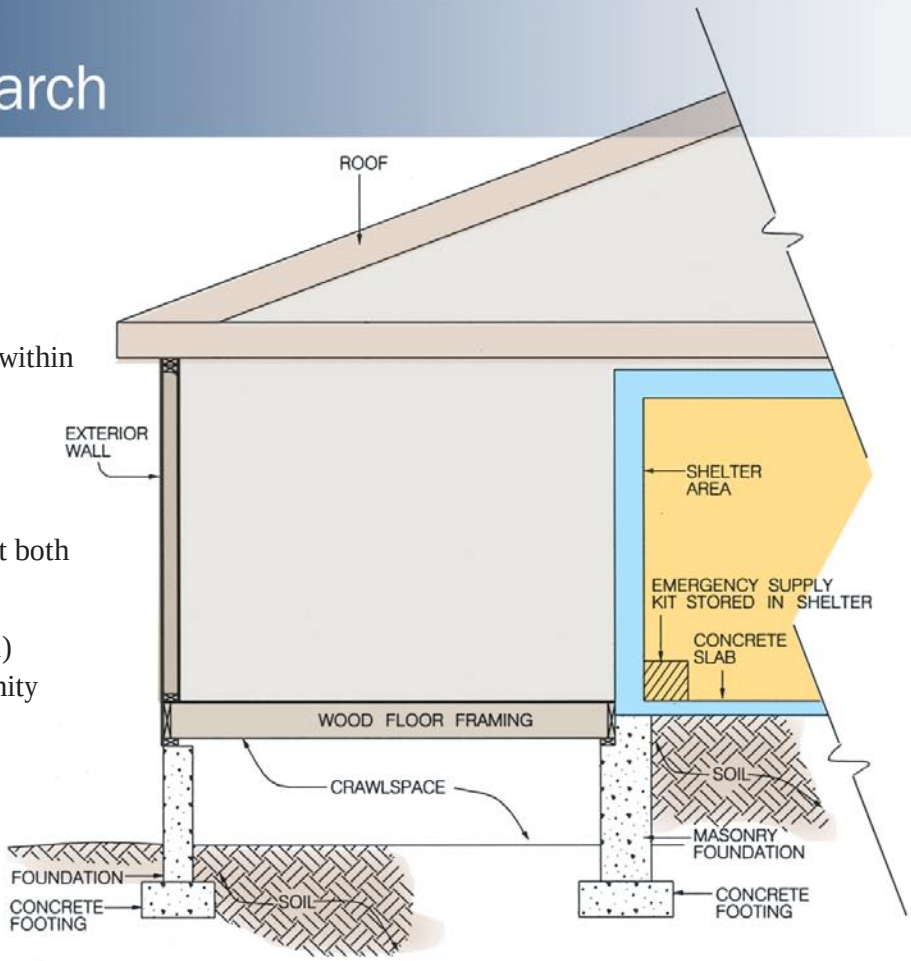
Residential Safe Rooms

Background and Research

March 2003

FEMA

What is a Wind Shelter?

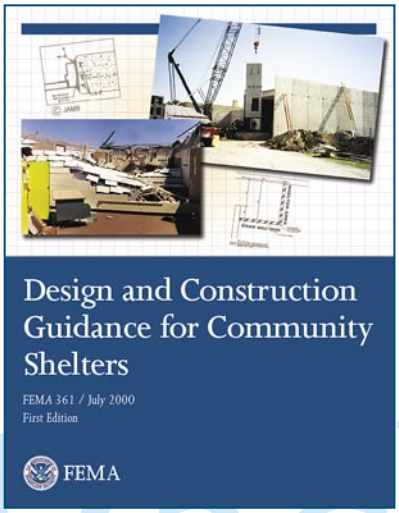


A wind shelter is an interior room or other space within a building, or even an entire separate structure, that is designed and constructed to protect its occupants from high winds, usually those associated with tornadoes or hurricanes. Wind shelters are intended to provide protection against both wind forces and the impact of windborne debris.

