



# Section I: Understanding the Hazards

Almost every state in the United States has been affected by extreme windstorms such as tornadoes and hurricanes. Virtually every state has been affected by a “considerable” tornado (see the terms in Figure I-1). All Atlantic and Gulf of Mexico coastal areas in the United States – including coastal areas of Puerto Rico and the U.S. Virgin Islands – and coastal areas of Hawaii have been affected by hurricanes. Even in states not normally considered to be susceptible to extreme windstorms, there are areas that experience dangerous extreme winds. These areas are typically near mountain ranges, and include the Pacific Northwest coast.

## What Is a Tornado?

According to the American Meteorological Society’s *Glossary of Meteorology*, a tornado is “a violently rotating column of air, pendant from a cumuliform cloud or underneath a cumuliform cloud, and often (but not always) visible as a funnel cloud.” Tornadoes typically occur in the spring and summer months, but can occur at any time in any part of the country. Tornadoes are sometimes spawned by hurricanes. The severity of a tornado is categorized by the Enhanced Fujita Scale (EF Scale). As of February 2007, the EF Scale (see Figure I-1) was adopted by the National Oceanic and Atmospheric Administration (NOAA) to replace the Fujita Scale (F Scale). The EF Scale is designed similar to the F Scale, but has been revised to have a greater number of Damage Indicators, which are used to characterize the degree of damage experienced by buildings during a tornado.

Not all parts of each state are at equal risk from tornadoes. For example, while Texas has the highest number of recorded tornadoes, the state’s least tornado-prone area (along the Gulf coast) has been hit by fewer tornadoes than northeastern Arkansas. Comparing the numbers of tornadoes recorded in different areas within a state can give you a better understanding of potential tornado activity in those areas. Figure I-2 shows the summary of recorded EF3, EF4, and EF5 tornadoes per 2,470 square miles in the United States and its possessions and territories. Between 1950 and 2006, tornadoes caused 5,506 deaths and 93,287 injuries.



### DEFINITION

In this publication, the term **missiles** refers to debris and other objects picked up by the wind and moved with enough force to damage and even penetrate windows, doors, walls, and other parts of a building. In general, the stronger the wind, the larger and heavier the missiles it can carry and the greater the risk of severe damage or injury. But even small stones, branches, and other lighter missiles can easily break glass doors and windows.

