Avoid lifting materials that weigh more than 50 pounds on your own
- Avoid repetitive motions
- Avoid use of excessive force
- Avoid awkward postures
- Avoid excessive heat or cold

Heat Stress

Common signs and symptoms that workers may experience if they have one of these conditions.

Heat Stress	Heat Exhaustion	Heat Stroke
Headache	Headache	Headache
Thirst	Dizziness	Dizziness
Profuse sweating	Confusion	Restlessness
Muscle aches	Nausea	Confusion
	Sweating-pale, clammy skin	Hot, flushed dry skin
	Cramps in legs & abdomen	Body temp above 104°F
	Rapid, weakening pulse & breathing	Unresponsive/disoriented

Heat Stress (continued)

- Drink when thirsty. Avoid alcohol, caffeinated drinks, or heavy meals.
- Know the signs of heat-related illnesses.
- Monitor yourself and coworkers, use the buddy-system. Use monitoring, such as body temperature readings.
- Block out direct sun or other heat sources, and take shelter in shaded areas.
- Use cooling fans/air-conditioning and rest regularly.
- Wear lightweight, light-colored, loose-fitting clothes and a hat, if available. Get medical help for symptoms, such as altered vital signs, confusion, profuse sweating, excessive fatigue, or rapid heartbeat.
- Fire fighters should unbutton and remove bunker gear when resting.

Heavy Equipment Use

The following are types of heavy equipment that may be used in response to an earthquake:

- Front end loaders
- Excavators/backhoes
- Forklifts
- Bobcats
- ATVs
- Tractors
- Cranes
- Trailers
- Dump trucks

Heavy Equipment Use (continued)

- OSHA requires machinery to be inspected by a qualified worker before each use.
- Be alert to the activities around you.
- Do not direct equipment unless trained to do so.
- Do not walk under or through areas where heavy equipment is lifting objects or behind equipment.
- Do not climb onto or ride loads being lifted or moved. Do not ride on equipment or in bucket.
- Pay attention to unstable ground caused by the quake and extremely sloped areas.
- Do not exceed the load capacity of lifting equipment.

Debris Removal Equipment

Hazards:

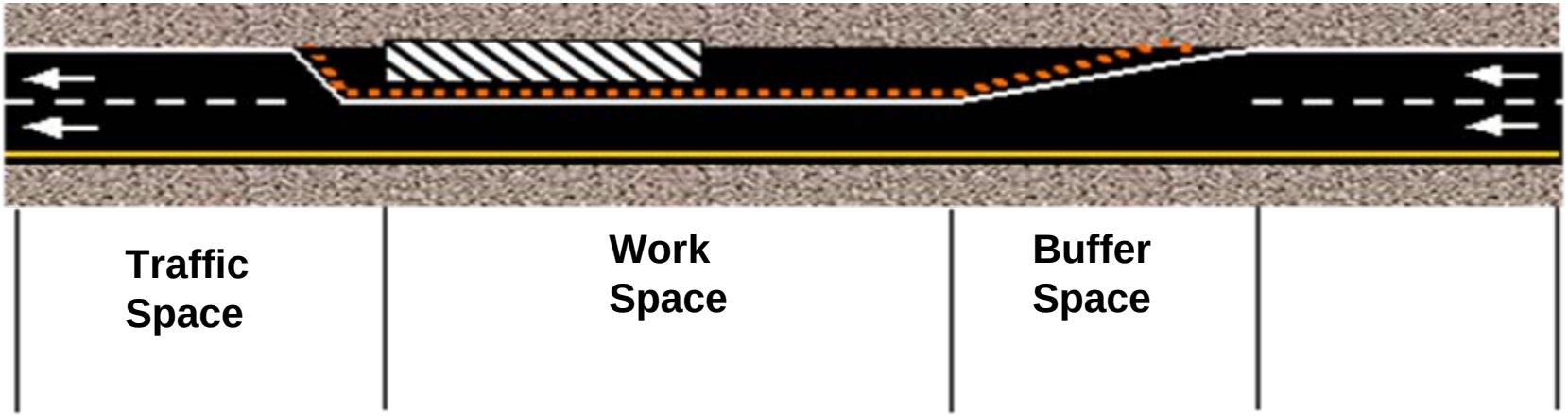
- Overhead power lines
- Traffic issues
- Congested, bottle-neck areas
- Worker on top of potentially unstable load
- Modified trailer used to haul oversized load debris
- No traffic control (direction)
- Low visibility from smoke and/or ash