Wind shelters typically fall into two categories: (1) residential safe rooms or shelters and (2) community shelters.

A residential safe room is a small, specially designed ("hardened") room, such as a bathroom or closet, or other space within the house that is intended to provide a place of refuge only for the people who live in the house. A residential shelter is similar in that it is intended to for use only by the occupants of a house, but it is a separate structure, often installed outside the house either aboveground or belowground. In contrast, a community shelter is intended to provide protection for a large number of people, anywhere from 12 to as many as several hundred.

Community shelters are usually built within or near large public, institutional, or commercial buildings such as schools, hospitals, and nursing homes. A community shelter can also be built in a neighborhood to provide protection for residents whose homes lack shelters. Although community shelters are designed to accommodate large numbers of people, they are not recovery shelters. In other words, they are not intended to provide housing for people whose homes have been damaged or destroyed during disasters.



FEMA 361

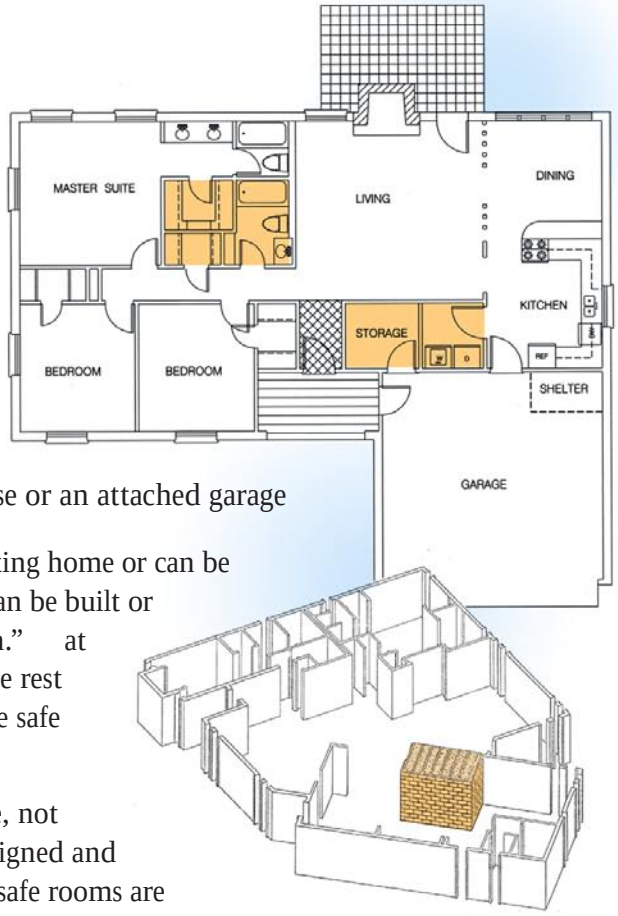
Community shelters and residential safe rooms and shelters are alike in that they are intended to provide protection only during a short-term, high-wind event (i.e., an event that lasts no more than 36 hours, such as a tornado or hurricane). In other ways, however, they are quite di erent.

is brochure focuses on residential safe rooms. For more information about community shelters, refer to the separate FEMA brochure Community Wind Shelters and to FEMA publication 361, *Design and Construction Guidance for Community Shelters*.