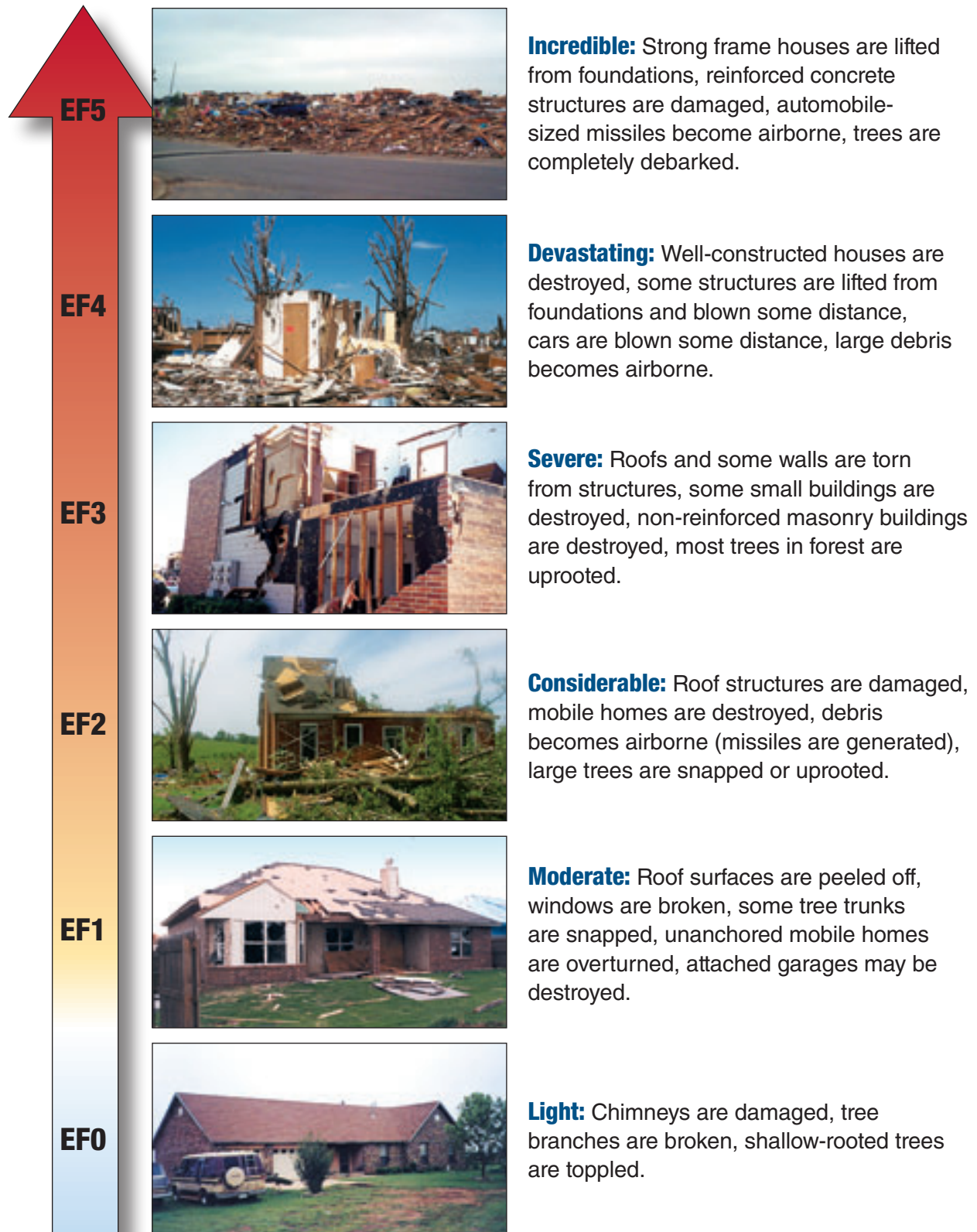
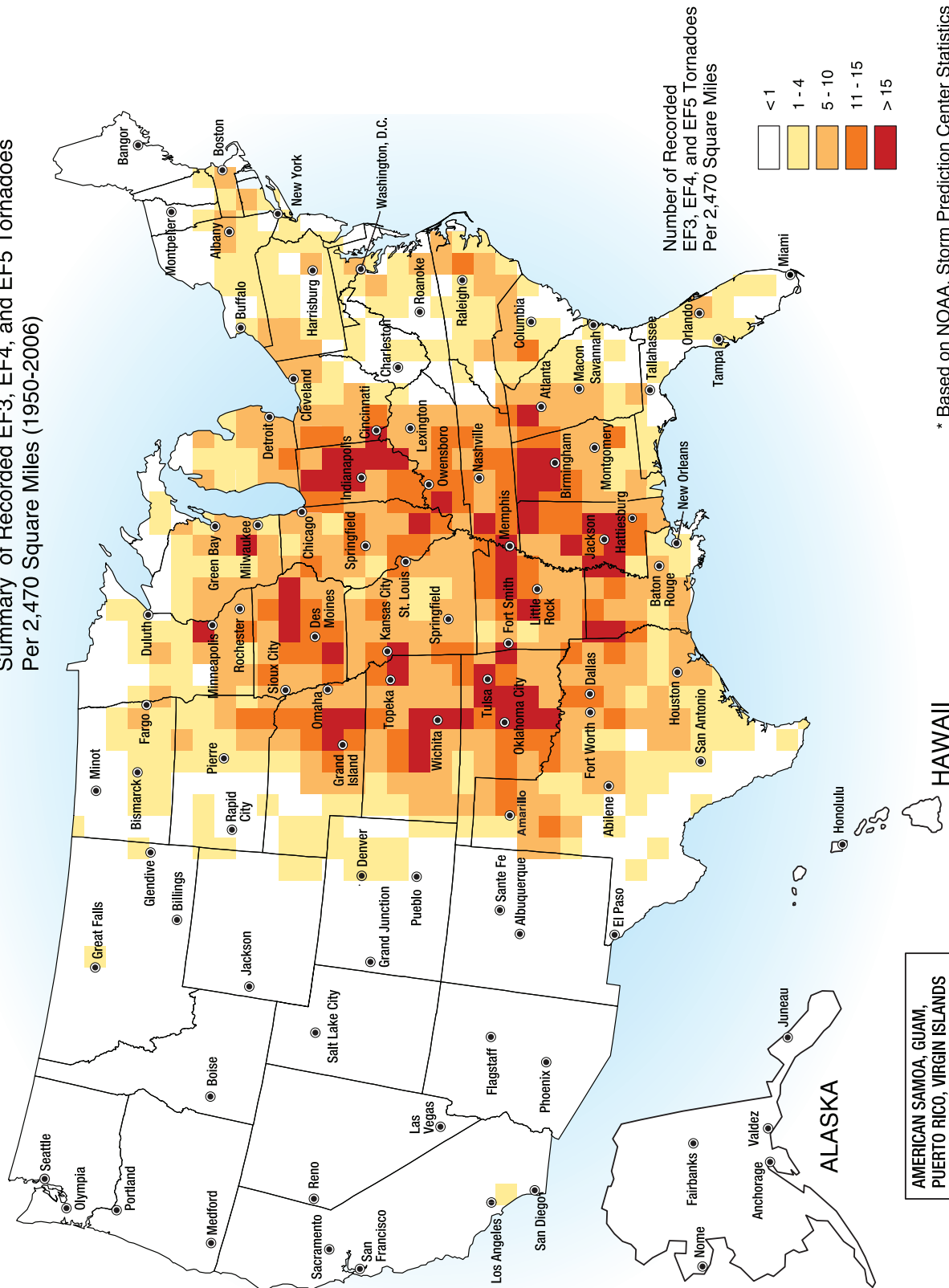


