Community Wind Shelters

Background and Research

August 2002

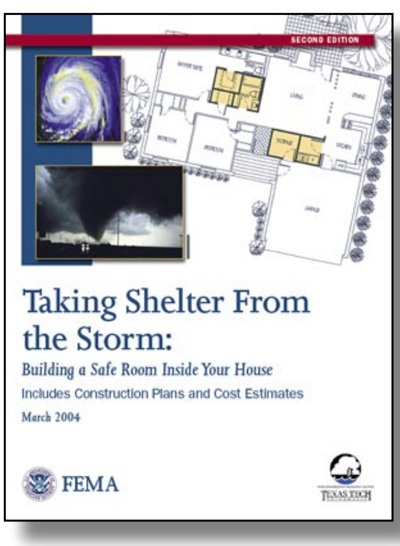
FEMA

Community Wind Shelters

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.



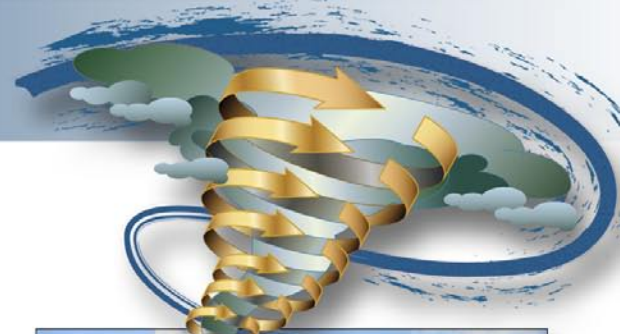
FEMA 320

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.

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 different. This brochure focuses on community shelters. For more information about residential safe rooms and shelters, refer to the separate FEMA brochure Residential Safe Rooms and to FEMA Publication 320, *Taking Shelter From the Storm: Building a Safe Room Inside Your House*.

Types of Community Shelters

A community shelter can be constructed as a separate building (stand-alone shelter) or as a room or area within a larger building (internal shelter). An example of a stand-alone shelter would be a building constructed in a central location within a single-family home neighborhood or manufactured home park. An internal shelter could be a specially constructed hallway, cafeteria, restroom, or multi-purpose room in a school, hospital, airport, or other large building.



In general, internal shelters are preferable because they offer several advantages over stand-alone shelters. The occupants of a building equipped with an internal shelter do not need to leave the building and will not have to risk exposure to high winds, windborne debris, lightning, or other storm conditions. Another advantage is that building occupants will be able to reach an internal shelter more quickly and easily. As a result, people threatened by a high-wind event are more likely to protect themselves adequately when a shelter is available within their building. In some situations, however, the construction of a stand-alone shelter may be the only practical choice. For example, incorporating an internal shelter into an existing building (retrofitting) may be impractical when extensive modifications to the structure or layout of the building would be necessary.

Both stand-alone and internal shelters can be single-use or multi-use structures. **Single-use** shelters are used as shelter space only. The advantages of single-use shelters include the following:

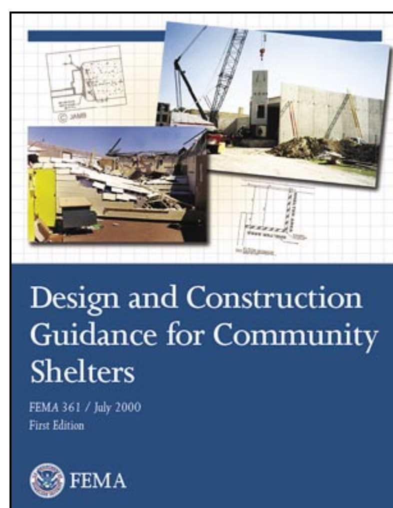
- simplified design that may be readily approved by a local building official or fire marshal
- simplified electrical and mechanical systems, because they are not required to provide normal daily accommodations for people
- no space lost to furnishings, stored materials, and other contents not related to the shelter function

Multi-use shelters are designed to serve other purposes in addition to providing shelter space. Examples of multi-use shelters are meeting rooms, exercise rooms, cafeterias, gymnasiums, libraries, restrooms, and hallways. The advantages of single-use shelters include the following:

- immediate return on investment for owners/operators
- efficient use of building space
- lower additional cost for a shelter, because the room is also used for another purpose

Where are Community Wind Shelters Needed?