Types of Residential Safe Rooms

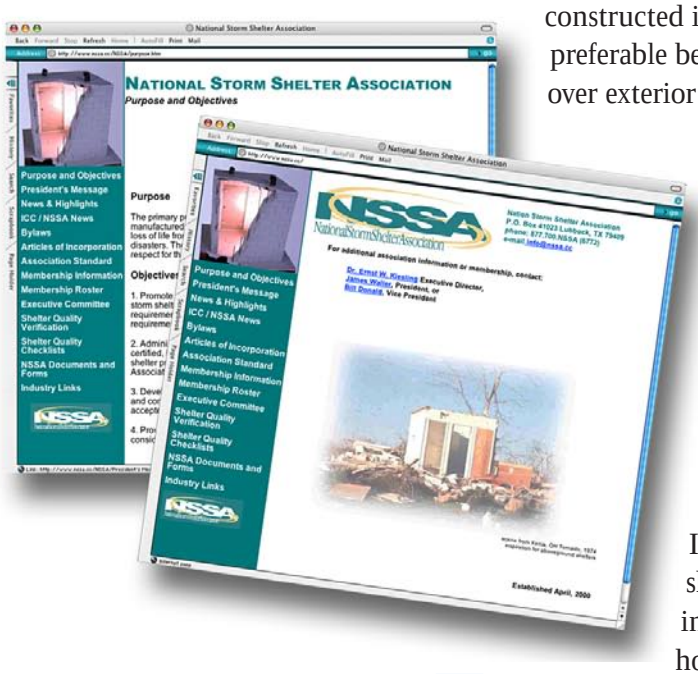
Residential safe rooms can take several forms:

- a room that normally serves another purpose, such as a bathroom or closet, and that has been strengthened (or "hardened") to resist wind forces and the impacts of windborne debris
- a room specifically designed and constructed to serve as shelter space only
- an underground space created beneath the floor of a house or an attached garage



In general, residential safe rooms can be built onsite in a new or existing home or can be manufactured units delivered to the site and installed. A safe room can be built or installed anywhere in a house, but it must be a "room within a room." at is, it's walls, ceiling, and floor must be structurally separate from the rest of the house, so that even if the surrounding house is destroyed, the safe room will remain intact.

is brochure focuses on safe rooms built or installed inside a house, not on shelters built or installed elsewhere on the property. Properly designed and constructed in-residence safe rooms are preferable because they o er several advantages over exterior shelters:

