



Tornado Safety



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Tornado Safety and Inspection

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Tornadoes, also known as twisters or cyclones, are whirling columns of air that form with little warning and carve unpredictable paths of destruction through communities worldwide.



America's "Tornado Alley" – roughly the area between the Rocky Mountains and the Appalachian Mountains – where tornadoes kill dozens and cause billions of dollars in damage annually, sustains the majority of these storms. The extreme danger posed by tornadoes to families and their homes justifies the need for InterNACHI inspectors and their clients to learn some basic tips concerning tornado behavior, preparedness, and post-storm damage inspection.

What Causes Tornadoes?

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Tornadoes form from giant storms called supercells, which are fast rotating updrafts created when colder polar air meets warmer tropical air. Changing wind speeds and direction can cause rising air to rotate vertically, creating within the larger supercell what is known as a mesocyclone. For reasons not yet understood, columns of strong rotating air can develop within the mesocyclone, eventually extending from the cloud base to the ground in the form of a tornado. Their size, shape and color vary greatly, from transparent, narrow funnels several hundred feet across to dark wedges wider than they are tall.

Tornadoes damage small areas and thus cause less damage nationwide than hurricanes and tropical storms, but for those caught in their path, tornadoes can wreak havoc unmatched by any other weather phenomenon. Most tornadoes have wind speeds of less than 110 miles per hour and dissipate after several miles, but larger storms can exceed 300 miles per hour and devastate communities hundreds of miles apart.

Facts and Figures

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- Of the 50 states, Florida experiences the most tornadoes per unit area, while Oklahoma is hit by the strongest tornadoes per unit area. Bangladesh, due to its poor building construction and general lack of tornado awareness, has the highest annual tornado death toll of any country.
- Tornadoes in the northern hemisphere generally rotate in a counterclockwise direction, while the opposite is true in the southern hemisphere.
- Supercells spawn land tornadoes. Dust devils and gustnadoes appear similar to tornadoes but they are distinct and far less dangerous phenomena.
- A waterspout is a relatively weak tornado that forms over water as a result of cumulus congestus clouds.
- Tornadoes are intense and can be long-lived. Consider the following extremes:
 - The Bridge Creek-Moore tornado that happened just outside Oklahoma City in 1999 had winds of 301 mph, the highest wind speed ever recorded.
 - The Great Bend tornado in Kansas that occurred in 1915 hurled a sack of flour 110 miles and a cancelled check 305 miles.
 - In 1925, the nicknamed Tri-State Tornado that affected Missouri, Illinois and Indiana holds three records for traveling 219 miles at 73 mph and killing 295 people.

Classifications

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Tornado strength is categorized by the following Enhanced Fujita Scale, whereby the storm receives an "F" rating from 0 to 5 based on the severity of the inflicted damage:



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- EF0: The weakest type of tornado can cause superficial damage to structures and vegetation.
- EF1: This rated tornado can cause major roof damage, with mobile homes seriously damaged.
- EF2: This stronger tornado may result in roof loss and wall collapse, with mobile homes destroyed and smaller trees uprooted.
- EF3: This is the maximum level that allows for reasonably effective residential sheltering in a first-floor interior room. Small cars can become projectiles and large trees can be snapped.
- EF4: At this level, most homes are completely destroyed, leaving a pile of debris on the foundation. A storm shelter is required to ensure safety. Trains and large trucks can be pushed over, and cars and large trees can be flung long distances.
- EF5: As the result of this strongest and most dangerous tornado, well-built homes can be lifted from their foundations and shredded in mid-air, then dispersed as coarse granules over large areas. Large trucks and farm equipment can be smashed into their components parts, skyscrapers may actually be deformed, and entire communities may be leveled. At a rate of occurrence of just 0.1%, EF5 tornadoes are extremely rare, yet they have caused more than 20% of all tornado casualties.

