Unlike most other natural hazards, earthquakes have no season and can cause devastation anytime of the year without warning.
On average, Canada experiences more than 5,000 earthquakes each year. Over the last 23 years, the USGS has detected about 200 earthquakes per year of magnitude 2.5 and larger. While all provinces and territories have some degree of earthquake risk, the western and southwestern regions of British Columbia are most at risk. Other at-risk areas include the St. Lawrence and Ottawa River valleys, as well as parts of the three northern territories.

Recognizing this risk and where it is most likely to occur makes it easier for businesses to determine where and how to invest in affordable, effective earthquake protections that could mean the difference between a business or institution surviving an earthquake with little or no damage or disruption or the business being taken offline for a long period or even permanently.

**Secure light fixtures in suspended ceilings and pendant light fixtures**

- Contact a professional licensed and insured contractor to properly brace light fixtures, especially those that rest in suspended ceilings without safety wires, and those that hang from rigid posts that can break when they sway.

- Heavy ornamental glass fixtures, like a chandelier in a banquet hall or hotel ballroom, are not well suited for use in seismically active areas. Consider using recessed or track lighting.

- For suspended fluorescent light fixtures, 12-gauge wire or chain straps can be used to keep fluorescent lights and ballasts from falling during a quake. Each corner should be supported for maximum strength.

- If a ceiling light has a cover (as fluorescent fixtures often do), it should be fastened to the fixture itself.

- Plastic sleeves over fluorescent light tubes will keep the glass from scattering if they break.
Secure suspended ceilings

- Contact a professional licensed and insured contractor to properly brace suspended ceilings, especially large-area ceilings such as in conference rooms and large open office spaces.
- Suspended ceilings should be attached to the structure at least every 12 feet each way using splay wires (diagonal wires in each of four directions from the grid to the floor above) and compression struts (1-inch diameter electrical conduit or steel stud), that resists the ceiling bouncing upward.
- Laid-in light fixtures, diffusers, and other services that rest in the ceiling grid should have independent safety wires to prevent them from falling if the ceiling grid collapses.
- Above-ceiling equipment such as fans, ducts, and heavy HVAC equipment should also be braced against sidesway.

Reinforce gas lines

- Gas lines should be properly braced and equipped with proper safety devices.
- Because most gas or propane lines are rigid, they can be torn from their connection points during an earthquake. This can be prevented by using flexible connection pipes installed between gas or propane appliances/equipment and their supply lines, and where the pipe crosses seismic joints between portions of buildings.
- Use of natural gas leak detectors can provide warning should an earthquake cause a gas leak in a building.

Seismic gas shutoff valves

- A seismic natural gas shut-off valve located on the natural gas meter will turn off the gas supply to the business in the event of an earthquake.
- Use a metal screen or grating to protect the gas meter from falling debris, like bricks and/or a collapsing chimney.

Brace water heaters and major appliances

- Horizontal forces created by an earthquake can topple water heaters that are not braced to the structure. Once a water heater has tipped over, the broken water pipe can flood the property, damaging or destroying floors, walls, furniture, inventory and computer systems.

**Bracing Diagram**

- **Extend blocking at least two (2) studs beyond bracket attachment.**
- **Existing wall**
  - **Attach bracket to blocking with two (2) #16 (or min. 1/4”) by 1 1/2” lag screws.**
- **Use one (1) heavy-duty shelving bracket in four (4) places.**
- **Attach bracket to plumber’s strapping with a minimum 1/4” x 1” hex bolt. Use a washer under the nut. Keep 1” between end of bracket and centre of bolt.**
- **Attach ends of strapping with a minimum 1/4” x 1” hex bolt. Use washers under head and nut. Keep 1” between end of strapping and centre of bolt.**
  - Use minimum 3/4” plumber’s strapping. Wrap around water heater and provide snug fit.
- **Method recommended by NIST. See NIST Report GCR 97-732 reference page 37.**

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Businesses are at additional risk of possible explosion and fire damage if the water heater is powered by natural gas, as gas lines are often severed during an earthquake.

