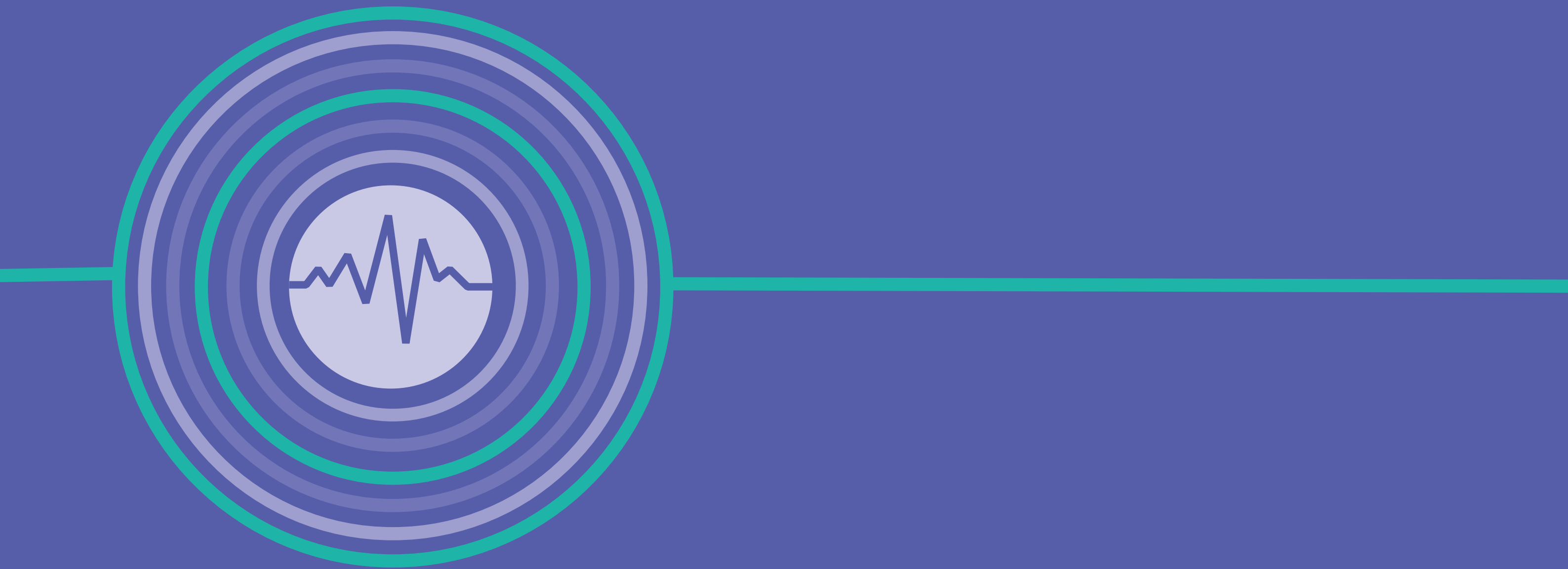
CHEMICAL RELEASES ASSOCIATED WITH EARTHQUAKES



This leaflet provides brief information about Natech and other chemical releases caused directly or indirectly by earthquakes. It is an extract from the WHO publication *Chemical releases caused by natural hazard events and disasters – information for public health authorities.* The full document provides additional information on the roles of the health sector in prevention, preparedness, response and recovery in relation to Natech events.

World Health Organization

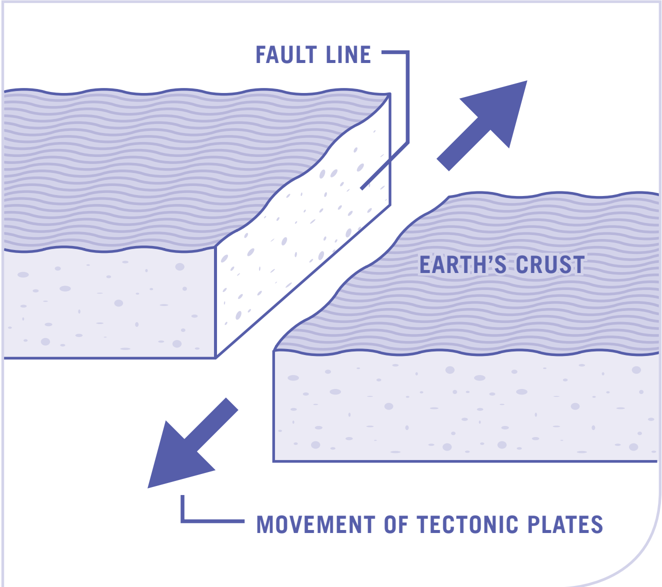
WHAT IS AN EARTHQUAKE?

An earthquake is a sudden release of energy in the earth's crust caused by movement between tectonic plates along a fault line.

It is characterized by violent shaking of the ground produced by deep seismic waves, which spread out from the initial point of rupture *(1)*.

