

# Earthquake Guidelines

## Overview

Earthquakes, especially major ones, are dangerous, inevitable, and can be an unpleasant fact of life (depending on where you live). It is not possible to prevent earthquakes or change the likelihood of an earthquake occurring. However, we can greatly increase our chances of safety and survival by being aware and prepared. Knowledge and preparation are keys to your survival during and after an earthquake,

There are no warnings for earthquakes. A person is more likely to be injured trying to move during an earthquake rather than immediately seeking a safe space near furniture or an interior wall (not doorways, as they are often not structural). For the United States population, "Drop, Cover, and Hold On" is recommended.

### If We Can't Prevent an Earthquake, Then What Can We Do?

The goal is to maintain hyperbaric and wound care operations following a major earthquake that may impact the structural integrity of the facility, and to ensure the continuum of care for patients, visitors, and casualties of the event.

## Earthquakes

- Occur without warning
- Can be deadly and extremely destructive
- Can occur at any time
- Aftershocks often cause the most damage

### DANGERS ASSOCIATED WITH EARTHQUAKES

The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Most casualties result from falling objects and debris or collapsing structures. Injuries are commonly caused by:

- Partial building collapse, such as falling masonry, collapsing walls, falling ceiling plaster
- Flying glass from broken windows
- Overturned bookcases, filing cabinets, fixtures, furniture, office machines, and appliances
- Fires, broken gas lines, etc. These dangers may be aggravated by lack of water due to broken water mains
- Fallen power lines (both inside and outside of the building)



Hospital Clinic  
Northridge, CA



Apartment Building  
San Francisco, CA



Dentist Office  
Northridge, CA

## Earthquake Guidelines

### How Vulnerable Is Your Hyperbaric Facility and Hospital Buildings?

Every hospital clinic should be assessed to identify its unique vulnerabilities, although studies of past earthquakes reveal some common issues. Much depends on a building's age, as this indicates which codes were used to guide its design and construction. In a clinical hyperbaric facility, many questions need to be addressed to ensure the safest possible environment for our staff and patients.

## Earthquake Safety

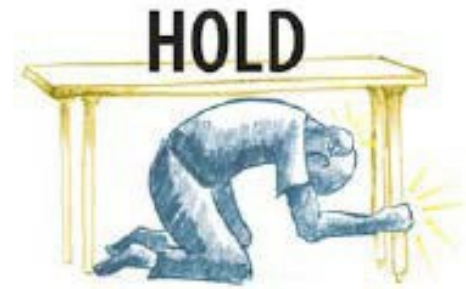
### WHAT TO DO DURING AN EARTHQUAKE

In an earthquake, the area immediately outside a building is the most dangerous place to be. We call this "the danger zone" because bricks, windows, facades, and architectural details are often the first parts of the building to fall off. The taller the building, the wider the danger zone.

But what if you are in the danger zone when the earthquake starts? You can follow the general rules of thumb:

- If you are inside, stay inside and if you are outside, stay outside.
- If you have to look way over your head to see the top of the building, get back into the building and find a safe place. You simply won't have enough time or mobility to get far enough away from tall buildings when the ground is moving.
- If you don't have to look up very much to see the top of the building, you are probably far enough away from it.

### When the Ground Shakes



### Myths vs. Fact

One of the great myths of an earthquake is that all buildings collapse. In the United States, we don't see a lot of buildings collapse, especially when you compare it to the number of buildings that are impacted by the earthquake.

The most vulnerable elements that can affect the functions of the hospital have been identified from past earthquakes:

- Emergency generator
- Bulk oxygen storage tank
- Internal and external emergency communication systems
- Patient elevators

These elements, other than the elevators, normally can be anchored and braced against seismic damage rather inexpensively.




Here is what rescuers and experts **DO NOT** recommend you do during an earthquake, based on years of research about how people are injured or killed during earthquakes:

- DO NOT run outside or to other rooms during shaking
- DO NOT stand in a doorway

## Earthquake Guidelines

### COLOR TAGGING SYSTEM

A color-tagged structure is a structure in the United States which has been classified by a color to represent the severity of damage or the overall condition of the building. The exact definition for each color may be different at local levels.

-  **A red tag indicates UNSAFE:** Extreme hazard, may collapse. Imminent danger of collapse from an aftershock. Unsafe for occupancy or entry, except by authorities.
-  **A yellow tag indicates LIMITED ENTRY:** Dangerous conditions believed to be present. Entry by owner permitted only for emergency purposes and only at own risk. No usage on a continuous basis. Entry by public not permitted. Possible major aftershock hazard.
-  **A green tag indicates INSPECTED:** No apparent hazard found, although repairs may be required. Original lateral load capacity not significantly decreased. No restriction on use or occupancy.

### EARTHQUAKE DAMAGE RATING SCALE

#### Modified Mercalli Intensity Scale (MMI)

Is used by all insurance providers to assess the damage to a building or structure. The linear scale for the Mercalli ranges from I, not felt, to XII, total destruction of the area affected by the quake. The consistency of the scale varies and depends on the distance from the epicenter. On the other hand, the scale on the Richter ranges from 2.0 to 10.0 or higher, but that has never been recorded. Because MMI measures the actual effects of an earthquake, it is much more useful to insurers in determining the level of damage to structures.

