



Emergency Checklist: Earthquake

Earthquakes cannot be prevented or predicted with any certainty. And, the cost associated with earthquake-triggered damage to buildings and property can be extraordinarily high. While this rare natural hazard cannot be eliminated, you can take preventive action that can greatly reduce the amount of damage sustained in the event of major earth movement. This involves advance planning, proper design and protection of buildings, and training of employees.

This checklist helps you identify property loss prevention measures you can take before and after an earthquake to help minimize the disruption it can cause to your facility.

For assistance in evaluating your exposures, developing appropriate design criteria and establishing an emergency response team, contact your local FM Global engineer or client service team.

Before an Earthquake Strikes

GENERAL

- Identify key site characteristics related to seismic risk:
 - The FM Global earthquake risk zone (see FM Global Property Loss Prevention Data Sheet 1-2, *Earthquakes*, and online resources at fmglobal.com)
 - Presence of unfavorable site soil (for example, if it is soft, liquefiable, or subject to lateral spreading)
 - Presence of secondary or complicating natural hazard exposures, such as fault rupture, landslide, tsunami, flood or severe weather
- Establish a comprehensive emergency action plan to control hazards, ensure the integrity of fire protection, conduct salvage and repair operations, and minimize business interruption (see FM Global Property Loss Prevention Data Sheet 10-2, *Emergency Response*).
- Provide and train an emergency response team (ERT) covering all shifts to implement the emergency action plan; stockpile emergency supplies that may be needed to support the ERT (see *The Emergency Response Team* [P8116]).
- Ensure emergency gear such as tools, firefighting equipment and electrical generators are accessible and adequate.
- Conduct recorded inspections and tests, as appropriate, of all seismic protection devices every five years.

Protection from Earthquake Forces

- Determine the structural integrity of existing buildings and other structures.
- Determine the loss exposure to contents due to overturning (toppling), sliding, swinging or rupture of:
 - Items that pose a threat of ensuing fire
 - Fire protection systems
 - Critical building and production support equipment, production machinery and contents
- For acquisitions and new construction, establish minimum seismic design criteria.
- Implement an anchorage/bracing policy whenever equipment and piping is installed or relocated.
- For design issues, engage qualified engineering consultants specializing in earthquake evaluation and rehabilitation.

Protection from Ensuing Fire

- Control fire hazards: Fire can be a major secondary effect of earthquake. Automatic fire suppression and less vulnerable construction decrease, but don't eliminate, the risk. See FM Global Property Loss Prevention Data Sheet 1-11, *Fire Following Earthquake*, for typical ways to reduce the fire threat, including:
 - Seismic shutoff valves on the main fuel gas (natural gas or LPG/propane) service line to each building



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- Seismically activated automatic shutoff valves for flammable gas and ignitable liquid distribution systems
 - Engineered restraint of interior gas-fired equipment supported on floors (boilers, etc.), or suspended from ceilings or roofs (space and radiant heaters, etc.)
 - Engineered anchorage of exterior gas-fired equipment
 - Engineered restraint for tanks, storage cabinets and equipment utilizing ignitable liquid
 - Flexible connections from flammable gas and ignitable liquid piping to equipment to accommodate differential movement
 - Retaining straps on C-clamp attachments and replacement of powder-driven fasteners used in hanger assemblies
 - Bracing, flexibility and clearance on piping that transfers flammable gas or ignitable liquid
 - Correction of deficiencies that could result in electrical arcing near combustible material
 - Upper and lower restraint of flammable and oxidizing gas cylinders to prevent toppling and “kicking out”
- Protect your fire protection systems: Severe ground-shaking often damages automatic sprinkler systems with inadequate earthquake protection, resulting in water damage and impairment of the system at the very time it is needed most. This risk can be minimized by following provisions in FM Global Property Loss Prevention Data Sheet 2-8, *Earthquake Protection for Water-Based Fire Protection Systems*. Here are some of the most important measures:
- Brace the sprinkler piping (risers, mains, large branch lines); do not use U-bolt hangers as seismic braces.
 - Provide flexibility on piping that spans between parts of structures that can move in different directions.
 - Provide clearance where sprinkler piping passes through nonfrangible walls or floors.
 - Protect sprinklers from damage with clearance, vertical restraint on branch lines, and splay wire bracing and compression struts on suspended ceiling systems.
 - Provide retaining straps on C-clamps and replace powder-driven fasteners, if used in hanger assemblies.

- Anchor water-supply equipment, such as suction tanks, fire pumps and drivers, controllers, starter batteries, fuel tanks and emergency generators for electric fire pumps.
- Anchor storage racks having in-rack sprinklers and repair any rack damage immediately (for example, damage from forklift impact).
- Provide redundant water supplies for critical facilities.

To Prevent Equipment/Storage Overturning

- Prioritize the need for restraint, based on whether movement would result in fire, other hazardous conditions or significant loss. Consider the equipment’s value, vulnerability, importance to production continuity, location and height-to-base ratio. Remember:
- Tall narrow objects are most prone to overturning, especially when mass is concentrated near the top.
 - Forces can be amplified in the structure; items at the top of the building are more likely to overturn than items at grade level.
- To mitigate overturning for high-priority items:
- Anchor the item to the floor or adjacent wall.
 - Improve stability by grouping items together and bolting or bracing them to each other.
 - Move heavier items to lower storage shelves.

To Prevent Equipment Sliding or Swinging

- Prioritize the need for restraint, applying the same criteria used above in “To Prevent Equipment/Storage Overturning.”
- Tabletop equipment and unanchored low-profile production equipment or utilities such as boilers, generators, transformers and HVAC units may be subject to sliding.
 - Common items subject to excessive swinging include suspended ceilings, space heaters, piping and electrical bus ducts.
- To protect high-priority items from damage caused by sliding or swinging:
- Anchor floor-supported items to the floor or adjacent wall.



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- Brace suspended items to the structure from which they are suspended.
- Install restraining devices at the edge of shelving or tables to prevent items from falling.
- Restrain suspended lighting fixtures in warehouses if they can impact adjacent items, causing damage to the fixture and allowing components to fall on storage below.

To Minimize Rupture Concerns

- Identify rigid items that are vulnerable to rupture, such as process piping and tanks, utility conduits or any piping where breakage would result in extended interruption of production.
 - Restrain equipment having attached utilities to prevent overturning, sliding and excessive swinging.
- For vulnerable piping or conduits, introduce the following improvements:
 - Sway bracing
 - Retaining straps for C-clamp attachments and replacement of powder-driven fasteners used in hanger assemblies
 - Clearance around pipes and conduits that pass through non-frangible walls and floors
 - Flexibility where needed, using swing joints and flexible couplings
 - Welded connections in piping systems whenever possible
 - Seismically activated automatic shutoff valves for hazardous liquid and gas distribution systems
 - Common foundations to support interconnected equipment
 - Trenches or dikes of adequate capacity where liquid might be released from ruptured tanks

After an Earthquake Strikes

- Empower ERT members to maintain as much fire protection in service as possible when sprinkler piping is damaged.
- Check that all sprinkler water supply valves are open and water supply is in service.

- Repair damaged fire protection systems immediately. If the system is impaired, follow *FM Global's Red Tag Permit System Wall Hanger* (P7427).
- Check process system and gas, water and electrical services for damage. Shut off as necessary.
- Prohibit hot work until fire protection is restored. For any repair that requires hot work, use and follow the instructions outlined in *FM Global's Hot Work Permit System Wall Hanger* (P9311).
- Conduct salvage operations with awareness that fire danger is greater shortly after an earthquake.

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