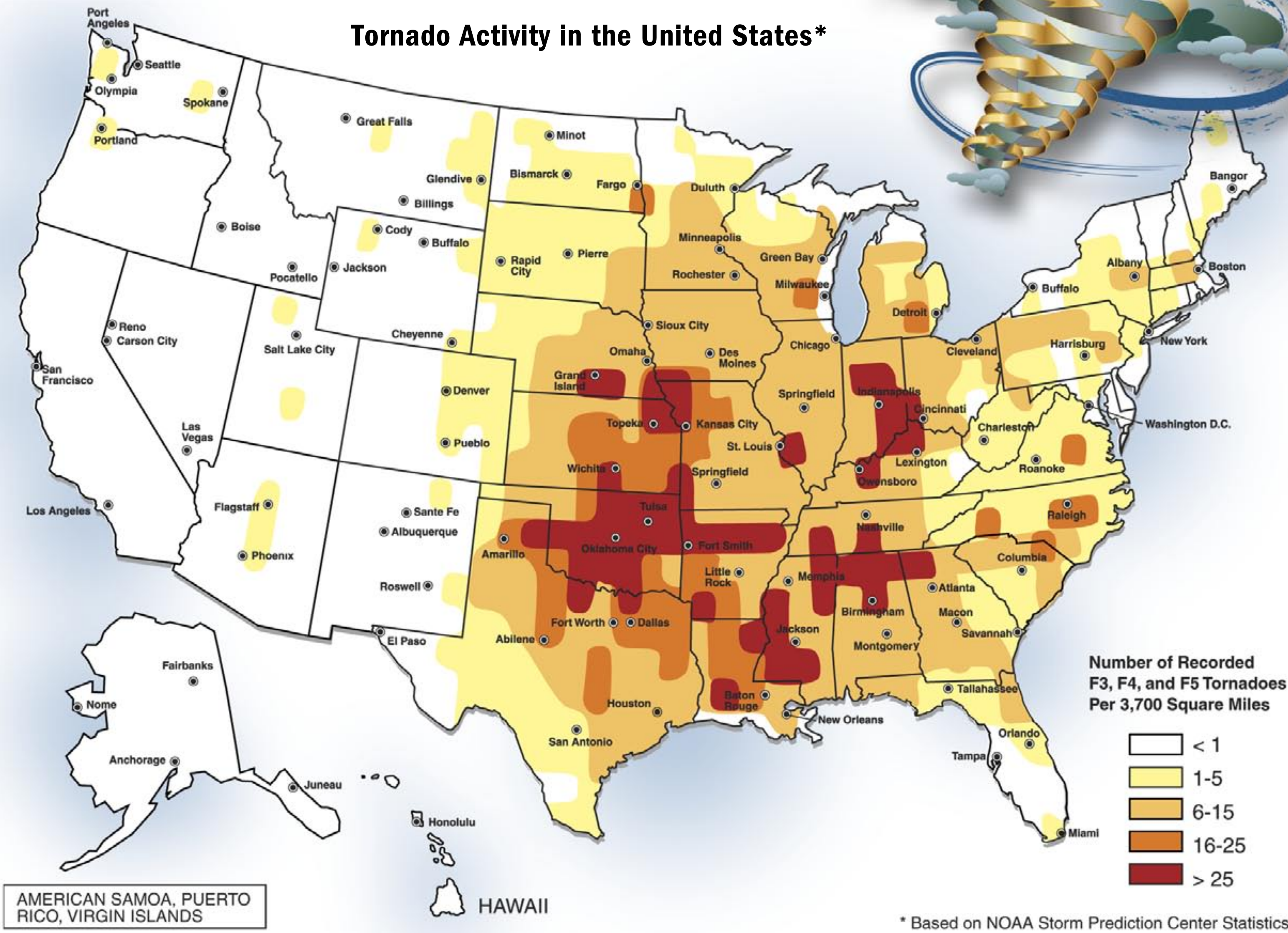
In areas subject to extreme-wind events, building owners, school and hospital administrators, neighborhood associations, and other individuals and organizations with responsibilities for public safety should consider building a community shelter. As noted in the following sections, wind hazards, such as those associated with tornadoes and hurricanes, vary throughout the United States. The decision to build a wind shelter will be based largely on the magnitude of the wind hazard in a given area and on the level of risk considered acceptable.