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While no two tornadoes are alike, the anatomy of a tornado's attack on a house is as systematic as it is fierce and is defined as "a progressive failure [that] begins top-down, then outside-in," according to Timothy Marshall, a tornado expert who writes for *Popular Mechanics*. Within the first second, pummeling debris tears away a structure's roof shingles and decking, while wind shatters and rushes through windows and raises the internal pressure. The upward force of the wind on the underside of the already weakened roof, combined with the uplift forces above the roof caused by the high wind, quickly overcome the relatively weak connections between the roof and the walls. The roof tears away from the house, leaving the exterior walls unsupported. In another second, the exterior walls blow out – first, the side walls parallel to the straight-line winds, followed by the windward wall, and finally the back wall – leaving the interior walls unprotected against the maelstrom. An EF4 tornado needs only four seconds to wipe a foundation clean.

Myth vs. Fact

Knowing what not to do can be just as essential as taking the proper safety precautions. Misconceptions concerning tornadoes persist in the media, which may lead to avoidable damage and even unnecessary injuries and deaths.

InterNACHI would like to dispel the following tornado myths that may harm building occupants:

- MYTH: Open windows to equalize the barometric pressure between the interior and the exterior pressure caused by a nearby tornado, thereby preventing damage to the building.

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FACT: While a pressure imbalance does exist, it is not great enough to cause a building to explode outward, as was once hypothesized. Damage is primarily caused where wind breaches the building from the outside, which is why windows and other openings should remain closed. Moreover, openings on the windward side of a building actually increase internal wind pressure, resulting in additional uplift force on the roof.

- **MYTH:** The safest location in a house is its southwest corner.

FACT: This notion originated in the 1887 text *Tornadoes*, from which it became conventional wisdom until a 1966 study indicated that the southwest corner is actually the most dangerous place to be during a tornado. The safest part of a structure during a tornado is the lowest central room, especially a bathroom or the area beneath a stairwell.

- **MYTH:** Tornadoes always travel in a northeasterly direction.



FACT: While in most areas, tornadoes tend to follow their parent storms to the northeast, they may stop, change direction, or suddenly backtrack, seemingly at random. Local geography plays a part, too, such as in Minnesota, where tornadoes sometimes travel northwest, and in coastal south Texas, where they sometimes travel southeast.

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- MYTH: Tornadoes are “attracted to” mobile homes.

FACT: The inordinate severity of damage inflicted on trailer parks, compared to conventional homes, can be attributed to the weakness of the building materials commonly used in mobile homes, their lack of foundations, and their small size.

- MYTH: Large auditoriums are safer during tornadoes than houses.

FACT: Many studies have concluded that large-span structures, such as auditoriums and gymnasiums, are vulnerable to high winds because of their high surface area. As such, these buildings should be avoided.

- MYTH: Tornadoes do not strike cities.

FACT: This myth is based on the comparatively small area occupied by downtown areas, which make them uncommon targets for tornadoes. Also, the urban heat-island effect may discourage the formation of weaker tornadoes. Significant tornadoes are unaffected by turbulent warm air, however, and EF4 and EF5 tornadoes have struck Atlanta, Georgia, Lubbock, Texas and even London, England.

- MYTH: Mountains, lakes and rivers are significant barriers against tornadoes.

FACT: Tornadoes have formed over rivers and lakes, and more than a dozen have crossed over the Mississippi River. Twisters have been observed as high as 12,000 feet (3,700 meters) above sea level and ascend 3,000-foot (910 meter) ridges without slowing down.

Damage to Homes

Specifically, the following elements should be inspected for damage:

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- gas leaks. Uprooted trees may have damaged underground gas pipes, which can lead to deadly fires;
- electrical damage. Electrical equipment should be dried and checked before being returned to service. If you see sparks or broken or frayed wires, or if you smell burning insulation, turn off the electricity at the main fuse box or circuit breaker. If you have to step in water to get to the fuse box or circuit breaker, call a utility repairperson or an electrician first for advice;
- plumbing. Tornadoes can easily shake and rattle a home, causing plumbing lines to twist and crack. Following the storm, homeowners can check their plumbing by turning on all plumbing fixtures, checking cabinets for signs of water damage, and checking ceilings from below for staining. Avoid using toilets if sewage lines have been damaged;
- roof and siding. Cracking, tears and gouges caused to the roof and siding by flying debris will eventually allow for the entry of rainwater and snowmelt. Gable roofs are especially vulnerable to damage from the high wind generated by tornadoes. For additional support, attach wall studs to roof rafters using hurricane clips, not nails;
- chimney damage. Chimney damage may slow or stop the ventilation of carbon monoxide (CO) – a poisonous, colorless, odorless and tasteless gas – allowing it to accumulate in the living area. Inspect the chimney closely for damage in a tornado-damaged house. For more information, read InterNACHI's article on chimney inspection;
- windows and gutters. Flying debris can smash windows, damage windowpanes and shutters, rip screens, and dent or tear away gutters;
- foundation. Strong winds can cause foundations to uplift. Check the perimeter of crawlspaces for any changes and inspect masonry for signs of separation or cracking;