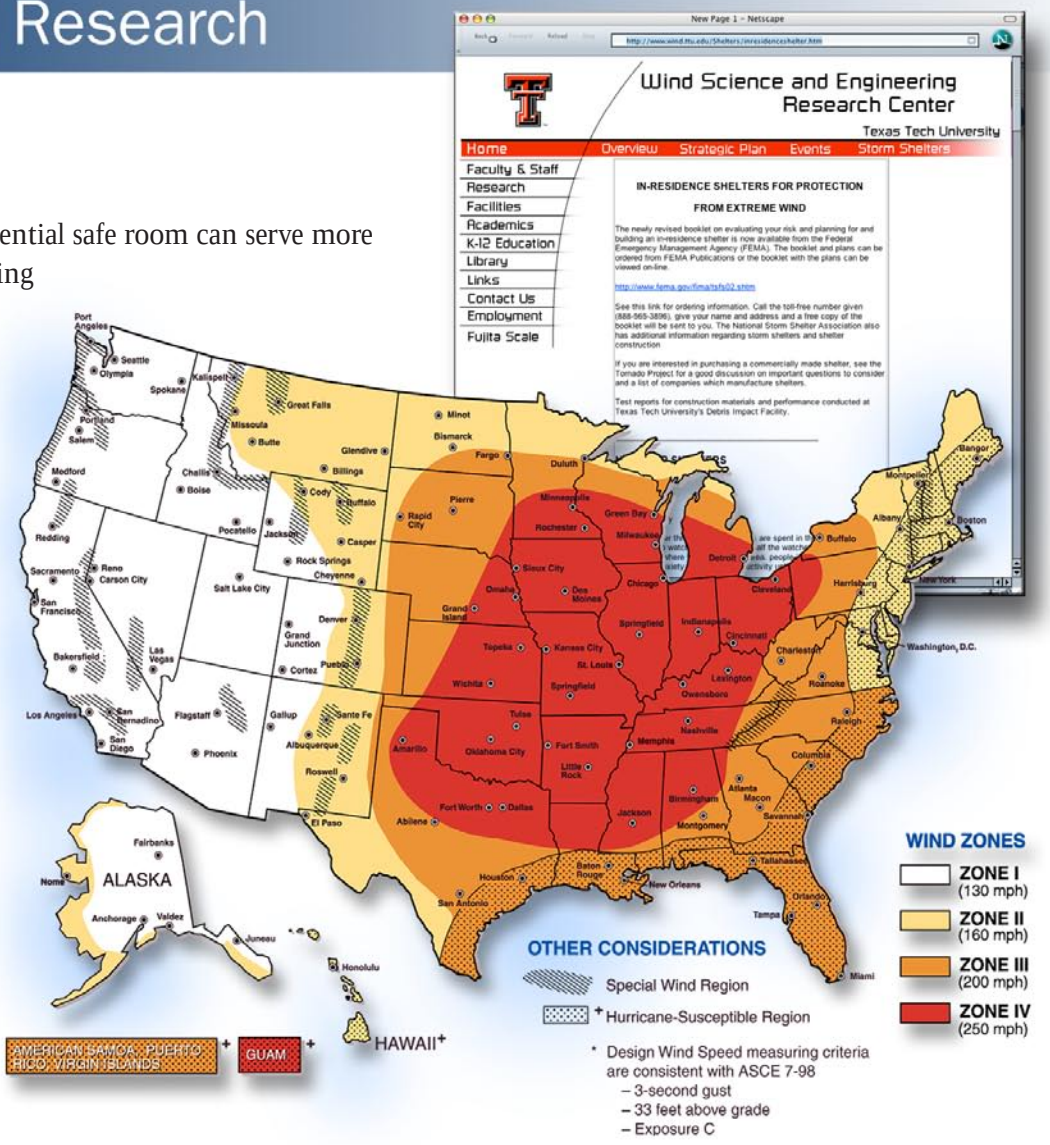


- e occupants of a house equipped with an internal safe room can reach the shelter without having to leave the house and risk exposure to high winds and debris, lightning, or other storm conditions.
- An internal safe room can be reached more quickly and easily.
- For those reasons, the occupants of a house with an internal safe room are more likely to protect themselves adequately.

In some situations, however, building or installing an exterior shelter may be the only practical choice. For example, incorporating an in-residence safe room into an existing house may be impractical when extensive modifications to the structure of the house are necessary. For manufactured homes, an exterior shelter is usually the only practical solution. FEMA has not developed designs for exterior shelters, but the National Storm Shelter Association (NSSA) can provide information about exterior shelters that meet the engineering requirements established by FEMA. Visit the NSSA website at http://www.nssa.cc/.

As mentioned earlier, a residential safe room can serve more than one purpose. Hardening a bathroom or closet to serve as a safe room makes more e cient use of space than building a room that serves as a safe room only. In smaller homes, providing for alternative safe room uses can be an important consideration.

Additional information about in-residence safe rooms, including design, construction, and related publications is available on the Texas Tech University website at http://www.wind.ttu.edu/Shelters/inresidenceshelter.htm.

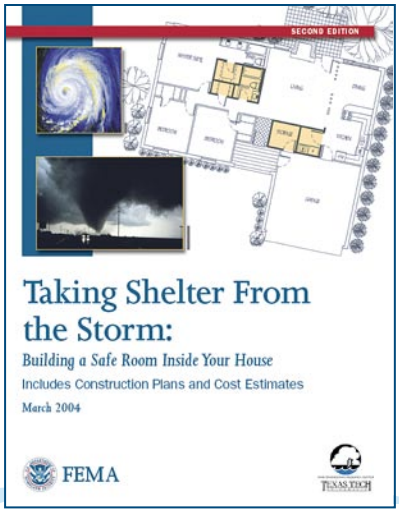


Wind Zones in the United States*

Where Are Safe Rooms Needed?

In areas subject to extreme-wind events, homeowners should consider building a residential safe room. As noted in the following sections, wind hazards, such as those associated with tornadoes and hurricanes, vary throughout the United States. e decision to build a safe room will be based largely on the magnitude of the wind hazard in a given area and on the level of risk considered acceptable.