FEMA 361

FEMA publication 361, Design and Construction Guidance for Community Shelters, contains tornado and hurricane statistics, wind speed and wind hazard data, a shelter benefit-cost model on CD-ROM, evaluation checklists for potential shelter areas in existing buildings, and other information that will help the reader assess risks in a specific area, determine the need for a shelter, and decide where and how a shelter should be built.

Tornado Activity in the United States*



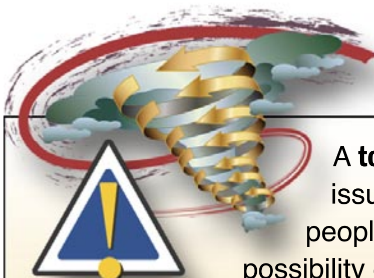
* Based on NOAA Storm Prediction Center Statistics

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.

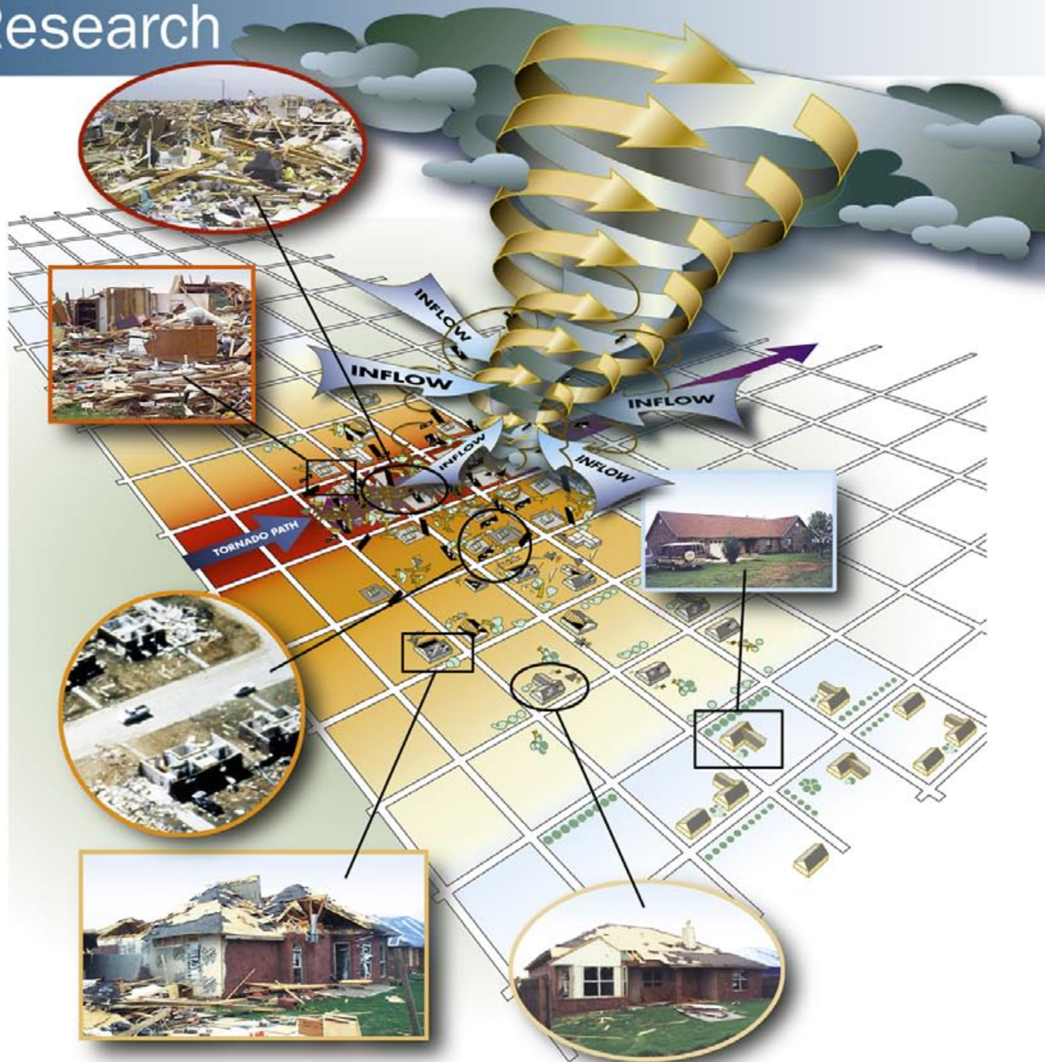


A **tornado watch** is issued to alert people to the possibility of tornado development in an area. A **tornado warning** means that a tornado has been spotted, or that Doppler radar indicates a thunderstorm circulation that can spawn a tornado.

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 Damage Scale

F0 | F1 | F2 | F3 | F4 | F5

F0 Light: Some damage can be seen to poorly maintained roofs. Unsecured lightweight objects, such as trash cans, are displaced.

F1 Moderate: Minor damage to roofs occurs, and windows are broken. Larger and heavier objects become displaced. Minor damage to trees and landscaping can be observed.

F2 Considerable: Roofs are damaged. Manufactured homes, on nonpermanent foundations, can be shifted off their foundations. Trees and landscaping either snap or are blown over. Medium-sized debris becomes airborne, damaging other structures.

F3 Severe: Roofs and some walls, especially unreinforced masonry, are torn from structures. Small ancillary buildings are often destroyed. Manufactured homes on nonpermanent foundations can be overturned. Some trees are uprooted.

F4 Devastating: Well constructed homes, as well as manufactured homes, are destroyed. Some structures are lifted off their foundations. Automobile-sized debris is displaced and often tumbles. Trees are often uprooted and blown over.

F5 Incredible: Strong frame houses and engineered buildings are lifted from their foundations or are significantly damaged or destroyed. Automobile-sized debris is moved significant distances. Trees are uprooted and splintered.