Water tanks should be secured using an approved seismic restraint kit that is strong enough for your size of tank. Installation instructions should be followed carefully.

Major appliances (e.g. refrigerators, stoves, dishwashers, washing machines and dryers) can also shift or topple in an earthquake, severing gas and/or water lines causing serious damage. Replace all rigid appliance connections with flexible metal armoured connectors and install automatic shut-off valves for both the gas and water supply.

Stoppers or wedges can keep large appliances from moving during an earthquake.

Other non-structural protections

Ensure that mechanical, electrical, and plumbing equipment such as transformers, switchgear, pumps, fans, and tanks are seismically anchored. Equipment on vibration isolators should have snubbers or other seismic restraint so that they do not bounce off their isolators.

Consider fastening several wall units together to form a wider footprint using #8 machine screws (minimum 3”).

The tops of top-heavy furniture should be secured to walls by anchoring the furniture to studs using flexible fasteners.

Heavy bookcases and other storage shelving should be attached to a structural member using L-brackets, Z-brackets, or straps to prevent them from overturning.

Heavier items such as large books should be placed on lower shelves to reduce the centre of gravity. Ledge barriers (wood, plastic, or metal) can be installed to prevent items from falling off shelves.

The wheels on all rolling furniture should be locked. Ideally, casters should be removed if possible.

Use lockable filing cabinets and attach them to the wall using the same method noted for bookcases and other storage shelving (above).

Self-locking drawers and cabinets should be installed. For retrofits, a locking mechanism (e.g., baby-proof latches) can be used.

Photographs/art, mirrors, bulletin boards and signage should not be placed close to desks and seating areas and should be secured to walls using closed-eye screws (where possible) instead of traditional picture hangers. The screw eye should be attached to a wooden or metal stud. Multiple screw eyes may be required depending on the weight of the item.

Flat panel televisions should be mounted to at least two framing studs spaced no more than 24 inches apart on centre. Heavy-duty brackets should be installed using manufacturers’ recommendations. For wall mount brackets that can only be installed to a single stud, the bracket might be retrofitted using items readily available from hardware or home improvement stores. However, before starting, ensure that the television is less than approximately 50 kilos (110 pounds, usually 60-inch diagonal screen size or smaller) and that framing studs behind the drywall are not more than 24 inches apart (on centre).
**Structural protections**

Building design and construction can vary greatly. Time of construction and codes used, building shape, materials, usage, maintenance, environment, structural frames and their interconnections all relate to the structural integrity of a building. There are multiple ways to construct a building using different types of systems that will have varying structural resistance to seismic group movements.

To determine your building’s risk for structural damage from an earthquake, consult a licenced and insured structural engineer.

**Fire protection systems**

Fires may follow an earthquake due to broken gas lines, downed power lines, spilling or pooling of fuels or other flammable liquids, chemical hazards, damaged equipment or appliances becoming electrically charged.

- Sprinkler systems in older buildings may lack sufficient bracing to protect the system during an earthquake. Adequate sway bracing of sprinkler systems will help ensure that the system remains operational after a seismic event.

- A fire protection engineer can assist you in providing adequate sway bracing for system risers, cross mains, branch lines, etc., in accordance with the National Fire Protection Association’s NFPA 13 Standard for the Installation of Sprinkler Systems.

- Non-water based automatic fire suppression systems, such as clean agent fire suppression, CO₂, restaurant/cafeteria fire suppression foam, etc. should also be evaluated for proper securement and post-quake functionality. Ensure that suppressant tanks are seismically secured to the building frame.

**Protecting data and data centres**

Both data and data equipment are at risk if businesses do not take steps to protect themselves from an earthquake.

Businesses should consider installation of an uninterruptible power supply (UPS), as power outages are common after an earthquake. A UPS provides battery or other backup that aids in saving data by keeping computer systems running without interruption when the power fails. UPS equipment and automatic transfer switches must all be seismically installed to ensure that they work when needed.