Driving and Traffic Issues

- **Worksites must be posted with legible traffic signs at points of hazard. Flag persons or Flaggers are used when signs, signals, and barricades do not provide adequate protection for workers. Workers in these areas may experience:**
  - **Damaged infrastructure**
  - **Heavy traffic-delays**
  - **Inexperienced or poor drivers**
  - **Poor visibility due to smoke, ash and fog**
  - **Fatigued drivers**
- **Those working near traffic should wear high visibility clothing or PPE.**

Road Work Zone Safety

- There must be a traffic control plan for the movement of vehicles.
- Traffic Control Devices should be used inside the work zone.
- Flaggers and others providing temporary traffic control should wear high visibility, reflective clothing.
- Flagger stations should be illuminated.
- Flaggers should be trained/certified and use the signaling methods required by the authority in charge.



Component Parts of a Temporary Traffic Control Zone

Module 3

Controlling Other Task-specific Hazards During an Earthquake Response

U.S. Department of Health and Human Services
National Institutes of Health
National Institute of Enviromental Health Sciences

Hot Work

- Follow all established hot work permit requirements; refer to competent hot work supervisor when questions arise.
- Establish a fire watch for duration of work and at least 30 minutes after work is complete (*See NFPA 241 and 51b*).
- Generation and retention of carbon monoxide and other toxic materials may reach high levels, especially in confined spaces or enclosed areas.
- **Follow hierarchy of controls!** Use ventilation, if possible, along with appropriate PPE, as outlined in hot work permit.

Jackhammers and Concrete Saws

- Only use jackhammers and concrete saws if trained to do so.
- Inspect and operate jackhammers and concrete saws in accordance with manufacturers recommendations.
- Wear appropriate PPE, including safety glasses, face shield, hard hat, safety shoes, durable work clothes, and gloves.
- Use hierarchy of controls if excessive dust is produced.
- Be aware of kickback, pull-in hazards.
- Take breaks when you become fatigued.
- Do not use on unstable surfaces.
- Do not use foot to guide pick.

Operating a Chain Saw

- Operate, adjust, and maintain the saw according to manufacturer's instructions.
- Properly sharpen the saw's chain and properly lubricate the bar and chain with bar and chain oil.
- Operator should periodically check and adjust the tension of the chain saw blade to ensure good cutting action.
- Choose the proper size of chain saw to match the job.
- Include safety features, such as a chain brake, front and rear hand guards, stop switch, chain catcher, and a spark arrester.

Operating a Chain Saw (continued)

- **Wear the appropriate protective equipment:**
  - Hard hat
  - Safety glasses
  - Hearing protection
  - Heavy work gloves
  - Cut-resistant legwear (chain saw chaps)
- **Always cut at waist level or below.**
- **Avoid contact with power lines.**
- **Bystanders or coworkers should remain at least:**
  - Two tree lengths (at least 150 feet) away from anyone felling a tree
  - 30 feet from anyone operating a chain saw to remove limbs or cut a fallen tree

High Pressure Washers

Associated hazards include:

- Chemical burns
- Lacerations
- Thermal burns
- Contusions
- Back and shoulder strains
- Carbon Monoxide production
- Chemical penetration
- Projectile production
- Electric shock

Safe use guidelines include:

- Inspection of washer
- Training and proper use
- PPE (including insulating rubber boots)
- Hazcom for cleaning agents
- Use with GFCI and proper electrical safety

Hand and Portable Power Tools

Hand Tools

- Inspect tools in accordance with manufacturer's specifications
- Take damaged tools out of service
- Use only sharp tools

Portable Power Tools

- Inspect tools in accordance with manufacturer's specifications
- Use with sharp blades
- Use with GFCI
- Use with proper gauge electric cord
- Use double insulated tools
- Always wear eye protection

Personal Protective Equipment (PPE)

Depending upon your work site's PPE program and assigned job task, any of the following PPE may be required:

- Protective clothing ranging from standard coveralls to a chemical resistant suit with hood and booties.
- Respirator ranging from an N-95 to a PAPR for high exposure and strenuous work. In rare cases a supplied air respirator may be required.
- Protective footwear with steel toe and insole. A chemical resistant boot or outer boot may be required for some work.