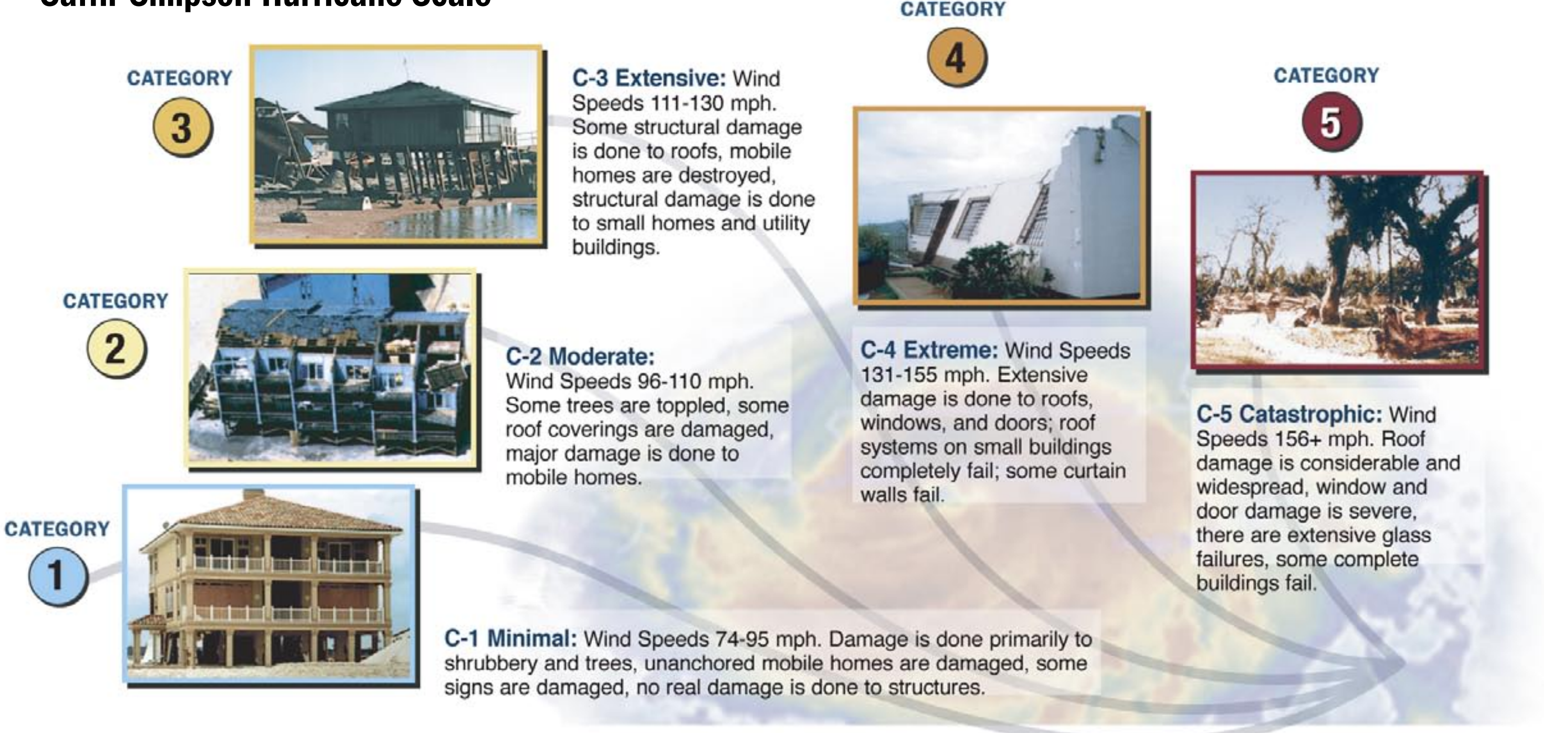
Hurricanes – Understanding the Hazards

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 Saffir-Simpson Hurricane Scale.

In the western Pacific, hurricanes are called typhoons and affect 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 Saffir-Simpson Hurricane Scale.

Saffir-Simpson Hurricane Scale



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. The 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. The 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 a community shelter woud be an appropriate and effective means of providing protection from high winds and windborne debris.