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- interior. Inspect for stress cracks in the corners where walls and ceilings meet, and especially the areas above windows and doors. Use a level to check for cupping of the floor and bowing of the walls. Water stains and mold on interior walls may appear some time after the tornado, indicating overlooked damage to the roof that has permitted moisture intrusion; and
- garage doors. Due to their large surface area, garage doors can be damaged or blown in before other parts of the house are damaged. The wind may then damage the interior and accelerate the home's collapse. Garage door system technicians can be hired to install horizontal bracing, impact-resistant coverings, and strengthen weak hinges and glider wheel tracks. Old or damaged doors should be replaced.

Tips for Clients

If a tornado is in your area, immediately take shelter indoors, preferably in a basement or first-floor room, closet, hallway, or the void beneath a stairwell. Bathrooms are generally safe, as plumbing fixtures strengthen the walls and anchor them to the ground, and bathtubs can protect against flying debris. Crouch face down beneath a heavy table or workbench, and cover your head with your hands to protect against falling debris. Do not leave the building until the storm has passed. If possible, cover yourself with some sort of thick padding, such as blankets or a mattress.

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Also, avoid the following areas:

- rooms with many windows. Before any other part of the house fails, windows typically shatter and allow the entry of dangerous projectiles, such as broken masonry and gravel, in addition to glass shards from the window itself;
- rooms with exterior walls. Exterior walls will fail before interior walls, which often survive intact;
- under heavy objects that are located on the floor above. A piano or refrigerator may fall through a weakened floor and crush anything below; and
- mobile homes. Only 10% of Americans live in mobile homes but nearly half of all tornado fatalities happen in them. Mobile homes that are not tied down can be flipped in 60- to 70-mph winds, and even small tornadoes can cause them to completely disintegrate, leaving occupants unprotected. Leave a mobile home immediately and seek shelter elsewhere. If none can be found, lie flat in the nearest ditch with your hands shielding your head.

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Inspectors may pass on the following tips to their clients:

- Watch for atmospheric conditions that accompany tornadoes, such as a dark, greenish sky, large hailstones, a cloud of debris, a roaring noise, or a lowering, spinning storm cloud.
- Monitor the Emergency Alert System (EAS) on the radio or TV and listen for tornado advisories. A tornado watch means that conditions are favorable for a tornado to form, while a tornado warning means a tornado has been sighted or detected on radar.
- If a tornado is approaching, shut off the water either at the main meter or at the water main that leads into the home.
- Before a storm, shut off the electricity, as sparks from electrical switches could ignite gas and cause an explosion.
- Keep all hazardous materials, such as poisons and chemical solvents, stored in a secure area away from emergency food and water supplies.
- Arrange furniture so that chairs and beds are away from windows, mirrors and picture frames.
- Secure top-heavy, freestanding furniture, such as bookcases and China cabinets, with L-brackets, corner brackets, eyebolts, flexible cable or braided wire, and place heavy items on the bottom shelves. This is an advisable safety precaution in general for families with small children and those who reside in earthquake-prone regions.
- Keep a disaster supply kit on hand. It should include a first-aid kit, a flashlight with extra batteries, essential medicines, a battery-operated radio, emergency food and water, and a hand-held can opener.
- Following a storm, do not use matches, lighters or appliances or operate light switches until you are sure there are no gas leaks. If you smell gas or hear a hissing noise, open a window and leave the building as quickly as possible. Turn off the gas at the outside main valve if you can and call the gas company from a neighbor's home. Wait for a professional to turn the gas back on.

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In summary, tornadoes are devastating and unpredictable, but a little knowledge concerning their basic behavior can save lives. Inspectors and their clients can benefit by being aware and prepared in order to protect both their families and their properties.