PPE (continued)

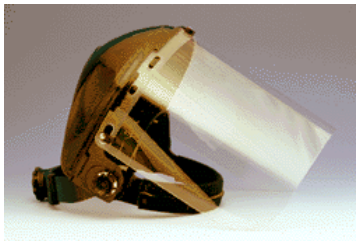
- Disposable cut/abrasive resistant work glove. A chemical resistant glove may be required for some work.
- Fully enclosed goggles (better for ash) or safety glasses.
- Ear protection in noisy areas.
- Head protection if in construction or demolition zones.
- Be sure to follow your work site's PPE program.
- If you are working near downed power lines:
  - Nomex clothing compliant with NFPA 1500, rubber gloves, dielectric overshoes, and insulated tools

The OSHA PPE standard (29 CFR 1910 Subpart I) must be followed when selecting and using PPE.

Examples of PPE

Safety glasses

Safety Goggles



Face Shield

Level C PPE with tyvek splash suit and APR respirators

Example of Leather gloves
Courtesy Kirkwood

Example of Nitrile gloves
Courtesy Kirkwood

N-95 respirator

½ face APR

Full face APR

PAPR

Air–Purifying Respirator

- Try to apply the following engineering controls, in addition to wearing a respirator:
  - Wet methods
  - Appropriate HEPA vacuum
- Minimize particulate matter (dust) production:
  - Do not use a vacuum that is not approved for ash and does not contain a HEPA filter.
  - Do not aggressively dry sweep.
  - Avoid walking in single file lines as those walking behind the leader may become covered in particulate matter

Wetted debris during clean up of 2003 Angora wildfire

Air–Purifying Respirator (continued)

- **Wearing NIOSH-approved respirators:**
  - **If in doubt about respirators, see your supervisor.**
  - An N-95 (filters out 95% of particles) or greater may be acceptable for some activities.
  - Use an elastomeric, half-mask respirator with N,R, or P-100 series filters if asbestos or carcinogen may be present.
  - If airborne contaminants are causing eye irritation, full-face respirators with P-100 organic vapor/acid gas (OV/AG) combination cartridges should be used.
  - Surgical masks should **not** be used because they do not provide adequate protection.
  - Replace filters when breathing becomes difficult or when you detect an odor through organic vapor cartridges (29 CFR 1910.134).

½ face respirator with P-100/OV/AG cartridges

Decontamination (Decon)

Depending on your job task, you may come in contact with hazardous materials that will require you to be decontaminated.

- Decon is the process of removing, destroying, or reducing the activity of materials, such as ash, asbestos, or toxic chemicals that could endanger an individual or the environment.
- Prevents spreading contamination to other locations (like your vehicle or home).
- Site workers who use the site's Standard Operating Procedure are less likely to be contaminated than site workers who do not use these practices.

Decontamination (continued)

- A decontamination plan should include:
  - Training
  - Location and layout of decontamination stations and areas
  - Decontamination methods
  - Required decontamination equipment
  - SOPs to minimize worker contact with contamination during decontamination
  - SOPs for decontamination line personnel
  - Procedures for collection, storage and disposal of clothing, equipment, and any other materials that have not been completely decontaminated
  - Disposal of PPE and decon solutions as contaminated waste
  - Adequate personal washing stations

Prevent the Spread of Contamination to Your Family and Home

- Bringing home contaminated work clothes or equipment may contaminate your home and place your family at risk.
- Bring a clean change of clothes to the worksite.
- Wash work clothes separately. Preferably in an employer provided location.

Animals, Insects and Plants

- **To protect yourself from mosquitoes:**
  - Use screens on dwellings.
  - Wear long pants, socks, and long-sleeved shirts.
  - Use insect repellents that contain DEET or Picaridin.

- **Beware of wild or stray animals:**
  - Avoid wild or stray animals; call local authorities to handle animals.
  - Get rid of dead animals according to local guidelines.
  - Wear and clean proper protective clothing when handling carcasses.
  - Look out for rodents in structures (especially confined spaces).