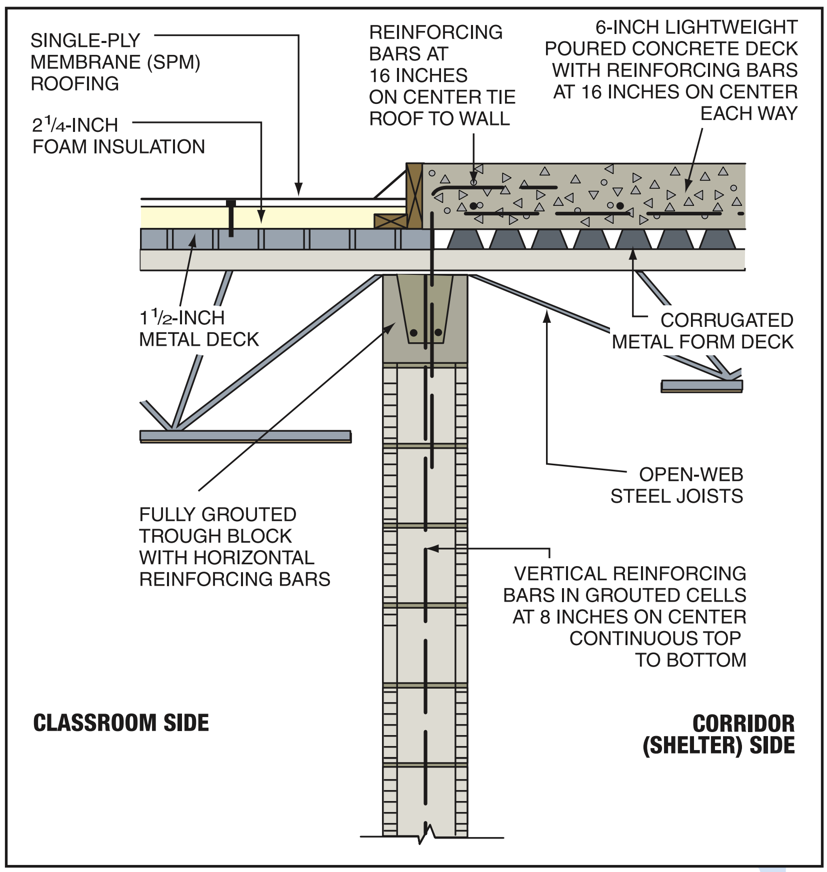
Shelter Strength

Clearly, to survive a tornado or hurricane, a building needs an extremely strong structure—to resist high-wind forces—and an extremely resistant envelope (the "skin" of the building)—to resist the impact of windborne debris. The results of research presented in FEMA 361 show that a shelter that can withstand 250-mph winds and the impact of a 15-pound 2x4 traveling at 100 mph will provide "near-absolute protection" for its occupants in virtually any high-wind event.

A shelter that provides **near-absolute** protection will protect its occupants from death and injury. This term does not mean that the shelter itself will be undamaged by high winds or debris. Repairs to a shelter's walls, ceilings, and doors may be necessary after a extreme-wind event.

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.

For the goal of near-absolute protection to be met, the entire shelter—including its walls, ceilings, and doors—must be designed and constructed to provide the required strength and impact resistance. Shelter designs typically call for larger, stronger, and a greater number of construction materials such as concrete bocks, reinforcing rods, connectors, and door hardware. Openings into the shelter area, such as windows, must be eliminated or kept to a minimum. When present, they must be protected with shutters or other coverings of adequate strength and impact resistance. Shelter design and construction must also consider other potential natural hazards at the site, such as flooding and earthquakes.



FEMA 361 contains examples of shelter design plans that include construction details and materials lists.

Other Considerations

Although essential to successful performance, strength is not the sole consideration in shelter design and construction. Shelters must also:

- be readily accessible
- be sited to minimize hazards
- provide for the comfort of their occupants
- be equipped with emergency supplies
- be operated and maintained according to formal plans

Accessibility

Shelters must be readily accessible to their users, especially those with disabilities that affect mobility. Accessibility requirements include the following:

- Shelters and the routes to them must be clearly identified by signs.
- Travel time to the shelter must be minimized.
- Walkways, hallways, and other routes to the shelter must be free of obstructions.
- Shelter design must meet all Federal, state, and local Americans with Disabilities Act (ADA) requirements.

Information about providing for the needs of disabled persons during emergencies is provided in FEMA's United States Fire Administration publication Emergency Procedures for Employees with Disabilities in Office Occupancies.