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 slight	Light	Moderate	Moderate/ heavy	Heavy	Very heavy
Peak Acc	<0.17	0.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
Peak Vel	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116

Peak Acc = Peak ground acceleration (g), Peak Vel = Peak ground velocity (cm/s)



# The Hyperbaric Facility

## WHAT THE FACILITY NEEDS TO DO DURING AND AFTER AN EARTHQUAKE

Planning for this type of natural disaster is usually covered in your hospital policies and procedures. These policies generally only address staff and patient safety during an earthquake, and the possible egress of your staff and patients to safety. What we will address is the operational assessment of equipment and the steps that are needed to get our facilities operational as fast as possible to aid in the treatment of the injured population.

Here are some general considerations and question that will need to be addressed:

1. On what level (floor) is the facility located? The higher the level, the greater the chance of structural damage.
  - a. Consider egress route for staff and patients.
2. What type of oxygen system is supplying the chamber (Dewars vs. Bulk)? Each has its own unique set of potential problems during an earthquake.
  - a. Consider how to check for oxygen system for operational readiness.
3. What are the current codes and requirements for both inpatient and outpatient facilities?
  - a. Know what codes can be applied to your facility (State & National Safety Codes).



## HYPERBARIC OPERATIONS

If your Class B chamber has lost primary and secondary oxygen supply due to a break in the oxygen supply line, **the emergency vent will not work.** Do the following procedure to bring the chamber back to 1 ATA:

1. Open the chamber exhaust to its maximum setting.
2. Increase the rate set to a rate of 5 or maximum setting. The chamber will slowly decrease in pressure over the course of five (5) to ten (10) minutes.

### Assess facility for damage, initiate repairs as appropriate or secure unsafe areas.

- Check the power plant and ensure that all vital functions are operating properly.
- Check all utilities and utility connections for damage (e.g., communication, fire alarm detection and suppression, HVAC, medical gases, sewage, water).
- Inspect gas lines (oxygen, air).
- Check for continuity of the supply lines (many facilities within the earthquake zones have automatic sensor valves and are designed to shut down for earthquakes larger than 4.0 Richter scale).
- Ensure continued functioning of emergency power generators.
- Activate alternate care sites for evacuated patients, if necessary. Implement evacuation of unsafe/unstable areas of the facility, if necessary. Activate search procedures, as appropriate.
- Assess status of security systems, access, and egress from facility and implement security plan.

## Earthquake Guidelines

### Hyperbaric chamber (during the earthquake and aftershocks)

This is a recommended checklist for the prevention of damage to the class B hyperbaric chamber – AFTER patient and staff safety concerns have been addressed.

These actions will possibly prevent damage to the acrylic pressure vessel during aftershocks. If we can prevent any damage to the chamber acrylic, it will allow the facility to be operational much sooner (it can take months to get a new acrylic for the chambers).

1. Cover the chamber acrylics with as many hospital blankets as possible (the more the better) and tape in place with any available tape.
  - This will prevent debris (from aftershocks) from damaging the outside of the chamber acrylics.
  - REMEMBER that the low-pressure side of the pressure vessel is where all the stress is and can do the most damage to the pressure vessel.
2. Close all gas (oxygen and air) valves.

### Placing the Hyperbaric Chamber Back into Service Post-Earthquake

1. After being cleared to enter the hyperbaric facility, you will need to check the operational status of your oxygen supply system (bulk or Dewars).
  - a. Walk the gas system from supply to chamber, looking for possible breaks in the piping and isolation vales that may have closed (DO NOT OPEN THEM if closed).



- b. Once the continuity of the piping has been confirmed, check for small leaks (this could cause an increased fire risk in a remote location within the facility or host hospital).
  - i. Start at the main supply (Bulk or Dewars tank). Look at the pressure within the tank itself.
    - o Ensure that all isolation vales are in the closed position.
  - ii. Start at the supply and open the first vales in the supply line (listen for leaks). Continue this process with each valve until you reach the chamber isolation valve at the back of each chamber. If no leaks, continue to the next step.
  - iii. Once you have all the oxygen supply isolation valves in the open position, close the main supply valve at the oxygen source (bulk tank or Dewars cylinder), then ensure that the chamber isolation valve is closed (at the back of the chamber on the wall).
  - iv. Record the line pressure at the oxygen alarm panel or hyperbaric zone isolation valve.



- v. After approximately 30 minutes, record any changes from the original pressure reading. If you see a drop in line pressure, this indicates a leak in the hyperbaric oxygen supply line that would need to be addressed before the start of hyperbaric operations.



- vi. Keeping all other possible valves in the open position will charge the oxygen supply line with between 50 and 90 psi of pressure. Shutting the two primary isolation valves will allow the hyperbaric technician to watch the oxygen supply gauge either on the wall or chamber for a drop in pressure over time. This will alert the technician to very small leaks within the piping system.
  - c. If everything checks out, then your system may be operationally ready. If in doubt, always reconfirm with your facility.
2. The next step is to inspect the chamber itself for possible damage (water, scratches, broken knobs etc.).
    - a. Check for grounding at all points. This will also address the structural integrity of the building ground as well as the chamber.
    - b. Check the communication system for operation.

**REMEMBER:** Before placing your chamber back into service, you will need clearance from both the host hospital and possibly your chamber service provider to ensure the complete system still meets all regulatory requirements as well as all supporting equipment.