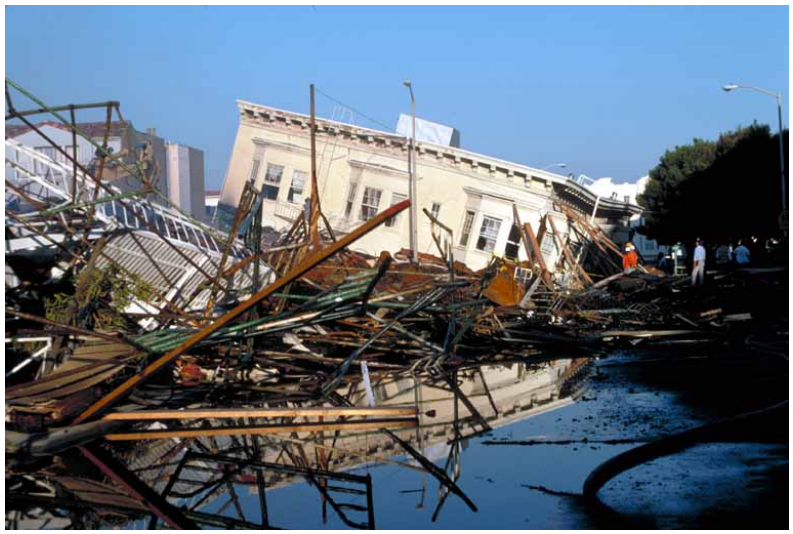
Animal, Insects and Plants (continued)

- Be on the alert for snakes that may be hiding in unusual places.
- If you are bitten:
  - Seek immediate medical attention.
  - Try to identify the snake so that if it is poisonous, you can be given the correct antivenin.
  - Do not cut the wound or attempt to suck the venom out; contact your local emergency department for further care.

- Protect your skin appropriately.
- Be aware of poisonous or harmful plants in your work area.

General Safety Tips

- Be careful and use safety measures outlined in your worksite's HASP at all times.
- Walking/working surfaces may be wet, slippery, and unstable. Spread sand and wear slip resistant footwear if possible (to reduce slips and falls).



General Safety Tips (continued)

- Walking over and handling debris that is unstable can cause cuts, scrapes, bruises, sprains, etc.
- Make sure you have had a current tetanus vaccination.
  - Revaccinate for a dirty wound if current vaccination is over five years old.
  - If you will be performing direct patient care or otherwise expect to have contact with bodily fluids, get the Hepatitis B vaccine series.
- Avoid contact with stagnant water.
  - If exposed to stagnant water, wash and decontaminate yourself and any contaminated equipment immediately.
- Use steel toe insole, non-slip footwear.
- Use durable outer gloves when handling debris.
- Wear ear protection for noisy environments.

Excavation Hazards

Search and rescue, structural repair, demolition and cleanup operations may require excavation

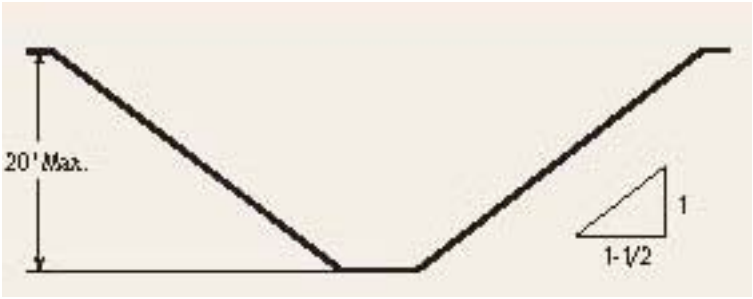
- Excavations can create many hazards that must be controlled to safely work around and in them.
- An excavation is any man-made cut, hole, trench, or depression in the earth formed by earth removal.
- A trench is defined as a narrow, below-ground excavation that is deeper than it is wide, and is no wider than 15 feet.
- The following are potential excavation hazards:
  - Cave in
  - Falls, falling loads
  - Hazardous atmosphere
  - Incidents involving mobile equipment

Excavation (continued)