FEMA Publication 320, Taking Shelter From the Storm: Building a Safe Room Inside Your House, contains tornado and hurricane statistics, wind speed and wind hazard data, a homeowner risk assessment worksheet, construction drawings for various types of residential safe rooms, and other information that will help a homeowner assess the risk in a specific area, determine the need for a safe room, and choose a safe room design. e construction drawings include all the information a contractor would need to build a safe room that provides adequate protection from the most severe wind events.



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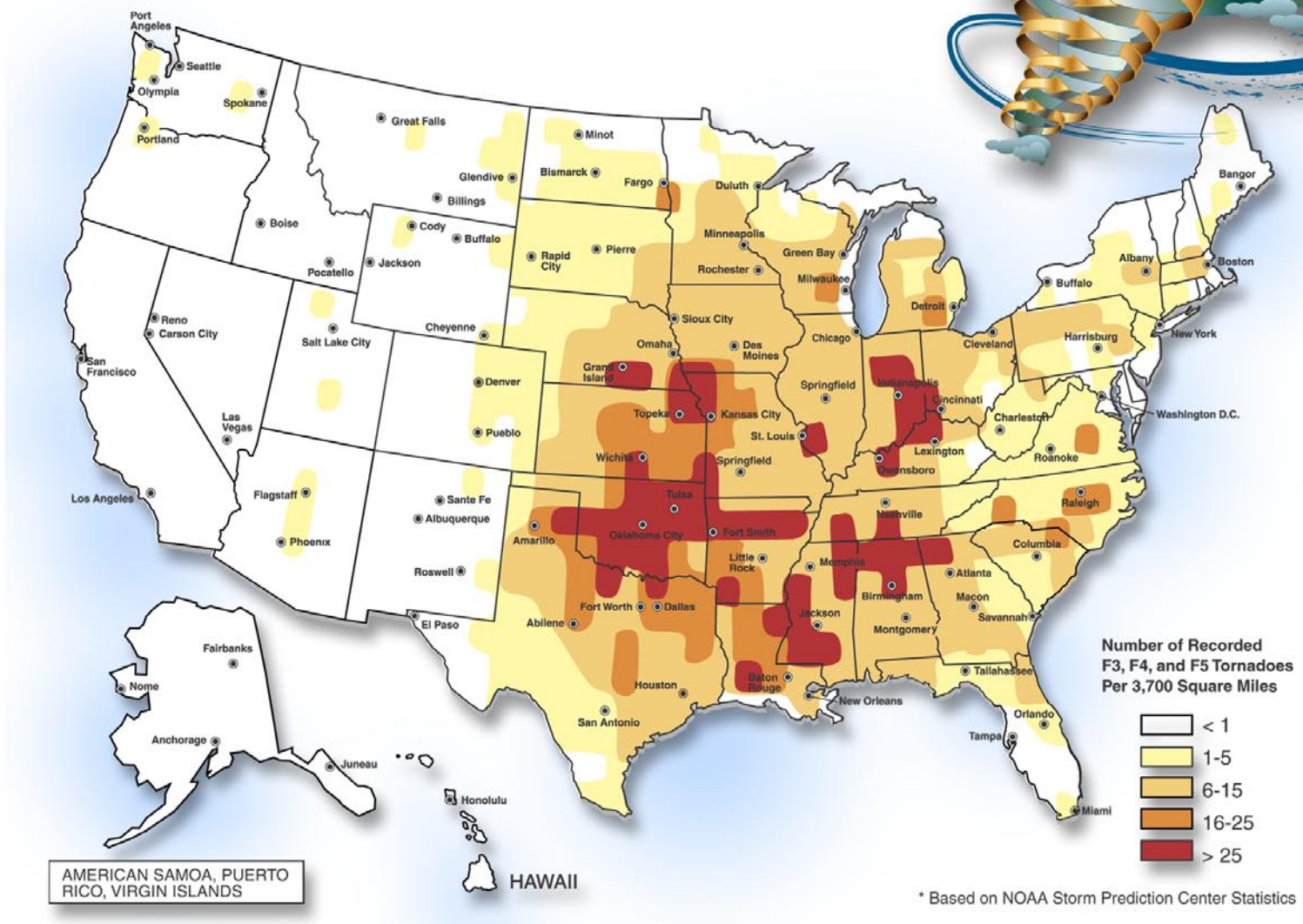