Earthquakes can result in ground shaking, soil liquefaction, landslides, fissures, avalanches and tsunamis. The extent of destruction and harm caused by an earthquake depends on:

- magnitude
- intensity and duration
- the local geology
- the time of day that it occurs
- building and industrial plant design and materials
- the risk-management measures put in place (*2–4*).



CLASSIFICATION OF EARTHQUAKES

A number of scales have been defined to measure the intensity and magnitude of earthquakes *(1, 4, 5)*, but the most commonly used are:

The Mercalli scale (MM):

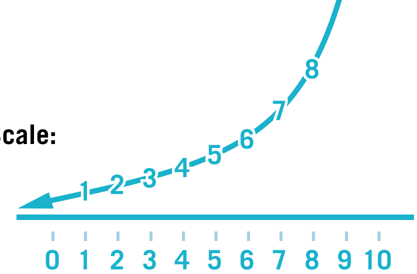
This ranks earthquakes according to their destructiveness using a scale from I to XII in Roman numerals, with XII being the most severe. **The scale is based on visual and other non-instrumental observations of the earthquake's effects.**

Scale:

The Richter scale (M_L):

This indicates the amplitude of ground movement as measured by a seismograph. The scale is logarithmic to base 10, thus a magnitude 5 earthquake is 10 times more powerful than one of magnitude 4. A magnitude 4 earthquake is perceptible but mild, whereas a magnitude 8 earthquake is potentially devastating.

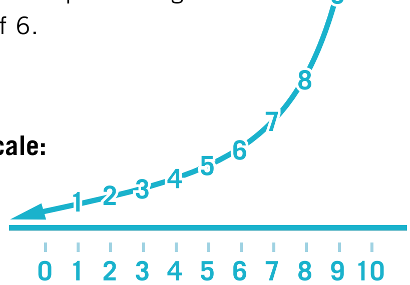
Scale:



The moment magnitude scale (M_W):

This is also based on seismographic measurement and is **the magnitude assessed in terms of the release of energy across the area of rupture on the fault.** It provides the most reliable estimate for very large earthquakes. The scale has been defined so that it is close to the Richter (M_L) scale up to a magnitude of 6.

Scale:



RISK FACTORS FOR CHEMICAL RELEASE

Sites where chemicals are produced, used or stored are vulnerable to earthquake-related damage and chemical release *(2, 6, 7)*.

Analysis of past events suggests that non-pressurized chemical-storage tanks, piping and old gas and oil pipelines are particularly vulnerable to rupture following an earthquake *(2, 8)*.

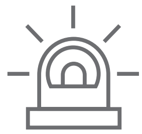
FACTORS THAT INCREASE THE RISKS TO THE POPULATION OF A CHEMICAL RELEASE DURING AN EARTHQUAKE INCLUDE THE FOLLOWING (*6, 9*):

Location

- Location of industrial facilities in seismic areas.
- High population density around industrial sites.

Structures

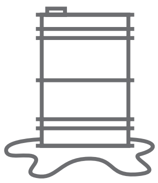
- Inadequate planning and building regulations.
- Structures that are not seismically resistant.



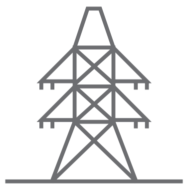
Preparedness and warning systems

- Inadequate warning systems.
- Lack of public awareness about earthquake risks.

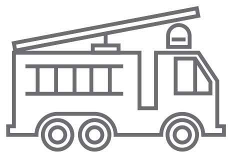
WHEN AN EARTHQUAKE OCCURS, THE NATECH RISK COULD BE FURTHER INCREASED BY A REDUCTION IN RESPONSE CAPACITY (*9, 10*):



The release of hazardous materials may hamper search and rescue operations.



Damage to on-site emergency equipment will hamper response, as will **damage to essential infrastructure**, such as the power supply, water supply and telecommunications.



The off-site emergency-response personnel and other resources may not be available as they may be occupied in dealing with the consequences of the earthquake.

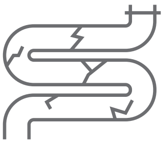
IN AREAS VULNERABLE TO EARTHQUAKES, industrial site emergency-response plans must include earthquake scenarios, so that workers and managers will be prepared for the specific conditions that exacerbate an emergency situation during and following an earthquake.

MECHANISMS OF CHEMICAL RELEASE

Failure of containment leading to chemical release typically arises from structural damage caused by the horizontal and vertical shaking forces of the earthquake, by falling debris, and by soil liquefaction resulting in building collapse *(2, 6, 10)*.

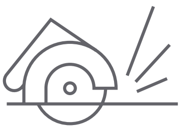
There may be multiple and simultaneous chemical releases at a single site or over extended industrial areas. **Box A1** in the WHO publication on *Chemical releases caused by natural hazard events and disasters* provides an illustrative case study.