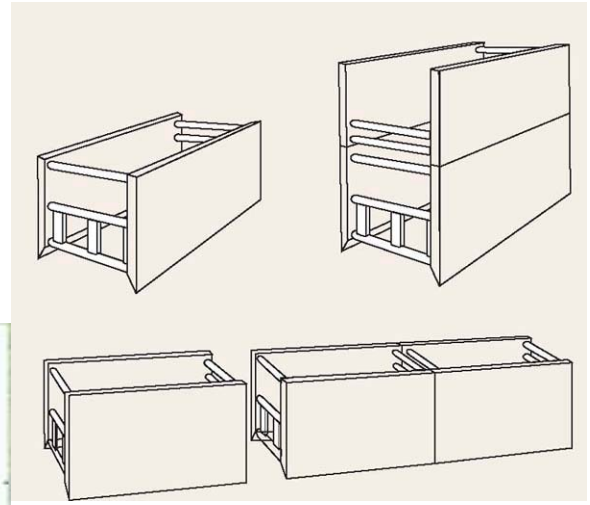
- A competent person must evaluate soil for excavation safety. All excavations/trenches should have safe means for entering and exiting (ladders, safe design, etc.). DO NOT enter an unsafe excavation!
- In trench excavations that are over 4 feet deep, a stairway, ladder, ramp or other safe means of egress must be provided so as to require no more than 25 feet of lateral travel for employees (i.e. Distance to egress must be 25 feet or less).
- If an excavation is five feet deep or more, one of the following engineering controls must be used:
  - Shoring
  - Shielding
  - Sloping

See OSHA's Trenching and Excavation Factsheet

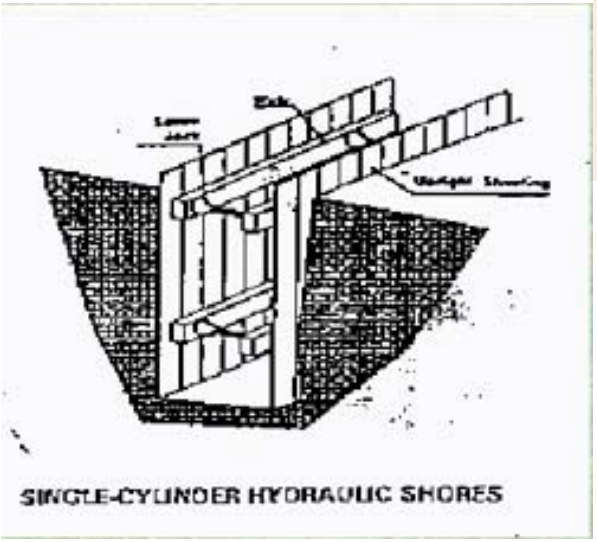
Controlling Excavation Hazards



Sloping in type C soil



Shielding



Shoring

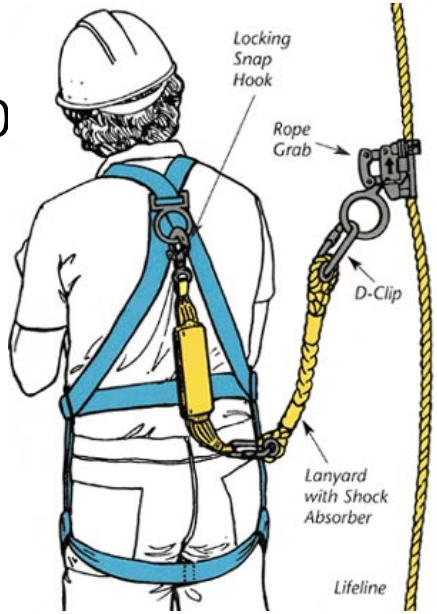
Aerial Lifts

An aerial lift is a vehicle-mounted device used to get a worker to an elevated position (also called “cherry picker” or “boom truck”).

- Only trained and authorized people may operate the lift.
- Read and understand the safety and operating instructions, including all warning decals or labels.
- Check for overhead objects before use.
- Stay far from debris piles, drop-offs, and floor openings.
- Never use near electric lines unless they are deenergized or adequate clearance is maintained.
- Refuel tanks only when the unit is off and charge batteries in a well ventilated area away from open flames.
- Elevate the lift only when it is on a firm and level surface.
- Whenever working out of an aerial lift, a full body harness must be worn and properly attached to the basket.
- Never drive the aerial lift when it is elevated above the limit the manufacturer considers safe.

Falls from Heights Six Feet and Higher

- Employees shall be protected from falls greater than six feet to a lower level. (29 CFR Part 1926.50
  - Guardrail systems
  - Safety net systems
  - Fall arrest systems (less effective than guardrail and safety net systems)
  - Cover or guard any openings or floor holes as soon as they are created
  - Make sure floor hole covers support two times the weight of employees, equipment, and materials
  - Be careful when stepping into areas that are unstable/uneven or where the surface cannot be visualized (i.e., if covered by water).