Tornadoes – Understanding the Hazards

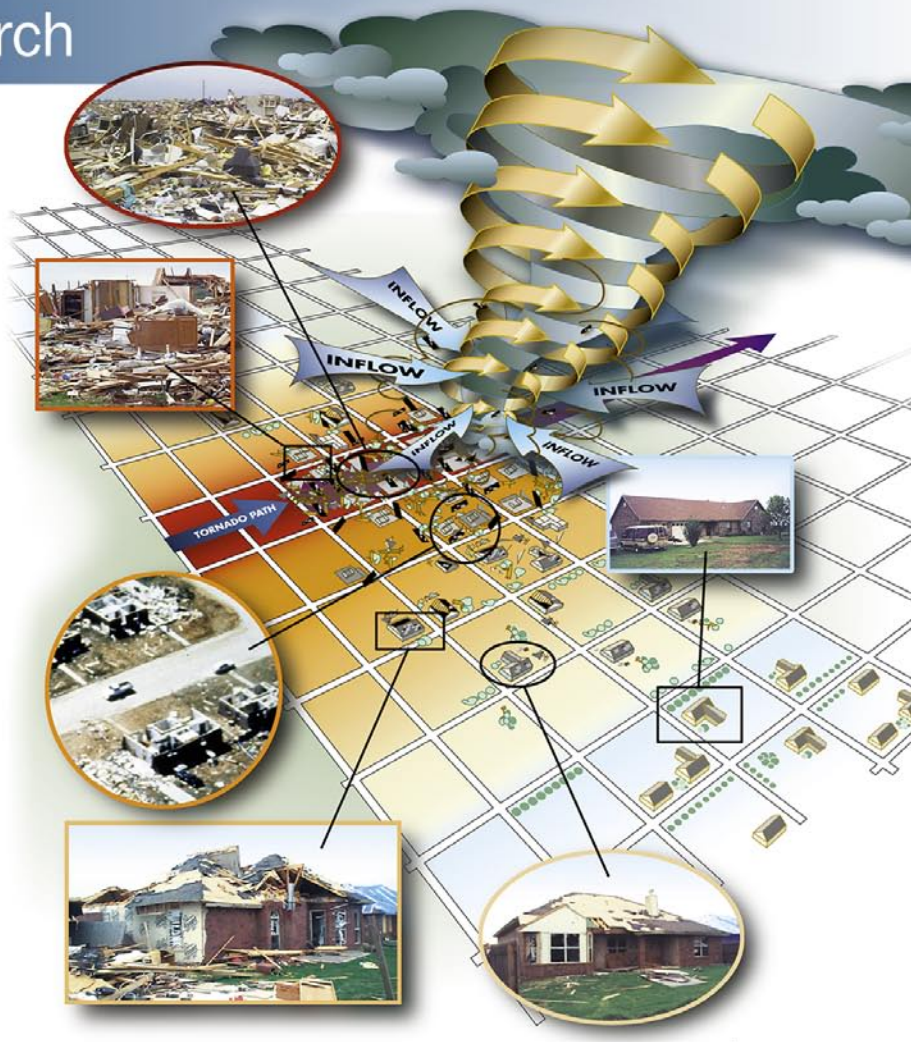
A tornado is a violently rotating column of air that extends from a thunderstorm cloud to the ground. On average, more than 1,200 tornadoes have been reported nationwide each year since 1995. Since 1950, tornadoes have caused an average of 89 deaths and 1,521 injuries annually, as well as devastating personal and property losses. As shown by the map, tornadoes occur primarily in the central and eastern portions of the United States.

Tornadoes are rated by the National Weather Service according to the Fujita Damage Scale. Fujita ratings vary from F0, for light damage, to F5, for total destruction.

