Tornado Risks and Hazards in the Southeastern United States

FEMA

TORNADO RECOVERY ADVISORY *RA1, June 2011*

Purpose and Intended Audience

The purpose of this Tornado Recovery Advisory is to provide background on the tornado hazard in the Southeast. The general population, homeowners and renters, policy makers, local officials, builders, and building departments should understand that tornado occurrence in the Southeast is not a rare event. In fact, of the top 20 States in tornado frequency, 5 are in the Southeast.

This advisory also identifies FEMA resources that can be used to help design and construct portions of almost any building type (including residences) to provide safe refuge from tornadoes, or to help minimize damage caused by these wind events.

This Recovery Advisory Addresses:

- Recent events
- Tornado occurrence outside "Tornado Alley"… how great is the risk?
- Assessing your risk
- Can a building survive a tornado? Yes!
- Weather radios

The National Weather Service uses the Enhanced Fujita Scale (EF Scale) to categorize tornado severity based on observed damage. The scale ranges from EF0 to EF5. See http://www.spc.noaa.gov/efscale for further information on the EF Scale.

EF Scale	3-Second Gust Speed (mph)
EF0	65–85
EF1	86–110
EF2	111–135
EF3	136–165
EF4	166–200
EF5	Over 200

Recent Events

In the late afternoon of April 27, 2011, a large outbreak of tornadoes struck Mississippi, Tennessee, Alabama, and portions of Georgia. The National Oceanic and Atmospheric Administration (NOAA) estimated there were approximately 190 tornadoes that touched down between 8:00 a.m. EDT April 27 and 8:00 a.m. EDT April 28, a record high for a single storm system. Three of the tornadoes were rated by the National Weather Service (NWS) as EF5, 11 were rated at EF4, 21 at EF3, and the remainder at EF2 and below on the Enhanced Fujita Scale. Fatalities for the events in April totaled 361[1] and hundreds more were injured, making April 27th the fourth deadliest day for tornadoes on record.[2] Total damage estimates are still being compiled from this event, but early estimates are that the insured loss for the storms could reach $6 billion, with Alabama accounting for 70 percent of that loss.[3]

On May 22, 2011, Joplin, Missouri, a town of 50,000 people, was devastated by a large tornado. NWS estimated that the tornado was an EF5 (greater than 200 mph) tornado. At the time of publication of this Recovery Advisory, 141 people from Joplin have been confirmed dead and 750 people reported as injured. The Joplin tornado is the deadliest single tornado since modern recordkeeping began in 1950 and is ranked eighth among the deadliest tornadoes in U.S. history.[4] Total damage estimates could reach $3 billion.[5]

1 NOAA, 2011. http://www.spc.noaa.gov/climo/torn/fataltorn.html accessed 5/27/11
2 NOAA, 2011. http://www.noaanews.noaa.gov/april_2011_tornado_information.html accessed 5/17/11
3 Gow, Lauren. May 17, 2011. "US tornado insured losses could reach $6bn" in Global Reinsurance
4 SOURCE: http://www.crh.noaa.gov/sgf/?n=event_2011may22_summary accessed 5/27/11
5 SOURCE: http://money.cnn.com/2011/05/24/news/economy/tornado_joplin/index.htm accessed 5/27/11

Tornado Occurrence Outside "Tornado Alley"… How Great Is the Risk?

"Tornado Alley" is an area of the heartland of the United States known for its tornado activity. Although the exact extent of Tornado Alley can be debated, most scientists agree that Texas, Oklahoma, and Kansas are well known for tornado risk and make up a large portion of Tornado Alley.

What most people may not be aware of is the amount of tornadic activity outside of Tornado Alley. FEMA Region IV has eight States subject to tornadoes and six subject to hurricanes (refer to Figure 1 and Table 1).

Although hurricanes have received most of the attention in recent years in the Southeast, the threat and risk of tornadoes is real. Table 1 below shows the number of tornadoes occurring in each of the States in FEMA Region IV. A total of 11,629 tornadoes were recorded by NOAA's Storm Prediction Center for the 60-year study period from 1950 through 2010. Between 2000 and 2010, Alabama alone experienced 636 tornadoes.