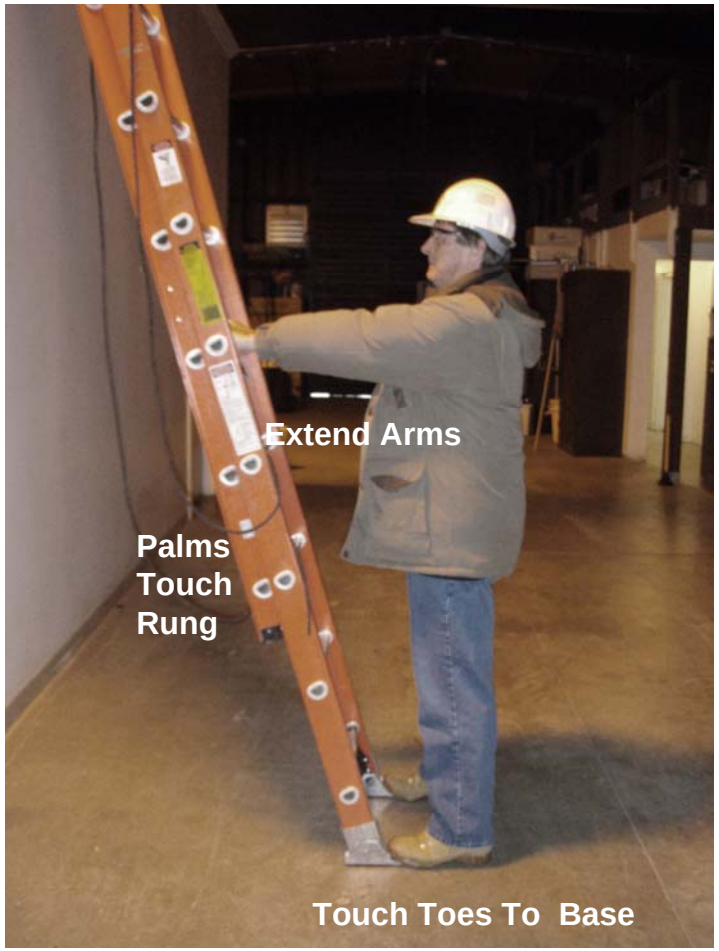


- Workers should prevent items from falling onto people below.

Ladder Safety

Ladders can create a falling hazard.

- Base must be set from the wall at a 1:4 ratio.
- Position portable ladders to extend at least three feet above landing; use a grab device when three foot extension is not possible.
- Secure at the top to a rigid support.
- Do not apply more weight on the ladder than it is designed to support, and make sure that the weight on the ladder will not cause it to slip off its support.
- Before each use, inspect ladders for cracked, broken, or defective parts.
- Use only ladders that comply with OSHA standards.



Ladder At Correct Angle!

Noise Exposure

- Wear appropriate hearing protection in noisy work environments.
  - Examples: working around chainsaws, heavy equipment, and blowers
- A worksite is considered noisy if you have to shout to be heard within three feet.
- The OSHA PEL for noise is 90dB.

Ear plugs

Ear muffs

Traumatic Stress

- A traumatic event is a shocking and emotionally overwhelming situation in which an individual perceives actual or threatened death or serious injury.
- Workers responding to an earthquake may experience traumatic stress.
- Reactions to traumatic events will vary, ranging from relatively mild to severe.
- It is very common for people to experience anxiety, terror, shock, and upset, as well as emotional numbness and personal or social disconnection.[1]

Pay attention to co-workers and how they are being affected by traumatic stress

[1] *International Society For Traumatic Stress Studies*

Traumatic Stress (continued)

Symptoms and negative effects of Traumatic Stress include:

- Physical illness (headaches, fatigue)
- Inability to function normally on the job
- Depression
- Anxiety
- Making efforts to avoid reminders of a traumatic event
- Marital and family conflict
- Hostility and aggression
- Death through suicide as a reaction to overwhelming stress

How to Cope With Traumatic Stress

Some useful techniques to reduce stress when participating in a response:

- Take a break from the news.
- Pace yourself and take frequent rest breaks.
- Watch out for each other.
- Be conscious of those around you. Responders who are exhausted, feeling stressed, or even temporarily distracted may place themselves and others at risk.
- Maintain as normal a schedule as possible.
- Drink plenty of fluids, such as water and juices.