All tornadoes produce high winds and carry windborne debris that can pose a danger to lives and property. Violent tornadoes (those rated F4 and F5) are capable of tremendous destruction with wind speeds of up to 250 mph near ground level. Violent tornadoes can rip buildings from their foundations, and the debris carried by their winds can easily break windows and even penetrate the walls or roof of a building.

A **tornado watch** is issued to alert people to the possibility of tornado development in an area. A **tornado warning** means that a tornado has been spotted, or that Doppler radar indicates a thunderstorm circulation that can spawn a tornado.

Potential Impact and Damage From a Tornado

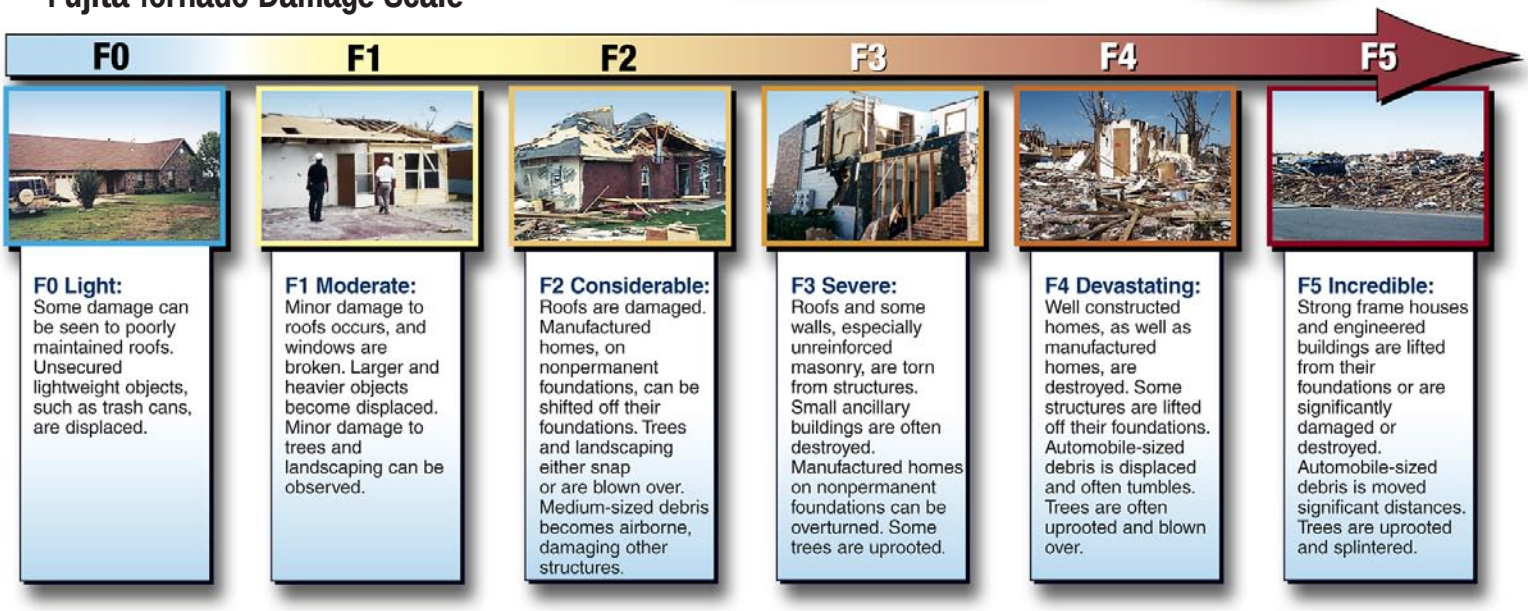


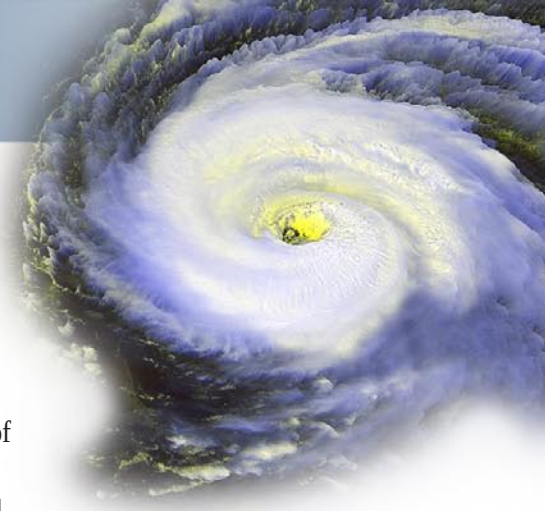
Tornado damage paths over 50 miles long and over 1 mile wide have been reported. A good example of the destructiveness of tornadoes is the damage caused by the 67 tornadoes that struck Oklahoma and Kansas on May 3, 1999, which included many F4 and F5 tornadoes.

This tornado outbreak resulted in 49 deaths and leveled entire neighborhoods.

Additional information about the Oklahoma and Kansas tornadoes is available in the FEMA Building Performance Assessment Team report Midwest Tornadoes of May 3, 1999, FEMA 342.

Fujita Tornado Damage Scale





Hurricanes – Understanding the Hazards

A hurricane is a type of tropical cyclone (the general term for all weather systems that circulate counterclockwise in the Northern Hemisphere over tropical waters) originating in the Atlantic Ocean, Caribbean Sea, or Gulf of Mexico. Around the core of a hurricane, winds can grow with great velocity. As the storm moves ashore, it can push ocean waters inland while spawning tornadoes and producing torrential rains and floods.

On average, 10 tropical storms (6 of which become hurricanes) develop each year in the Atlantic Ocean. Approximately five hurricanes strike the United States mainland every 3 years; two of those storms will be major hurricanes (Category 3 or greater on the Sa r-Simpson Hurricane Scale).

Saf r-Simpson Hurricane Scale

In the western Pacific, hurricanes are called typhoons and a ect the Pacific Islands, including Hawaii, Guam, and American Samoa. Historically, typhoons have been classified by strength as either typhoons (storms with less than 150 mph winds) or super typhoons (storms with wind speeds of 150 mph or greater) rather than by the Sa r-Simpson Hurricane Scale.