Siting

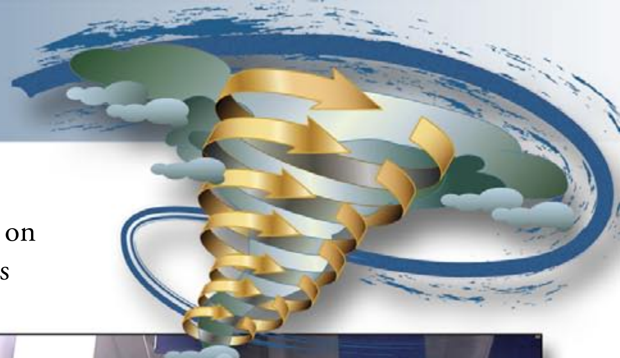
In addition to being located where they are readily accessible, shelters must be sited to minimize additional hazards—for example, outside the 500-year floodplain and away from large objects that could become windborne debris, such as light towers, antennas, and satellite dishes.

Occupant Comfort

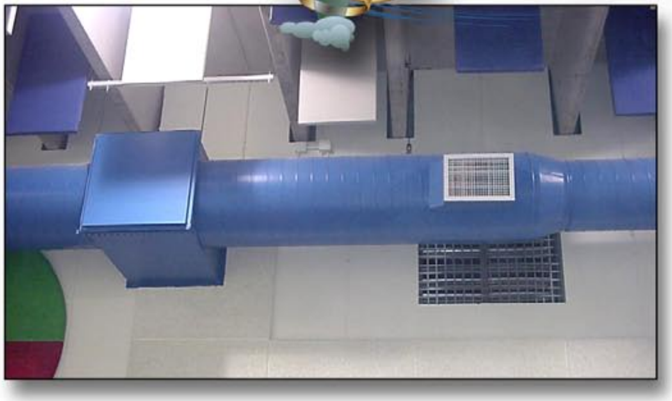
The comfort of shelter occupants will depend largely on the amount of space provided per occupant and adequate ventilation, lighting, water and food, and toilets.

The **amount of space** required per person depends on the duration of occupancy. For this reason, the required space differs between shelters intended for tornado protection and those intended for hurricane protection. Historical data indicate that a tornado shelter will typically have a maximum occupancy time of 2 hours. By contrast, a hurricane shelter will have a maximum occupancy time of 36 hours. The recommended minimums for occupant space are 5 square feet per person for tornado shelters and 10 square feet per person for hurricane shelters.

Note that these square footage figures are minimums; larger amounts of space are required for special situations. For example, the 5 square feet minimum for tornado shelters assumes that the shelter occupants will be standing for the duration of the event. Larger amounts of space are required for seated occupants and those with special needs, such as wheelchair users. Additional information about required shelter space is presented in FEMA 361.



Shelter **ventilation** systems can be passive or active. Passive systems depend on ducts or other openings that allow for the natural flow of air. Active systems depend on mechanical fans or blowers. Both types of systems must meet the requirements of local codes. Active systems should be provided with emergency backup power.



For multi-use shelters, **lighting**, including emergency lighting, is usually required by local codes. Similar lighting is recommended for single-use shelters as well. A backup power source is essential for emergency lighting systems. Batteries are recommended because they can be placed within the shelter area, where they will be protected. Natural lighting for shelter areas is also possible, but all windows must be protected with covers that meet the requirements for resistance to wind pressures and debris impact.

Adequate supplies of **water** are essential for both tornado and hurricane shelters. **Food** should be provided in hurricane shelters, but is not a major concern in tornado shelters, because of the short duration of use.

A minimum of two t**oilets** are recommended for both tornado and hurricane shelters. In hurricane shelters, which will be occupied for longer periods, the toilets must be able to function without power, water supply, and possibly waste disposal. Chemical toilets are a practical alternative to standard toilets. Shelter operators should ensure that the toilets are installed in a separate room or screened for privacy.