Figure I-1. Typical tornado damage



# TORNADO ACTIVITY IN THE UNITED STATES\*

Summary of Recorded EF3, EF4, and EF5 Tornadoes Per 2,470 Square Miles (1950-2006)



\* Based on NOAA, Storm Prediction Center Statistics

Figure I-2. The number of tornadoes recorded per 2,470 square miles

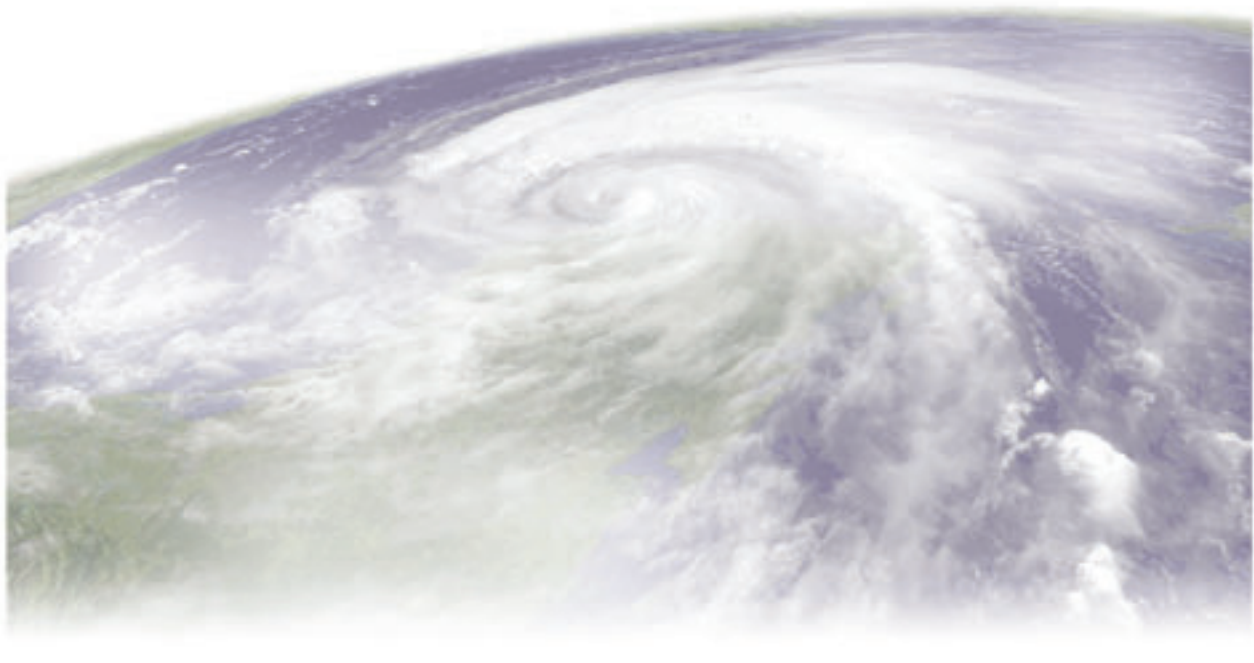


## What Is a Hurricane?

Hurricanes are categorized by the Saffir-Simpson scale (see Figure I-3).

In the United States, 279 hurricanes were recorded to have made landfall between 1851 and 2006. Over one-third of these hurricanes (96) were classified as major hurricanes (designated Category 3 and higher on the Saffir-Simpson Hurricane Scale). Hurricanes have made landfall in Florida more than in any other state. The second most hurricane-affected state is Texas, but every state on the Gulf coast and bordering the Atlantic Ocean is susceptible to damage caused by hurricanes, as are U.S. island possessions and territories. Hurricanes between 1900 and 2006 resulted in 17,832 deaths.

In recent years, the U.S. territories of Puerto Rico, American Samoa, and Guam have been seriously affected by numerous tropical cyclones.