When a hurricane threatens, weather services issue hurricane watches and warnings.

A **hurricane watch** is issued when a hurricane is possible within 36 hours.

A **hurricane warning** is issued when a hurricane is expected within 24 hours. An evacuation notice may be issued in conjunction with a hurricane warning.

Although the highest wind speeds associated with hurricanes are not as great as those of the most severe tornadoes, hurricane winds and the debris they can carry are still extremely dangerous. e loss of life and property from hurricane-generated winds can be staggering. An example of a hurricane that caused severe wind damage is Hurricane Andrew, which made landfall in southeastern Florida in August 1992, generating strong winds and heavy rain over a vast portion of southern Dade County. e high winds associated with this Category 4 storm (131 mph to 155 mph) caused extensive damage in areas well beyond the reach of storm surge – areas where building or installing a residential safe room would be an appropriate and e ective means of providing protection from high winds and windborne debris.

Safe Room Strength – Testing and Design

For FEMA, the goal of safe room design and construction is to provide "near-absolute protection" from the forces of winds and debris during a storm with winds as high as 250 mph.
A safe room that provides near-absolute protection will protect its occupants from death and injury; the safe room itself, however, may be damaged by high winds or debris. As a result, repairs to the walls, ceilings, and door of a safe room may be necessary after an extreme-wind event.

Clearly, to provide the desired level of protection, a safe room needs an extremely strong structure to resist high-wind forces and an extremely resistant envelope (walls, roof, and floor) to resist the impact of windborne debris. To support the development of adequate safe room designs, the Wind Engineering Research Center of Texas Tech University conducted extensive laboratory tests of safe room construction materials. e testing program included determining wind pressure and debris impact loads resulting from various wind speeds and testing the ability of building materials (roof and wall sections, doors, and door hardware) to resist those loads and impacts.