Individuals with prolonged traumatic stress (anxiety, depression, etc.) that disrupt their daily functioning should consult with a trained and experienced mental health professional.

Coping With Traumatic Stress (continued)

- Try to eat a variety of foods, and increase your intake of complex carbohydrates (breads, muffins made with whole grains).
- Whenever possible, take breaks away from the work area. Eat and drink in the cleanest area possible.
- Recognize and accept what you cannot change - the chain of command, organizational structure, waiting, equipment failures, etc.
- Talk to people when YOU feel like it. You decide when you want to discuss your experience. Talking about an event may be reliving it. Choose your own comfort level.
- If your employer provides you with formal mental health support, use it!
- Give yourself permission to feel rotten; you are in a difficult situation.
- Recurring thoughts, dreams, or flashbacks are normal - do not try to fight them. They will decrease over time.
- Communicate with your loved ones at home as frequently as possible.

Protecting Your Family During an Earthquake

Create an emergency response preparedness kit containing:

- Water
- Non-perishable food (at least three days worth)
- First aid supplies
- Medications
- Battery powered radio
- Flashlight
- Tools
- Duct tape
- Cash/traveler's checks
- Clothing
- Bedding
- Toiletry items
- Special needs items
- Important documents (i.e. birth certificate, passport, etc.)

Earthquake Response Activity

- Use a final activity that will include all students in the course, if time permits (four hour or longer course). It should allow previously covered topics to be combined and "put to the test" in an actual earthquake scenario.

- The Great Southern California ShakeOut is based on a potential magnitude 7.8 earthquake on the southern San Andreas Fault hypothetically occurring on November 13, 2008. The scenario earthquake and projected damages are used as a basis for public drills and emergency response exercises. Training activities are included in the scenario and should be reworked to fit your audience, timeframe, geographic location, and level of training.

  http://www.shakeout.org/

Summary

- Proper training is a key component of a safe response.
- The Earthquake may create or release dusts and other chemicals that may be hazardous to human health.
- The hazards and issues covered in this training tool are dynamic and require vigilance and flexibility.
- The key to a safe response is attention to the safety issues of your work environment.
- In addition to the similar physical hazards of a construction or demolition site, there are added factors, including potential aftershocks, trapped victims, dense population displacement, lack of infrastructure, and other earthquake-caused events (liquefaction, sea-waves).

Information Sources

This training tool is based on recommendations from:

- National Institute of Environmental Health Sciences (NIEHS)
- National Institute for Occupational Safety and Health (NIOSH)
- Occupational Safety and Health Administration (OSHA)
- Centers for Disease Control and Prevention (CDC)
- Environmental Protection Agency (EPA)
- United States Geological Survey (USGS)
- Multiple West Coast CERT Sites

Factsheets from these agencies and other earthquake resources are available on the NIEHS National Clearinghouse for Worker Safety and Health Training website: http://tools.niehs.nih.gov/wetp/.

Additional Resources

Additional information on what to do after an earthquake can be found at:

- FEMA: What to do after an Earthquake
  http://www.fema.gov/hazard/earthquake/eq_after.shtm
- CDC: What to do after an Earthquake
  http://www.bt.cdc.gov/disasters/earthquakes/after.asp
- American Red Cross: What to do after a Disaster
  http://www.redcross.org/portal/site/en/menuitem.86f46a12f382290517a8f210b80f78a0/?vgnextoid=3750a5f0f013b110VgnVCM10000089f0870aRCRD&vgnextfmt=default
- CA Department of Conservation: What to do before, during and after an Earthquake
  http://www.consrv.ca.gov/index/Earthquakes/Pages/qh_earthquakes_what.aspx
- San Francisco Department of Emergency Management
  http://www.sfgov.org/site/dem_index.asp?id=95933

Why This Training Tool Was Created

This training tool was created by the NIEHS National Clearinghouse for Worker Safety and Health Training under contract no. 273-05-C-0017 from the National Institute of Environmental Health Sciences Worker Education and Training Program (WETP). WETP has trained nearly two million emergency responders and hazardous waste workers since 1987 to do their jobs safely. WETP is part of the Department of Health and Human Services, which is a cooperating agency under the Worker Safety and Health Support Annex of the National Response Framework. As part of the coordinated effort, WETP created this training tool for those who may be involved in an earthquake response.