HORIZONTAL AND VERTICAL SHAKING FORCES OF THE EARTH-QUAKE, FALLING DEBRIS, AND SOIL LIQUEFACTION



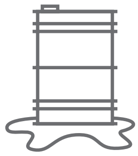
Damage to industrial sites

At industrial sites, mechanisms of chemical release include: rupture of pipelines and connection flanges; buckling and rupture of storage vessels; liquid sloshing (which compromises the structural integrity of tanks that are full or nearly full) leading to tank-shell damage and collapse; **and damage to the power supply,** which can cause process upsets and affect safety measures such as temperature and pressure monitors and control valves *(2)*. Damage to storage vessels at petroleum installations can release huge quantities of petroleum products into the environment, including into waterways *(6)*.



Release of asbestos

Clean-up operations can result in the release of asbestos fibres from asbestos cement. This material is commonly used in many countries for roofing and pipes. Clearing fallen or damaged structures may involve sawing, breaking up and moving asbestos cement, which releases harmful fibres into the air *(11)*. The uncontrolled burning of post-disaster waste can result in the generation of toxic and irritant smoke.

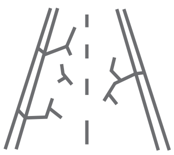


Damage to drums, barrels and sacks

In the case of warehouses and other storage sites, smaller vessels such as **drums, barrels and sacks containing chemicals can be damaged by tipping and by falling structures.** This may result in the mixing of chemicals with the generation of toxic reaction products or a fire or explosion hazard *(6, 8)*.

Fires, dust and toxic fumes

Fires are a relatively common occurrence following earthquakes, for example caused by ignition of fuel storage tank contents and rupture of gas mains *(2, 6)*. Fires at fuel storage depots may burn for several days releasing toxic combustion products into the air for a prolonged period *(7)*. Fires in buildings can release large amounts of dust and fibres from asbestos and fibreglass insulation *(6, 12)*.



Damage to railways and roads

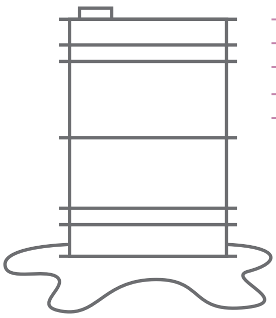
Damage to railways and roads can result in derailment, tipping and collisions of tankers transporting chemicals with subsequent rupture and chemical release *(8)*.

POTENTIAL IMPACTS ON HUMAN HEALTH

Chemicals released following an earthquake can cause dermal, respiratory and systemic toxic effects following direct exposure of victims and rescuers.

Toxic effects and injuries may also result from environmental contamination, and fires and explosions. The general public, rescuers and those involved in clean-up operations may be exposed to a range of hazards, which can be divided into those related to chemicals and those unrelated *(6, 13)*. Examples are given below.

Chemical-related



- **Burns** from exposure to spilled corrosive chemicals.
- **Respiratory tract injury** from inhalation of irritant gases, combustion products, heavy dust and fibres (e.g. from damaged asbestos and fibreglass insulation) *(6)*.
- **Carbon monoxide poisoning** resulting from the incorrect use of petrol/diesel generators, or the use of barbeques, braziers or buckets of coal or charcoal for heating and cooking, when electricity and gas supplies are lost *(3, 14)*.
- **Poisoning** from exposure to spilled toxic chemicals and the consumption of contaminated food or water.
- **Injuries and poisoning** in workers involved in rescue and clean-up (after the Loma Prieta earthquake in California, USA, nearly 20% of work-related injuries were caused by exposure to hazardous materials *(6)*).

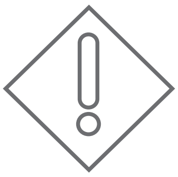
Non chemical-related

- **Burns** from fires.
- **Electrocution** from fallen power lines.
- **Injuries and deaths** as a result of falls, building collapse, falling masonry, etc. *(3)*. Injuries may also occur during the rescue and clean-up phases, e.g. when cutting and moving fallen debris.
- **Consequences of evacuation**, e.g. increased risk of infectious diseases at the evacuation sites, exacerbation of pre-existing health problems during patient transfer, saturation of health-care facilities reducing ability to provide adequate treatment, potential problems with water supply and sanitation, etc. *(15)*.
- **Psychosocial effects**, including post-traumatic stress disorder *(13)*.

RESPONSE AND RECOVERY CONSIDERATIONS

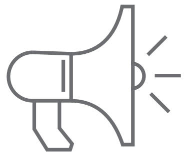
Key activities in response and recovery are:

Risk assessment



Prevention of exposure

Medical assessment and management



Risk and crisis communication

A

Risk assessment

1. Obtain information on potentially affected hazardous sites in order to assess the risks to health and determine the appropriate risk-management measures.
2. Identify the chemicals involved in the accident: check if an inventory is available, e.g. in the site emergency plan; if not, use the *Flash environmental assessment tool (16)*. Look for labels with hazard information.
3. Collect and consider any clinical information available from exposed individuals, as this may help to identify some chemicals or chemical groups.
4. If feasible, organize the collection and analysis of environmental samples (air, soil, water, crops) in order to identify and quantify contamination by chemicals. This information may be particularly helpful in the recovery phase.

B

1. Based on the risk assessments, provide advice as required to the civil defence, fire or other designated service on the need for: