Tornado Risks and Hazards in the Midwest United States

FEMA

MAY 2007 TORNADO RECOVERY ADVISORY *FEMA DR-1699-RA1*

Purpose and Intended Audience

The purpose of this Tornado Recovery Advisory (RA) is to summarize facts about the Midwest tornado hazard, specifically the area served by FEMA Region VII. Region VII includes Iowa, Kansas, Missouri, and Nebraska. The general population, specifically homeowners and renters, policy makers, local officials, builders, and building officials know and understand that tornado occurrence in the Midwest is not a rare event. In fact, more than half of the 20 states with the highest frequency of tornado occurrence on record, and 4 of the top 5 (Texas, Oklahoma, Kansas, and Nebraska) are located in the Midwest.

See these 2007 Tornado Recovery Advisories for information about sheltering from tornadoes:

- *Storm Shelters: Selecting Design Criteria* (Tornado RA2)
- *Residential Sheltering: In-Residence and Stand-Alone Shelters* (Tornado RA3)

In addition, this RA identifies FEMA resources that can be used to help design and construct shelters that provide safe haven from tornadoes. These resources also guide construction of most building types (including residences) to minimize damage from extreme wind events.

This Recovery Advisory Addresses:

- Recent events
- Tornado occurrence in "Tornado Alley"
- Assessing risk
- Can a building survive a tornado? Yes!
- Weather radios

The Fujita Scale categorizes tornado severity based on observed damage. The six-step scale ranges from F0 (light damage) to F5 (incredible damage). Since February 2007, the National Weather Service has used the Enhanced Fujita Scale (EF Scale). This new scale ranges from EF0 to EF5. See http://www.spc.noaa.gov/efscale/ for further information on the EF Scale.

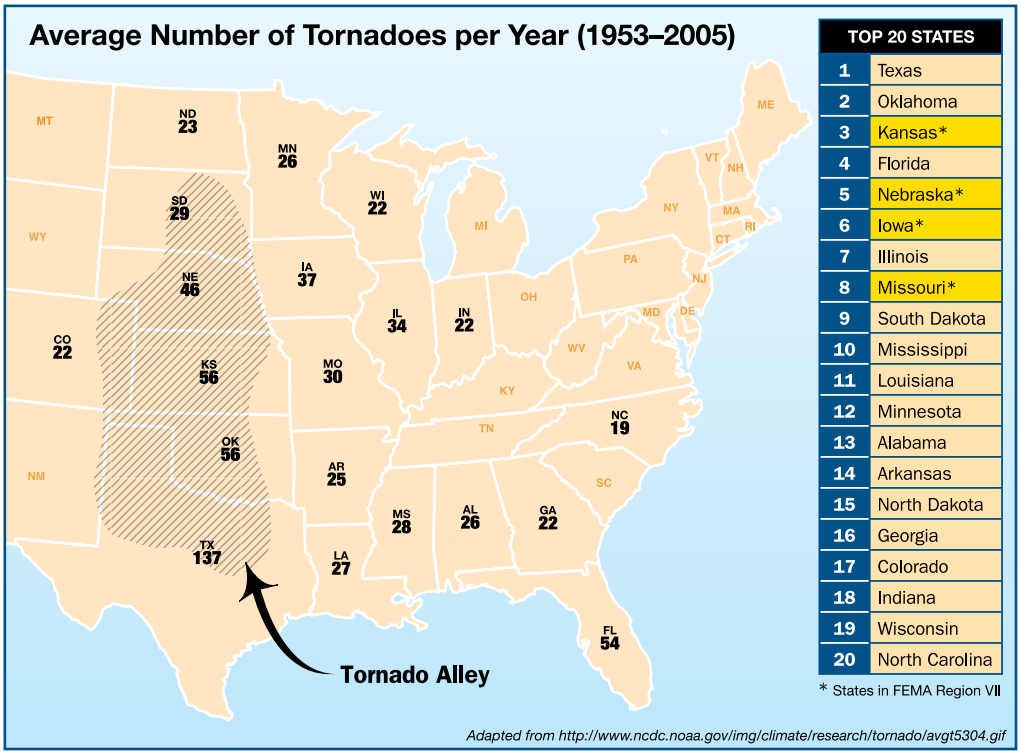
Fujita Scale		EF Scale	
Fujita Scale	3-Second Gust Speed (mph)	EF Scale	3-Second Gust Speed (mph)
F0	45–78	EF0	65–85
F1	79–117	EF1	86–109
F2	118–161	EF2	110–137
F3	162–209	EF3	138–167
F4	210–261	EF4	168–199
F5	262–317	EF5	200–234

Recent Events

On the evening of May 4, 2007, "supercell" thunderstorms formed across portions of the Midwestern U.S., spawning tornadoes in several states. An intense supercell developed southwest of Greensburg, Kansas that evening, resulting in the formation of 12 tornadoes. One of these tornadoes formed in northwest Comanche County at approximately 9:00 pm and moved northeastward through Kiowa County. At about 9:45 pm, this tornado reached Greensburg, Kansas, a small community of approximately 1,400 people, and traveled from the town's southern edge to its northwest border. The tornado was rated an EF5 (see sidebar) with an estimated wind speed greater than 205 miles per hour (mph) and had a reported swath of 1.7 miles. The tornado destroyed or severely damaged the majority of the buildings in Greensburg and caused the deaths of 10 people. The death toll in Greensburg could have been higher were it not for a 20-minute tornado warning issued by the National Weather Service that gave the residents time to take refuge.

Tornado Occurrence in "Tornado Alley"

"Tornado Alley" is an area of the U.S. heart-land known for its tornado activity. Although the boundaries of Tornado Alley can be debated, most scientists agree that Texas, Oklahoma, Kansas, and Nebraska are well known for tornado risk and make up a large portion of Tornado Alley. Tornado risk includes the potential for property damage, injury, and loss of life all of which are increased with a higher frequency of occurrence. See the section "Assessing Your Risk" on the next page to determine the risk in your area.



Tornado Alley's climate and location are ideally suited to create supercell thunderstorms, which commonly spawn violent tornadoes. FEMA Region VII includes part of the area known as Tornado Alley and is composed of Iowa, Kansas, Missouri, and Nebraska, four of the most tornado-prone states in the United States.

As in the rest of the United States, the majority of tornadoes in Tornado Alley are typically weak or moderately strong (classified as EF2 and smaller on the Enhanced Fujita Scale). However, even these weaker tornadoes can be deadly. Further, tornadoes are not always single tornado events; sometimes outbreaks of several tornadoes are associated with a large storm system. This type of tornado outbreak happens frequently in Tornado Alley due to the supercell thunderstorms that affect the area. In fact, there have been two such occurrences in the recent past in the Midwest:

States in FEMA Region VII	Total Tornado Occurrences (1950–2005)	Total Fatalities (1950–2005)
Iowa	1,989	67
Kansas	3,061	214
Missouri	1,604	200
Nebraska	2,344	54

The Great Plains Tornado Outbreak of May 3, 1999

- Over 70 tornadoes occurred during this outbreak in Oklahoma, Kansas, and Texas, 4 of which were considered violent (F4 or F5)
- An F5 tornado struck the Oklahoma City area, two F4 tornadoes struck populated areas north of Oklahoma City, and one struck the Wichita, Kansas area
- 49 people were killed and approximately 800 were injured
- Over 2,000 homes were destroyed and more than 7,000 were damaged
- Damage was estimated at $1.2 billion

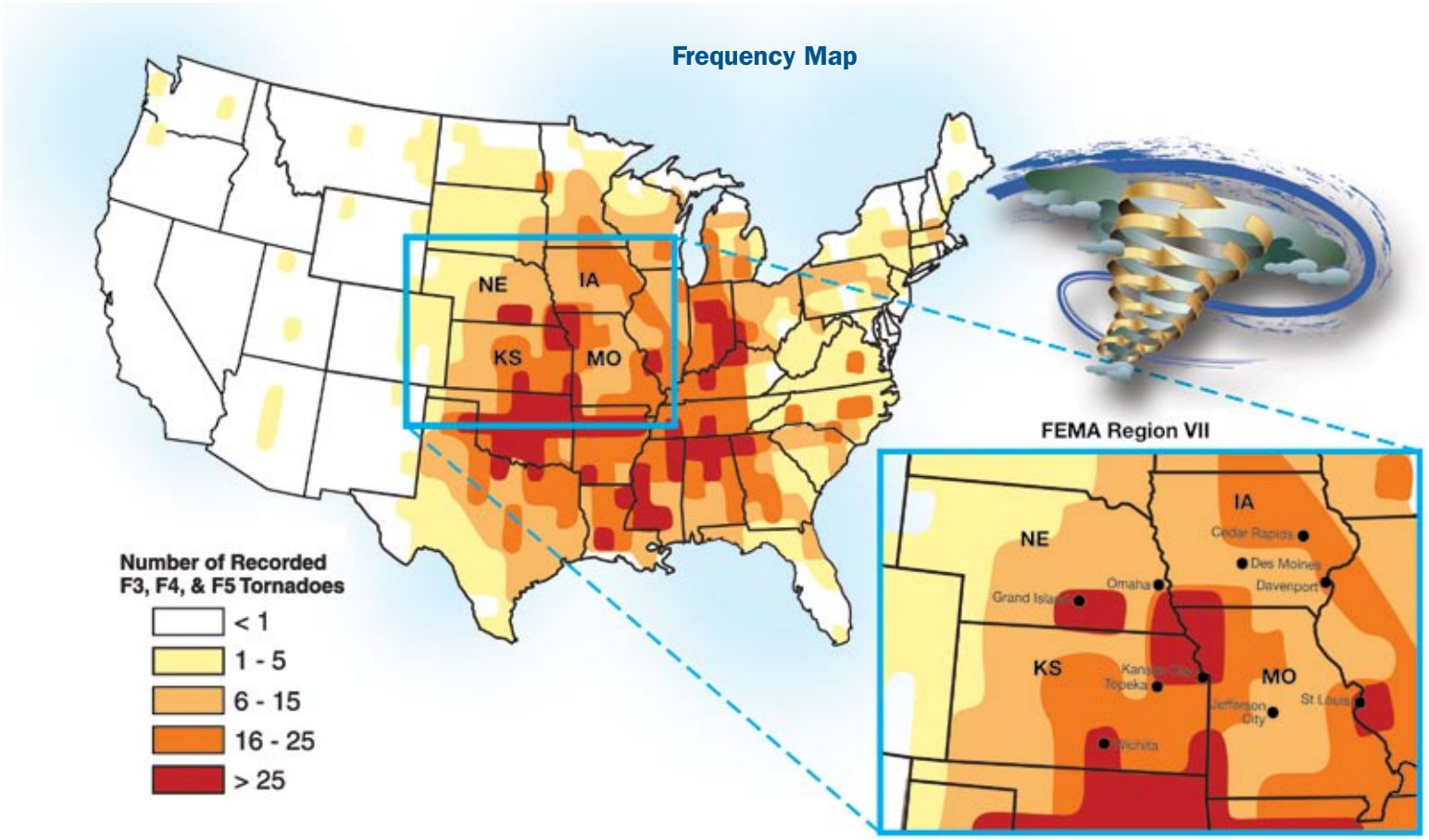
May 8, 2003 Outbreak

- An estimated 80 tornadoes touched down throughout 8 states
- Significant damage was reported in Kansas, Oklahoma, and Missouri, including the Kansas City and Oklahoma City areas
- 37 deaths were reported
- In Oklahoma, an estimated 300 homes were destroyed and 1,500 were damaged

Assessing Your Risk

To determine your exposure to a low, moderate, or high tornado risk, use the Frequency Map below to determine how many tornadoes were recorded for the area where your building is located. Find the row in the "Risk Table" below that matches that number. Next, look at the Wind Zone Map on the next page and note your wind zone (I, II, III, or IV). Find the matching column in the Risk Table and look for the box where your frequency row and wind zone column meet. Your risk level is given in that box and helps you assess the need for a shelter. A shelter is the preferred method of protection in high-risk areas.

Example: If your building is located in Wichita, Kansas, note that Wichita is in an area shaded red on the Frequency Map. According to the map, the number of tornadoes in the Wichita area is >25. On the Wind Zone Map on the next page, Wichita is within Wind Zone IV. The box in the Risk Table below where the >15 row and the Zone IV column meet is shaded dark blue, which shows that the building is in an area of high risk.



SOURCE: FEMA 361, *Design and Construction Guidance for Community Shelters,* July 2000

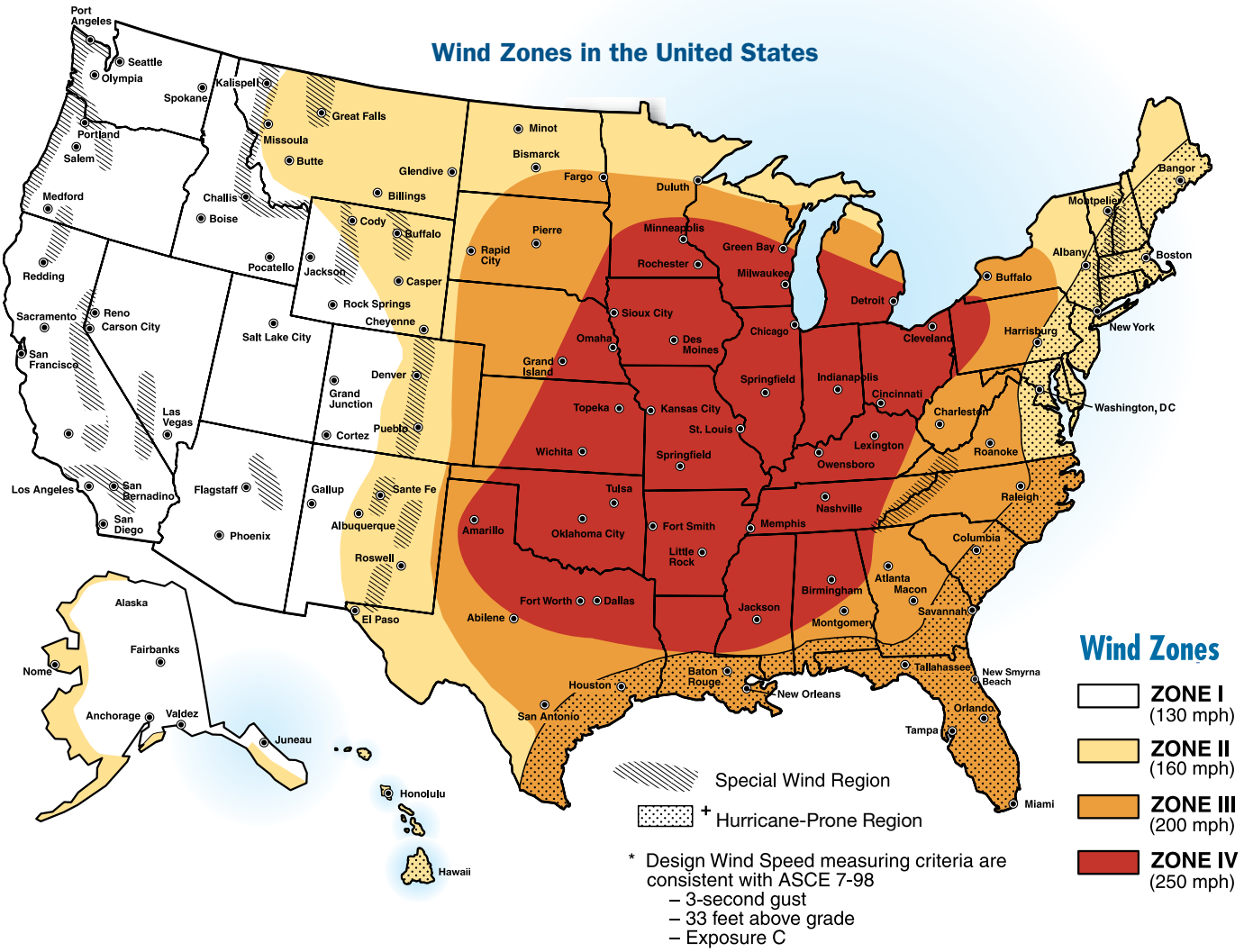
Levels of Risk for High-Wind Events

Number of Tornadoes (see Wind Zone Map)	Wind Zone (see Frquency Map)			
	I	II	III	IV
<1	LOW Risk	LOW Risk	LOW Risk	MODERATE Risk
1–5	LOW Risk	MODERATE Risk	HIGH Risk	HIGH Risk
6–10	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 – Sheltering from high winds is a matter of preference.

MODERATE Risk – Shelter should be considered for protection from high winds.

HIGH Risk – Shelter is the preferred method of protection from high winds.



Can a Building Survive a Tornado? Yes!

High-wind shelters can be designed and constructed to protect occupants from winds and windborne debris associated with all tornadoes (EF0–EF5). Buildings designed and constructed above basic code requirements (also known as "hardened" buildings), and newer structures designed and constructed to modern, hazard-resistant codes can resist the wind load forces from weak tornadoes (EF1 or weaker). Even strong tornadoes have wind speeds away from the center or vortex of the storm that can be similar to building code level wind speeds. Much of the damage is caused by winds rushing toward and being pulled into the tornado itself. Many newer homes designed and constructed to modern codes, such as the *International Residential Codes* (IRC 2000 Edition and newer), may survive without structural failure if struck by weak tornadoes or if located on the periphery of the paths of strong tornadoes. The primary damage to these newer homes is to the cladding and exterior systems: roof covering, roof deck, exterior walls and windows.

For most building uses, it is economically impractical to design the entire building to resist tornadoes. However, portions of buildings can be designed as shelters to protect occupants from tornadoes. For information on designing shelters to resist tornadoes, see the Tornado RA titled *Storm Shelters: Selecting Design Criteria.* For residential shelters, see the Tornado RA titled *Residential Sheltering: In-Residence and Stand-Alone Shelters.*

For existing buildings that do not have specifically designed tornado shelters, or for populations that don't have access to community tornado shelters, it is recommended that best available refuge areas be identified in advance by a qualified architect or engineer. For further information on best available refuge areas, see *Tornado Protection: Selecting Safe Areas in Buildings* (FEMA 431), November 2003.

Weather Radios

All individuals living or working in tornado-prone areas should have a weather radio inside their home or place of work. A weather radio is particularly important for those living in an area that does not have storm warning sirens.

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, and 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 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.

Features to look for in a NOAA Weather Radio:

- The most desirable feature is an alarm tone. This allows you to have the radio turned on but silent, listening for a special tone that is broadcast before watch and warning messages that give immediate information about a life-threatening situation.
- Specific Area Message Encoding (SAME) technology, a feature available since the mid-1990s, is capable of providing detailed, area-specific information. Unlike other NOAA Weather Radios, the SAME feature will filter out alerts that do not affect your immediate area.
- It should operate on batteries during times when electrical service may be interrupted. Look for radios with an AC adapter and battery compartment.
- The radio should be tunable to all seven NWR frequencies. For the latest list of frequencies and transmitter locations, check the NOAA Weather Radio Web site http://www.weather.gov/nwr.
- The hearing and visually impaired can receive watches and warnings by connecting weather radio alarms to other kinds of attention-getting devices, such as strobe lights, pagers, bed-shakers, personal computers, and text printers.

Other methods to receive forecasts, watches, and warnings directly from the NWS:

- Tune in to your local radio and television stations for the latest weather forecasts, watches, and warnings.
- NWS products and services are also available on the Internet at http://www.weather.gov/nwr. Delivery of data across the Internet, however, cannot be guaranteed because of potential interruption of service.
- Another low-cost method for receiving essential information is to use a wireless data system called the Emergency Managers Weather Information Network (EMWIN). This system presents the information directly on your home or office computer. Users can set various alarms to go off to be alerted to particular information, whether for their local area or adjacent areas. For more information, visit the EMWIN Web site http://www.weather.gov/emwin/index.htm.

Useful Links and Resources

Taking Shelter from the Storm: Building a Safe Room Inside Your House (FEMA 320), March 2004, 2nd Edition

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

Tornado Protection: Selecting Safe Areas in Buildings (FEMA 431), November 2003