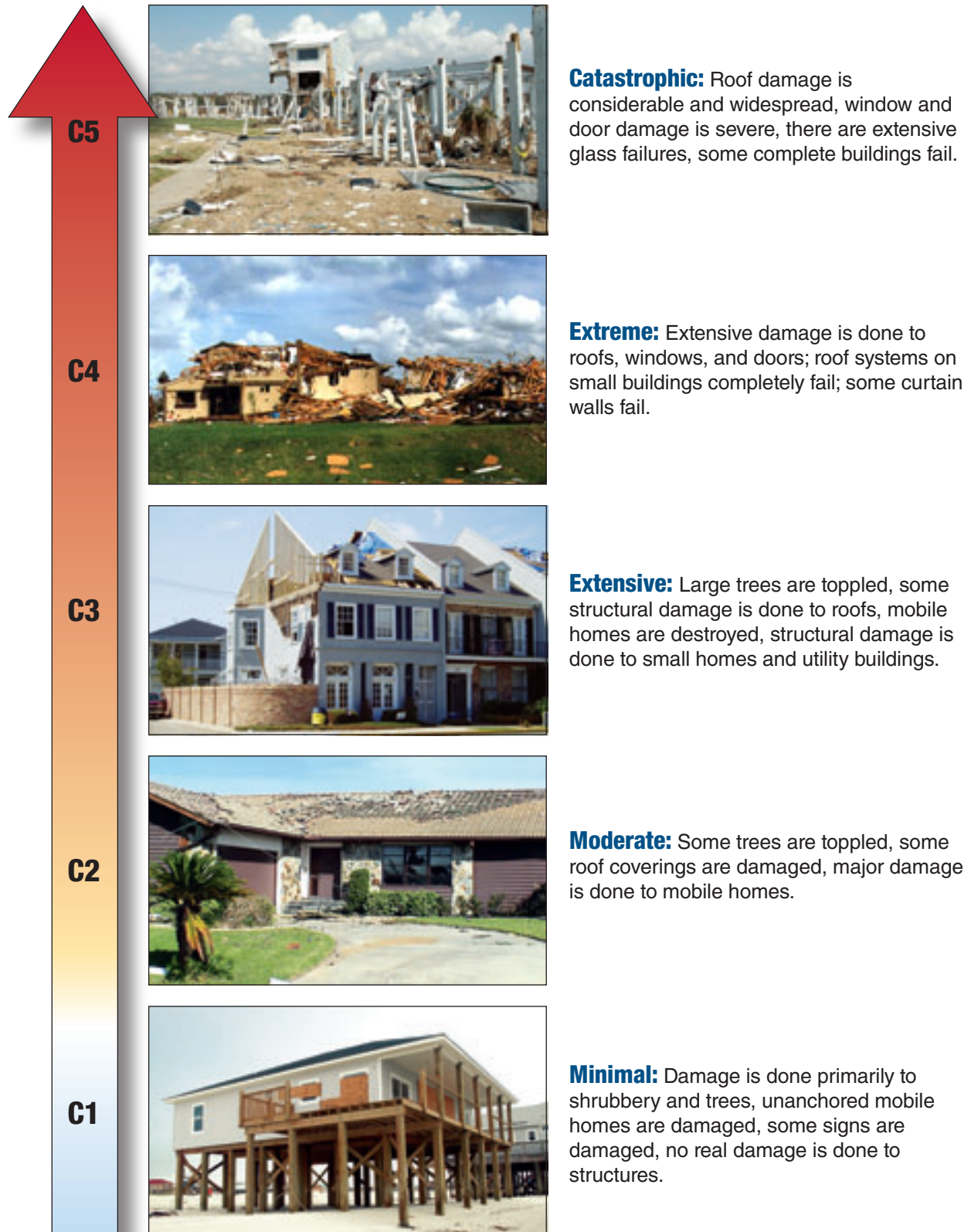


Figure I-3. Typical hurricane damage



## Do You Need a Safe Room?

On the basis of 60 years of tornado history and more than 150 years of hurricane history, the United States has been divided into four zones that geographically reflect the number and strength of extreme windstorms. Figure I-4 shows these four zones. Zone IV has experienced the most and the strongest tornado activity. Zone III has experienced significant tornado activity and includes coastal areas that are susceptible to hurricanes. The release of the ICC-500 has codified much of FEMA's guidance for safe room design and construction. However, there are additional details in the ICC-500 regarding hurricane shelters, including a new shelter design wind speed map that could be helpful to understanding your risk of extreme-wind events due to hurricanes. A safe room designed and constructed to the prescriptive designs included in this publication (and properly sited to address flood hazards) will meet or exceed the ICC-500 residential and small community shelter (less than 16 people) design criteria.

A safe room using the prescriptive designs of this publication should not be installed in a hurricane-prone area that may be inundated by storm surge from any hurricane, including Category 5 hurricanes. Further, it is best not to install residential or small community safe rooms in any area susceptible to flooding defined by the 500-year floodplain. However, in areas not prone to storm surge, a safe room may be installed within mapped floodplains only when the designs provided herein:

- Are accepted as meeting the safe room elevation flood criteria presented in the text box on pages 23 and 24
- Comply with all local floodplain ordinances
- Are coordinated with local emergency management

Your home or place of business is probably built in accordance with local building codes that consider the effects of minimum, “code-approved” design winds for your area. Building codes require that buildings be able to withstand a “*design*” wind event. In most tornado-prone regions, the building code design wind event is a wind event with 90 mph winds. For hurricane-prone areas, design wind events in the code range from 90 to 150 mph. A tornado or extreme hurricane can cause winds much greater than those on which local code requirements are based. Having a home built to “code”

A safe room may be designed and constructed to meet all applicable FEMA criteria. However, use of the safe room during a hurricane may not be in compliance with mandatory evacuation orders of the local jurisdiction. FEMA recommends that all safe room occupants comply with local jurisdictional directions and orders during a hurricane event (which may include evacuation) even if they have constructed a safe room.

does not mean that your home can withstand wind from any event, no matter how extreme. The safe room designs in this publication provide a place to seek safe shelter during these extreme-wind events.

The worksheet on page 10 will help you determine your level of risk from these extreme events and will assist you in your consideration of a safe room. If you decide that you need a safe room, Section II will help you and your builder/contractor in planning your safe room. To learn more about the wind history for the area where you live, check with your local building official, meteorologist, emergency management official, or television weather reporter.



WIND ZONES IN THE UNITED STATES\*

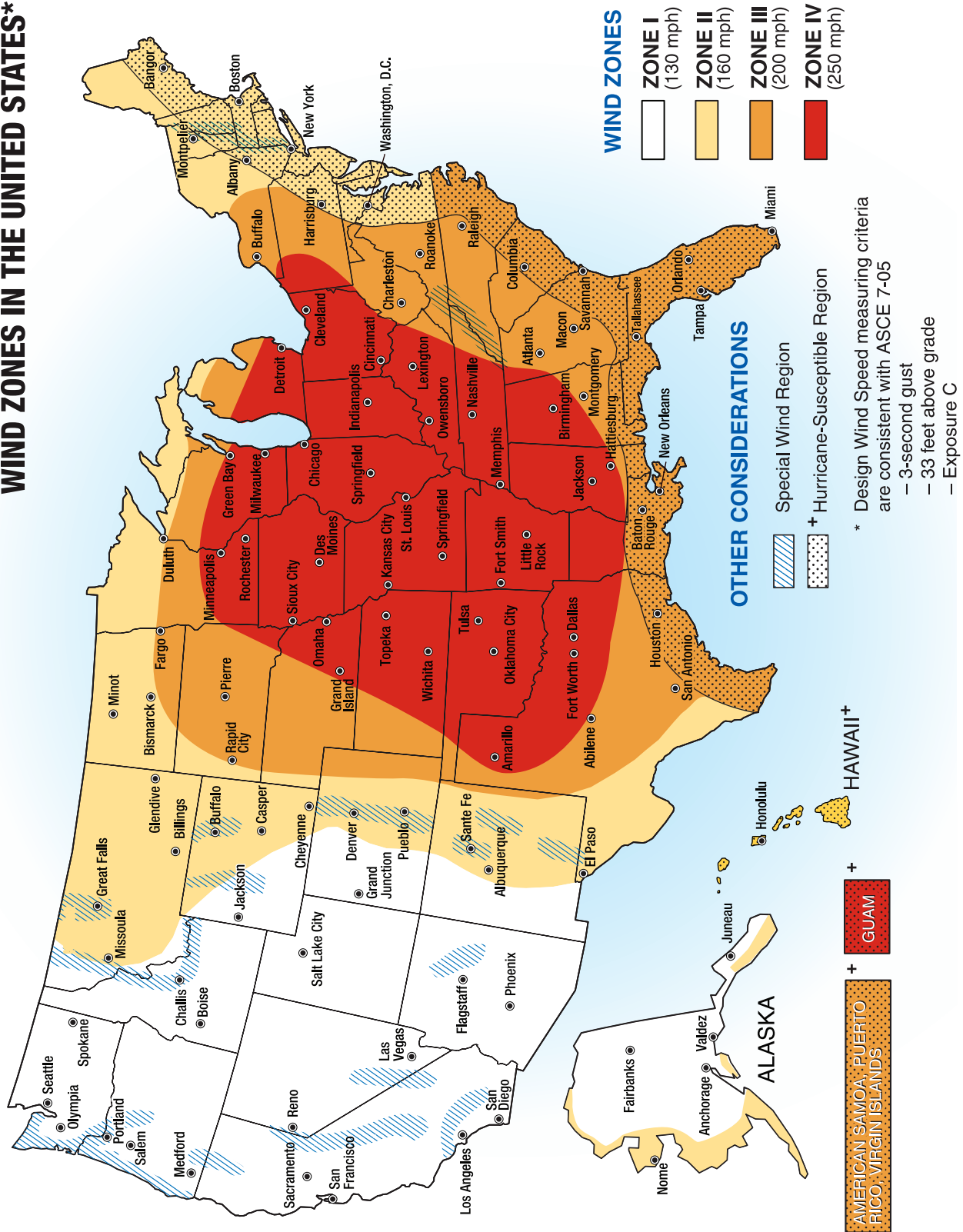


Figure I-4. Wind zones in the United States



**DEFINITION**

In this publication, the term **storm surge** means an abnormal rise in sea level accompanying a hurricane or other intense storm, and whose height is the difference between the observed level of the sea surface and the level that would have occurred in the absence of the cyclone. Storm surge (see Figure I-5) is usually estimated by subtracting the normal or astronomic high tide from the observed storm tide.

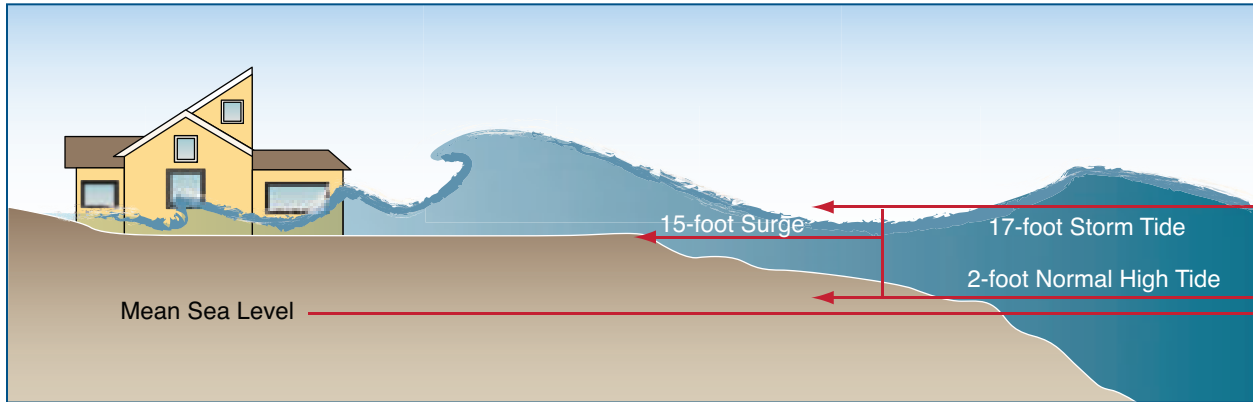


Figure I-5. Storm surge



**WARNING**

A safe room designed to protect you and your family or employees from a hurricane or tornado should not be built in an area expected to be flooded during a hurricane, thunderstorm, or other severe weather event.

Residents of hazard-prone coastal areas should abide by the warnings of their local emergency services personnel and evacuate to safer ground. The protection from wind provided by safe rooms and shelters is quickly negated when people find themselves trapped and inundated by floodwaters.

If you do not know whether your home or small business is in a **storm surge** area or other area subject to flooding, check the community service section of your local phone book for storm surge evacuation information or ask your local emergency management or floodplain management official.

## Homeowner's Worksheet: Assessing Your Risk

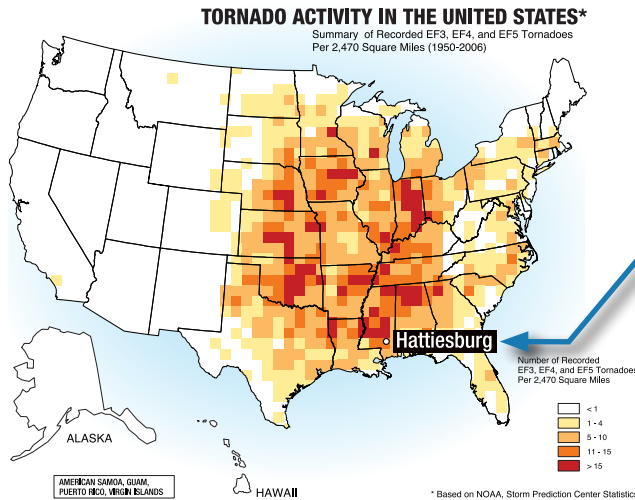
To complete the worksheet on page 10, refer to the tornado occurrence and wind hazard maps for tornadoes and hurricanes on pages 3 and 7 (Figures I-2 and I-4, respectively). Using the map on page 3, note how many tornadoes were recorded per 2,470 square miles for the area where you live. Find the row on the worksheet that matches that number. Next, look at the map on page 7 and note the wind zone (I, II, III, or IV) in which you live. Find the matching column on the worksheet. Finally, find the box inside the worksheet that lines up with both the number of tornadoes per





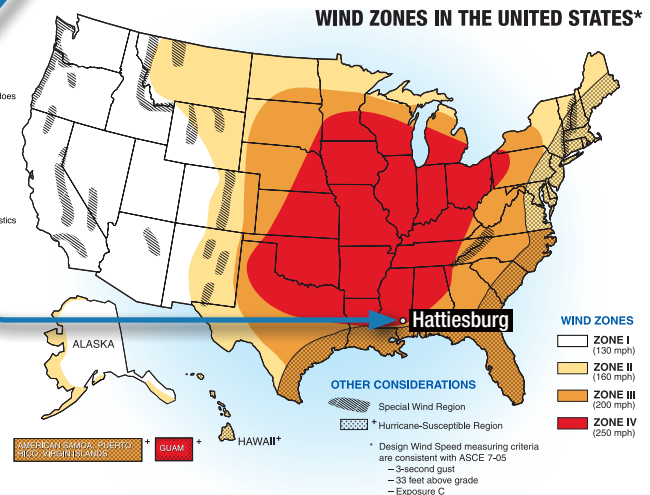
2,470 square miles in your area and your wind zone. The color of that box tells you the level of your risk from extreme winds and helps you decide whether to build a safe room.

Hurricane-susceptible regions can be seen in Figure I-4, running from the southern tip of Texas to the Northeast. Revised hurricane shelter design wind speeds have been released in the ICC-500. For the purpose of the prescriptive solutions offered in this publication, the wind speeds given in Figure I-4 are used to calculate pressures and required resistances for residential safe rooms.



For example, if you live in Hattiesburg, MS, you would see that Hattiesburg is in an area shaded medium orange on the map on page 3. So according to the map key, the number of tornadoes per 2,470 square miles in the Hattiesburg area is 11-15.

On the map on page 7, Hattiesburg appears within the red-shaded area. The map key tells you that Hattiesburg is in Wind Zone IV.



The box where the 11-15 row and the Zone IV column meet is shaded dark blue, which shows that you live in an area of high risk. A safe room is the preferred method of wind protection in high-risk areas. Note that some areas of low or moderate risk, shown as pale blue or medium blue in the worksheet, are within the region of the United States that is subject to hurricanes (see Figure I-4). If you live in this hurricane-susceptible region, your risk is considered high, even though the worksheet indicates only a moderate or low risk.

		WIND ZONE (SEE FIGURE I-4)			
		I	II	III	IV
NUMBER OF TORNADOES PER 2,470 SQUARE MILES (SEE FIGURE I-2)	< 1	LOW RISK	LOW RISK ★	LOW RISK ★	MODERATE RISK
	1 - 4	LOW RISK	MODERATE RISK ★	HIGH RISK	HIGH RISK
	5 - 10	LOW RISK	MODERATE RISK ★	HIGH RISK	HIGH RISK
	11 - 15	HIGH RISK	HIGH RISK	HIGH RISK	HIGH RISK
	> 15	HIGH RISK	HIGH RISK	HIGH RISK	HIGH RISK



Table I-1. Homeowner's Worksheet

		WIND ZONE (SEE FIGURE I-4)			
		I	II	III	IV
NUMBER OF TORNADOES PER 2,470 SQUARE MILES (SEE FIGURE I-2)	< 1	LOW RISK	LOW RISK ★	LOW RISK ★	MODERATE RISK
	1 – 4	LOW RISK	MODERATE RISK ★	HIGH RISK	HIGH RISK
	5 – 10	LOW RISK	MODERATE RISK ★	HIGH RISK	HIGH RISK
	11 – 15	HIGH RISK	HIGH RISK	HIGH RISK	HIGH RISK
	> 15	HIGH RISK	HIGH RISK	HIGH RISK	HIGH RISK

- LOW RISK** Need for an extreme-wind safe room is a matter of homeowner or small business owner preference.
- MODERATE RISK** Safe room should be considered for protection from extreme winds.
- HIGH RISK** Safe room is the preferred method of protection from extreme winds.