Emergency Supplies

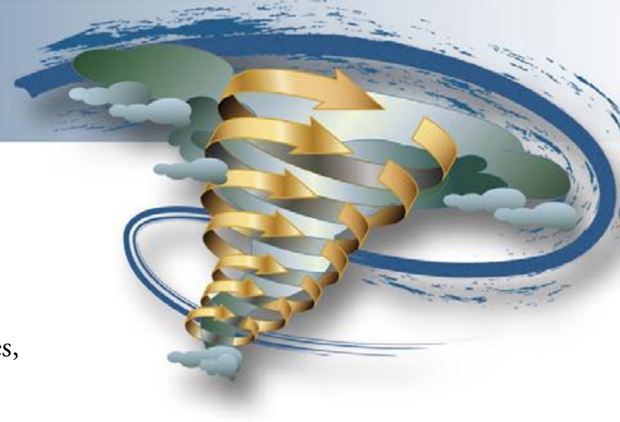
All shelters should be equipped with emergency supplies, including flashlights,
fire extinguishers, first-aid kits, radios (including weather radios and extra batteries), and a signaling device (such as an air horn).

Operations and Maintenance Plans

Operations and maintenance plans are required for all community shelters. The **Operations Plan** should clearly describe, and define the appropriate actions to be taken for, tornado watches and warnings and hurricane watches and warnings. The plan should also designate a Community Shelter Management Team and its responsibilities. Tasks assigned to the team should include the following:

- sending the warning signal to those who rely on the shelter
- evacuating community residents or building occupants and directing them to the shelter
- opening the shelter
- taking a head count at the shelter
- securing the shelter
- monitoring the storm from within the shelter and determining when it is safe for the occupants to leave
- cleaning and restocking the shelter
- conducting practice drills

Background



The **Maintenance Plan** should include the following:

- a checklist of emergency supplies
- a schedule of regular maintenance activities (e.g., supply inventories, equipment checks)

New Construction vs. Retrofitting

An additional consideration is whether a shelter will be built as new or retrofit construction. Building a shelter as a new building or part of a new building is generally more efficient and economical than retrofitting (modifying an existing building to meet specific design requirements).

Retrofit shelter construction involves making all changes necessary to strengthen an existing room or area of a building so that it will provide the required resistance to wind forces and debris impact. This process could involve extensive modifications to the foundation, frame, envelope, connections, and other building components. It could also involve modifications outside the shelter area as necessary to meet access, ventilation, emergency power, and other requirements. In addition, an internal shelter created through retrofitting must be structurally separate from the surrounding building so that damage to the surrounding building would not affect the shelter. Although retrofit shelter construction can be disruptive to building occupants, as well as more expensive than new construction, it may be the only option in some circumstances.

Sources of Shelter Information

Publications

FEMA has prepared a series of case studies that document the construction of community wind shelters. The issues covered include shelter needs, funding mechanisms, shelter design and construction, multiple uses for shelter areas, and shelter performance in actual events.

Sources of wind shelter information include the following:

Association Standard for the Design, Construction, and Performance of Storm Shelters, National Storm Shelter Association, Lubbock, TX, 2001.

Design and Construction Guidance for Community Shelters (FEMA 361), FEMA, Washington, DC, July 2000.

Safe Room & Community Shelter Resource CD (FEMA 388–CD), FEMA, Washington, DC, October 2001.

Taking Shelter From the Storm: Building a Safe Room Inside Your House (FEMA 320), FEMA, Washington, DC, August 1999.

Tornado Protection – Selecting Safe Areas in Buildings (FEMA 431), FEMA, Washington, DC, November 2003.

Copies of FEMA publications are available from the FEMA Publications Distribution Center at (800) 480-2520.

Related Websites

FEMA Safe Rooms – http://www.fema.gov/mit/saferoom/

Texas Tech University Wind Science and Engineering Research Center – http://www.wind.ttu.edu/

National Storm Shelter Association – http://www.nssa.cc/