Consider meeting with information technology specialists, earthquake engineers and business continuity experts to determine a solution and plan that best fits your company’s needs. A qualified earthquake engineer should be experienced and familiar with leading standards for the seismic screening, installation, and retrofit of electrical and other data-centre equipment, especially FEMA E-74 and IEEE 693.

See ICLR’s *Mind your business: Protect your data and data centre from earthquakes* (May 2024) for more details.

**Warehouse rack storage**

- Buildings located in at-risk seismic zones with warehouse space that includes open frame/pallet racks must include seismic-rated rack storage that is designed and installed by licensed and insured experts.

- All work should comply with respective building/fire codes, local municipal requirements (if any) and occupational health and safety regulations.

See ICLR’s *Mind your business: Warehouse rack storage and seismic risk* (November 2023) for more details.

**Emergency power**

As power outages become more commonplace in some areas, and as society’s reliance on electricity increases, businesses should consider the installation of a source of backup power, like an emergency generator for the temporary provision of electricity during a power outage.

Emergency generators not only serve to protect life and provide comfort during prolonged service interruptions but can also work to mitigate property damage by preventing the freezing and bursting of pipes in winter and keeping sump pump systems operational when the power is out, to name but two examples.

Emergency power can also dramatically reduce or even eliminate interruptions to business, allowing an operation to continue even when the grid is down.
Businesses are advised to consult with licenced and insured experts when considering the installation of backup power for a commercial operation or institution. An emergency generator must be seismically installed, including the generator, day tank, main fuel tank, starter batteries, fuel lines, automatic transfer switch, and other related electrical equipment. Emergency generators and fuel storage must also be regularly serviced and tested to ensure that they are available when needed.

**Building occupancy resumption program**

If a major earthquake damages your building, it may be hard to secure the services of a structural engineer to evaluate the building’s safety and to design repairs. Municipal building officials commonly perform rapid safety evaluations, but many municipalities lack sufficient resources and familiarity with safety assessment protocols, either of which can delay your return to safe buildings. To avoid these delays, find out if your local building department has adopted a building occupancy resumption program (BORP) and consider enrolling. A BORP allows owners to pre-certify qualified structural engineers for post-earthquake inspection of their buildings. If your municipality lacks a BORP, consider implementing your own unofficial approach by retaining a qualified earthquake engineer who is familiar with rapid post-earthquake safety assessment with ATC-20 and can lead your post-earthquake recovery efforts.

**Learn and practice self-protection**

Your most valuable assets are your employees, contractors, and visitors, who can be hurt if they do not know what to do in an earthquake, or if they panic or misunderstand how to protect themselves when shaking begins. Learn and regularly practice drop, cover, and hold-on self-protective actions by registering for and participating in annual Great ShakeOut earthquake drills. They take only minutes of training and practice each year. See [www.shakeout.org](http://www.shakeout.org) for more information. If you do nothing else to protect your business from earthquake, do this.

**For more guidance**


For more guidance on how to evaluate your building for potentially unacceptable risk, or to direct a contractor, have a trained building professional use the methodology detailed in the National Research Council’s multi-criteria and multi-level seismic risk management framework (level 1 here: [https://doi.org/10.4224/40001929](https://doi.org/10.4224/40001929), level 2 here: [https://doi.org/10.4224/40001931](https://doi.org/10.4224/40001931)). If the screening tools indicate unacceptable risk, engage a structural engineer to design remediation measures and a construction contractor to perform them.

As of this writing, Level-3 retrofit criteria appear to be under development but not yet published. Until that guidance is published, the most prudent retrofit design objective is to make the building meet current code requirements for strength and stiffness, as opposed to some factor less than 1.0. Why? Building-code requirements generally increase over time; retrofitting to a level that would be deficient under current code likely ensures that the retrofit will become even more deficient and require revisiting the work later.