★ Safe room is the preferred method of protection from extreme winds if the home or small business is in a hurricane-susceptible region.

## Emergency Planning and Emergency Supply Kit

Whether or not you decide that you need a safe room in your home or small business, you can take two important steps to provide near-absolute protection for you, your family, or employees during a hurricane or tornado: prepare an emergency plan and put an emergency supply kit together. If you decide to build a safe room, your emergency plan should include notifying local emergency managers, first responders (local fire stations), and family members or others outside the immediate area that you have a safe room. This will allow emergency personnel to quickly free you if the exit from your safe room becomes blocked by debris. You should also prepare an emergency supply kit and either keep it in your safe room or be ready to bring it with you if you need to evacuate your home. Some of the items that the emergency supply kit should include are:

- An adequate supply of water for each person in your home or small business (1 gallon per person per day)
- Non-perishable foods that do not have to be prepared or cooked (if these include canned goods, remember to bring a manual can opener)



- Disposable eating utensils, plates, cups, paper towels, etc.
- A first-aid kit, including necessary prescription medicines, bandages, and antibiotic ointment
- Tools and supplies:
  - flashlight (one per person; do not bring candles or anything that lights with a flame)
  - battery-operated radio or television and NOAA<sup>1</sup> weather radio
  - cellular phone or Citizen's Band (CB) radio
  - extra batteries for the above tools
  - wrench (to turn off gas and water)
  - insect repellent and sunscreen
  - personal hygiene items such as hand wipes and toilet paper
- Extra change of clothing per person (store in plastic trash bags to keep clean and dry)
- Appropriate outer wear (e.g., sunglasses, ponchos, jackets, gloves, headwear, boots, etc.)
- Bedding materials such as pillows and blankets or sleeping bags
- Special items for:
  - babies – formula, diapers, bottles, powdered milk
  - children – entertainment items such as books, games, or toys
  - adults – contact lenses and supplies, extra glasses, and a sufficient supply of prescription medications
  - pets – appropriate supplies such as water (1/2 gallon per day), food, leash, ID tag, carrying container, etc.
- Additional items:
  - important documents such as insurance documents, a list of all your important contacts (e.g., family, doctors, insurance agents), banking information, leases/mortgage, proof of occupancy (such as a utility bill), and a waterproof container in which to keep these documents
  - ABC<sup>2</sup> rated fire extinguisher
  - roofing tarps or plastic sheeting
  - roll of large heavy-duty trash bags and duct tape
  - money (cash)

1 The National Oceanic and Atmospheric Administration (NOAA) Weather Radio (NWR) is a nationwide network of radio stations broadcasting continuous weather information directly from a nearby National Weather Service (NWS) office. NWR broadcasts NWS warnings, watches, forecasts, and other hazard information 24 hours a day, as well as post-event information for all types of hazards, both natural and technological. NOAA Weather Radios are available at electronics stores across the country and range in cost from \$25 up to \$100 or more, depending on the quality of the receiver and number of features. The NWS does not endorse any particular make or model of receiver.

2 ABC refers to fires originating from three types of sources: A - paper, wood, or fabric; B - gasoline or oil; or C - electrical.



You can get more information about emergency planning from American Red Cross (ARC) and FEMA publications, which you can obtain free of charge by calling FEMA at 1-800-480-2520, or by writing to FEMA, P.O. Box 2012, Jessup, MD 20794-2012. These publications include the following:

**Planning Documents:**

*Are You Ready? An In-depth Guide to Citizen Preparedness*, FEMA IS-22

*Emergency Preparedness Checklist*, FEMA L-154 (ARC 4471)

*Emergency Food and Water Supplies*, ARC 5055

*Your Family Disaster Supplies Kit*, ARC 4463

*Preparing for Disasters for People with Special Needs*, FEMA 476 (ARC 4497)

**Safe Room Documents:**

*Design and Construction Guidance for Community Safe Rooms*, FEMA 361

*Safe Room and Community Shelter Resource CD*, FEMA 388 CD

*Tornado Protection - Selecting Refuge Areas in Buildings*, FEMA 431

These publications are also available on the FEMA web site –

<http://www.fema.gov> – and at the American Red Cross web site – <http://www.redcross.org>.



The Department of Homeland Security (DHS), has developed the [READY.gov](http://www.ready.gov) web site. You can find emergency planning and preparation guidance for all types of potential hazards. To obtain a copy of *Preparing Makes Sense. Get Ready Now*, go to <http://www.ready.gov>.