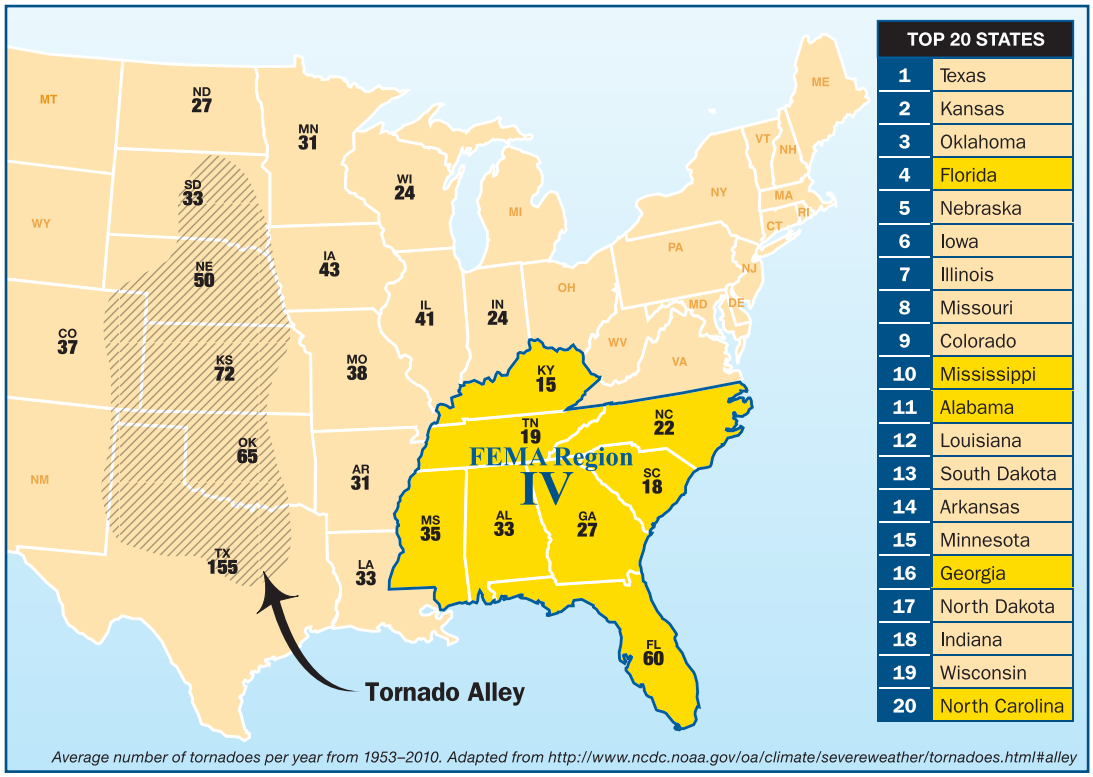

Figure 1: Average number of tornadoes per year in FEMA Region IV and Tornado Alley

Except for in the States of Mississippi and Alabama, tornadoes occurring in the Southeast are typically weak to moderately strong (EF0, EF1, EF2, and EF3 tornadoes). However, these weaker tornadoes can be as deadly as the stronger (EF4 or EF5) tornadoes. For example, more than 50 of the 78 deadliest tornadoes that occurred in Florida between 1882 and 2007 were EF3 or weaker. Further, tornadoes are not always single events; sometimes several tornado outbreaks result from a large storm system.

In addition to the April 27, 2011, outbreak, other notable outbreaks in the Southeast include:

The Super Outbreak of April 3–4, 1974

- 148 tornadoes responsible for 330 fatalities
- Approximately 5,484 injuries
- Approximately $600 million (1975 dollars) in damages
- Tornadoes affected 13 States from Alabama to Michigan

Table 1: Tornado occurrences in FEMA Region IV

States in FEMA Region IV	Total Tornado Occurrences (1950–2010)	Total Fatalities (1950–2010)	Total Injuries (1950–2010)	Fatality Rank
Alabama	1,695	441	6,808	4
Florida	3,052	161	3,307	16
Georgia	1,381	190	4,059	14
Kentucky	741	180	3,310	15
Mississippi	1,790	443	6,223	2
North Carolina	1,116	114	2,536	17
South Carolina	894	60	1,693	23
Tennessee	960	399	5,114	5
TOTAL	11,629	1,988	33,050	

Values do not include Spring 2011 tornadoes.
SOURCE: TornadoHistoryProject.com, which compiles NOAA Storm Prediction Center data found at http://www.spc.noaa.gov/wcm/#data

The Carolinas Outbreak of March 28, 1984
- 22 tornadoes responsible for 57 fatalities
- Approximately 1,250 injuries
- Approximately $200 million (1984 dollars) in damages
- 37 percent of fatalities occurred in manufactured homes

The Palm Sunday Outbreak of March 27, 1994
- 27 tornadoes responsible for 42 fatalities
- Approximately 491 injuries
- Approximately $107 million (1994 dollars) in damages
- Tornadoes hit Alabama, Georgia, South Carolina, and North Carolina

The Enterprise, Alabama Tornado of March 1, 2007
- 8 fatalities and 50 injuries in Enterprise High School
- The fatalities occurred when walls and roof structure collapsed onto a group of students huddled in the hallway in a crouched position
- Tornado estimated at an EF4

In 2010, the Alabama Building Commission passed a bill (Act 2010-746 Safe Space) requiring that all new K-12 school construction projects awarded after July 1, 2010, provide a storm shelter that complies with the ICC-500 storm shelter standard. This was in large part due to the tragic events of March 1, 2007, when a tornado destroyed the Enterprise High School, killing 7 students and 1 teacher.

Assessing Your Risk

To determine if you have a low, moderate, or high tornado risk, use the Frequency map (Figure 2) to determine how many tornadoes were recorded per 2,470 square miles for the area where your building is located. Find the row in Table 2 that matches that number. Next, look at the Wind Speed map (Figure 3) and note the design wind speed (130 mph, 160 mph, 200 mph, 250 mph) for your building location. Find the matching column in Table 2 and find the box that lines up with both the number of tornadoes per 2,470 square miles in your area and your wind speed. The color in that box tells you the level of your risk from extreme winds and helps you decide whether to build a safe room. A safe room is the preferred method of wind protection in high-risk areas.

Example: If your building is located in Birmingham, Alabama, you would see that Birmingham is in an area shaded red on the Frequency map (Figure 2). According to that map, the number of tornadoes per 2,470 square miles in the Birmingham area is >15. On the Wind Speed map (Figure 3), Birmingham is within the dark blue area, identified by the map key with a design wind speed of 250 mph. The box in the Risk Table (Table 2) where the frequency >15 row and the 250 mph wind speed column meet is shaded dark blue, which shows that the building is in an area of high risk.

Note that some areas of low or moderate risk, shown as pale blue or medium blue on Table 2, are within the region of the United States that is also subject to hurricanes (see Figure 3). If you live in this hurricane-prone region, your risk is considered high even if Table 2 shows a moderate or low risk.

Can a Building Survive a Tornado? Yes!

Tornado safe rooms can be designed and constructed to protect occupants from winds and wind-borne debris associated with all tornadoes (EF0–EF5). Buildings designed and constructed above basic code requirements (aka “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). Furthermore, even when stronger tornadoes strike, not all damage is from the rotating vortex of the tornado. Much of the damage is from straight-line winds rushing toward and being pulled into the tornado itself. Many newer homes and commercial buildings designed and constructed to modern codes, such as the *International Residential Code* and *International Building Code* (2009 editions and newer), have load paths that better resist high-wind forces (specified in building codes for hurricane resistance) and may survive without structural failure. The damage to these newer homes and buildings is often 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 safe rooms to provide occupant protection from tornadoes. For information on designing safe rooms to resist the strongest tornadoes and hurricane events, see the Tornado Recovery Advisory RA2 titled “Safe Rooms: Selecting Design Criteria” (updated in 2011). For residential safe rooms, see the Tornado Recovery Advisory RA3 titled “Residential Sheltering: In-Residence and Stand-Alone Safe Rooms” (updated in 2011).

Unless a building has a specifically designed safe room, or occupants have access to a community safe room nearby, building owners should work with a qualified architect or engineer to identify the best available refuge areas in the building. For more information on best available refuge areas, see *Tornado Protection: Selecting Refuge Areas in Buildings* (FEMA P-431, 2009) and the Extreme-Wind Refuge Area Evaluation Checklists in *Design and Construction Guidance for Community Safe Rooms* (FEMA P-361, Appendix B1, 2008).

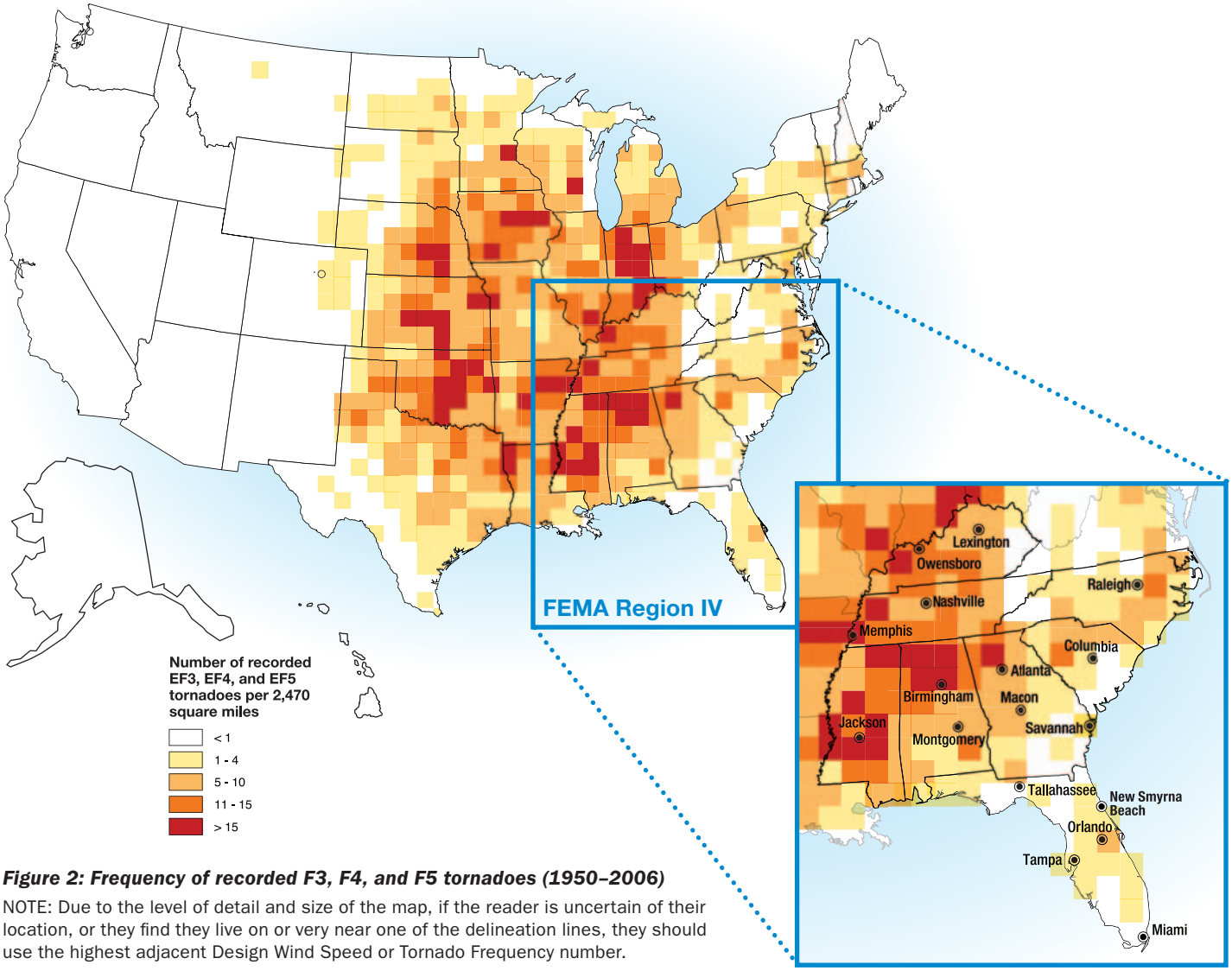

Figure 2: Frequency of recorded F3, F4, and F5 tornadoes (1950–2006)

NOTE: Due to the level of detail and size of the map, if the reader is uncertain of their location, or they find they live on or very near one of the delineation lines, they should use the highest adjacent Design Wind Speed or Tornado Frequency number.

SOURCE: FEMA 320, *Taking Shelter From the Storm: Building a Safe Room For Your Home or Small Business,* August 2008, 3rd Edition

Table 2: Levels of risk during high-wind events

Number of Tornadoes per 2,470 Square Miles (see Figure 2)	Design Wind Speed (see Figure 3)			
	130 mph	160 mph	200 mph	250 mph
<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.

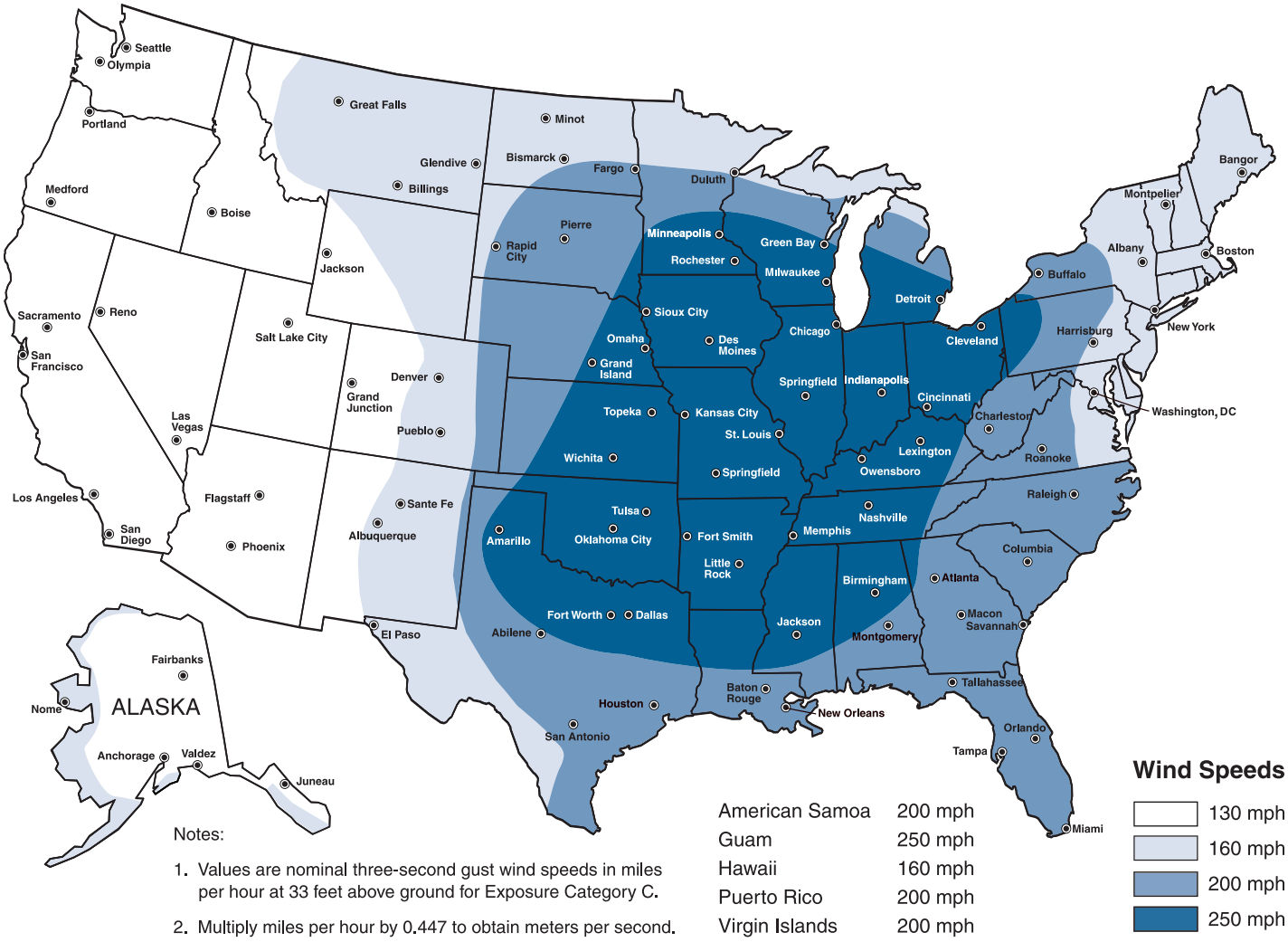

Figure 3: Tornado safe room design wind speeds in the United States

SOURCE: FEMA 361, *Design and Construction Guidance for Community Safe Rooms,* August 2008, 2nd Edition

Weather Radios

Everyone living or working in tornado-prone areas should have a weather radio at their home or place of work. A weather radio is particularly important for those living in areas that do not have storm warning sirens.

The NOAA Weather Radio (NWR) is a nationwide network of radio stations broadcasting continuous weather information directly from a nearby 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.

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 until a special tone is broadcast before watch and warning messages of an imminent life-threatening situation.
- Specific Area Message Encoding (SAME) technology, a NOAA Weather Radio 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.

- The NOAA Weather Radio should be operated on batteries 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, like strobe lights, pagers, bed-shakers, personal computers, and text printers.

Automated Spanish translation systems are available for use on transmitters serving a significant Hispanic population to broadcast Spanish translations of all emergency weather and natural hazard messages immediately after the official Emergency Alert System (EAS) warning is issued. For more information in Spanish, please visit the NOAA Web site http://www.weather.gov/nwr/indexsp.htm.

Other Methods to Receive Forecasts, Watches, and Warnings:

- Tune in to your local radio and television stations for the latest weather forecasts, watches, and warnings. In the event of power loss, battery-operated weather radios can be an interim solution to receive 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 the NWS's essential information is available on 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 may set various alarms 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.

FEMA is in the process of introducing the Personal Localized Alerting Network (PLAN), which will allow customers with certain types of mobile devices, such as smartphones, to receive emergency alerts specific to their location. Some cities are planned to be online by the end of 2011, and large portions of the United States should have the service by mid-2012. This service will enable certain national, State, and local agencies to send customers alerts for public safety emergencies like tornado warnings and watches. Customers with PLAN-capable devices will be notified by text message of emergencies relevant to their geographic area.

National Weather Service StormReady Program

In addition to the guidance and outreach offered by FEMA, the National Weather Service has established the StormReady Program to help communities prepare for extreme weather events. The StormReady Program, established in 1999, helps communities establish the communication and safety skills and awareness to reduce impacts from extreme events. This is done by strengthening local safety programs and helping communities with advanced planning, education, and awareness. Through this program, the National Weather Service also provides a number of publications and other forms of information on various types of natural hazards. Visit http://www.stormready.noaa.gov for more information.

Useful Links and Resources

Taking Shelter from the Storm: Building a Safe Room For Your Home or Small Business (FEMA 320), August 2008, 3rd Edition. http://www.fema.gov/library/viewRecord.do?id=1536

Design and Construction Guidance for Community Safe Rooms (FEMA 361) August 2008, 2nd Edition. http://www.fema.gov/library/viewRecord.do?id=1657

Tornado Protection: Selecting Refuge Areas in Buildings (FEMA P-431), FEMA, October 2009, 2nd Edition. http://www.fema.gov/library/viewRecord.do?id=1563

National Storm Shelter Association (NSSA). http://www.NSSA.cc

ICC/NSSA Standard for the Design and Construction of Storm Shelters (ICC-500), June 2008. http://www.iccsafe.org/Store/Pages/Product.aspx?id=8850P08_PD-X-SS-P-2008-000001