thunderstorms... tornadoes... lightning...

Nature's Most Violent Storms

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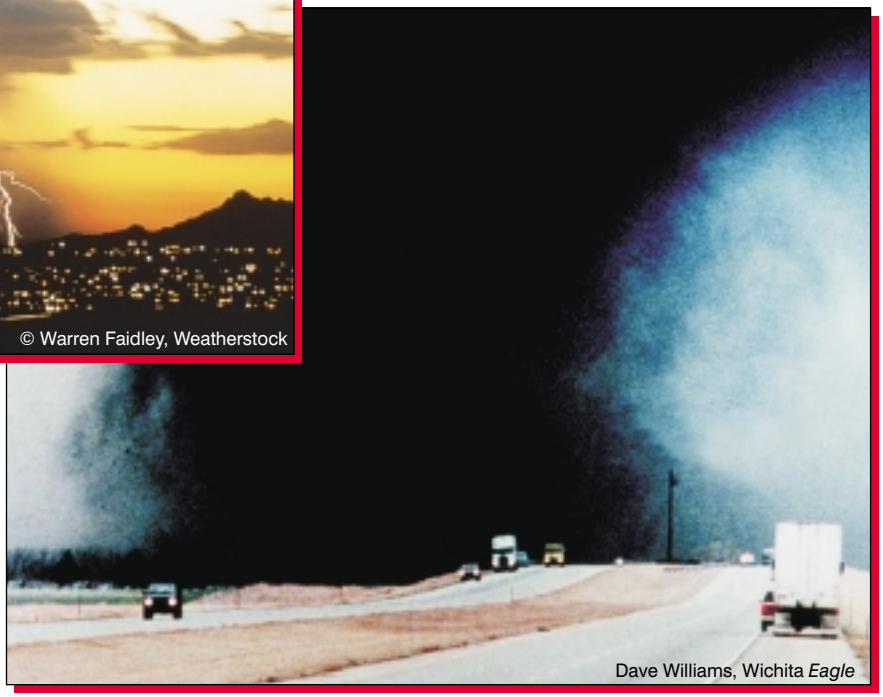


Dave Williams, Wichita *Eagle*

A PREPAREDNESS GUIDE

Including Tornado Safety Information for Schools

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service

American Red Cross

FAMILY DISASTER PLAN

Families should be prepared for all hazards that could affect their area. NOAA's National Weather Service, the Federal Emergency Management Agency, and the American Red Cross urge every family to develop a family disaster plan.

Where will your family be when disaster strikes? They could be anywhere—at work, at school, or in the car. How will you find each other? Will you know if your children are safe? Disaster may force you to evacuate your neighborhood or confine you to your home. What would you do if basic services—water, gas, electricity, or telephones—were cut off?

Follow these basic steps to develop a family disaster plan...

I. Gather information about hazards. Contact your local National Weather Service office, emergency management office, and American Red Cross chapter. Find out what type of disasters could occur and how you should respond. Learn your community's warning signals and evacuation plans.

II. Meet with your family to create a plan. Discuss the information you have gathered. Pick two places to meet: a spot outside your home for an emergency, such as fire, and a place away from your neighborhood in case you can't return home. Choose an out-of-state friend as your "family check-in contact" for everyone to call if the family gets separated. Discuss what you would do if advised to evacuate.

III. Implement your plan. (1) Post emergency telephone numbers by phones; (2) Install safety features in your house, such as smoke detectors and fire extinguishers; (3) Inspect your home for potential hazards (such as items that can move, fall, break, or catch fire) and correct them; (4) Have your family learn basic safety measures, such as CPR and first aid; how to use a fire extinguisher; and how and when to turn off water, gas, and electricity in your home; (5) Teach children how and when to call 911 or your local Emergency Medical Services number; (6) Keep enough supplies in your home to meet your needs for at least three days. Assemble a disaster supplies kit with items you may need in case of an evacuation. Store these supplies in sturdy, easy-to-carry containers, such as backpacks or duffle bags. Keep important family documents in a waterproof container. Keep a smaller disaster supplies kit in the trunk of your car.

A DISASTER SUPPLIES KIT SHOULD INCLUDE:

A 3-day supply of water (one gallon per person per day) and food that won't spoil • one change of clothing and footwear per person • one blanket or sleeping bag per person • a first aid kit, including prescription medicines • emergency tools, including a battery-powered NOAA Weather Radio and a portable radio, flashlight, and plenty of extra batteries • an extra set of car keys and a credit card or cash • special items for infant, elderly, or disabled family members.

IV. Practice and maintain your plan. Ask questions to make sure your family remembers meeting places, phone numbers, and safety rules. Conduct drills. Test your smoke detectors monthly and change the batteries two times each year. Test and recharge your fire extinguisher(s) according to manufacturer's instructions. Replace stored water and food every 6 months. Contact your local National Weather Service office, American Red Cross chapter, or local office of emergency management for a copy of "Your Family Disaster Plan" (L-191/ARC4466).

LOCAL SPONSORSHIP:

NOAA/PA 99050
ARC 1122

Introduction...

This preparedness guide explains thunderstorms and related hazards and suggests life-saving actions YOU can take. With this information, YOU can recognize severe weather, develop a plan, and be ready to act when threatening weather approaches. Remember...your safety is up to YOU!

Why Talk About Thunderstorms? They Produce...

■ Tornadoes...

- ✔ Cause an average of 70 fatalities and 1,500 injuries each year.
- ✔ Produce wind speeds in excess of 250 mph.
- ✔ Can be one mile wide and stay on the ground over 50 miles.

■ Lightning...

- ✔ Causes an average of 80 fatalities and 300 injuries each year.
- ✔ Occurs with all thunderstorms.

■ Strong Winds...

- ✔ Can exceed 100 mph.
- ✔ Can cause damage equal to a tornado.
- ✔ Can be extremely dangerous to aviation.

■ Flash Flooding...

- ✔ Is the #1 cause of deaths associated with thunderstorms...more than 140 fatalities each year.

■ Hail...

- ✔ Causes more than $1 billion in crop and property damage each year.

For More Information

Contact your local National Weather Service office, American Red Cross chapter, or the Federal Emergency Management Agency for a variety of weather-related brochures. Specific information on flash flooding can be found in the "Flash Floods and Floods...The Awesome Power" brochure (NOAA PA 92050). Brochures can be viewed and downloaded from the Internet at **www.nws.noaa.gov/om/brochures.shtml** Preparedness information can be obtained from the Federal Emergency Management Agency at **www.fema.gov/library/prepandprev.shtm** or the Red Cross at www.redcross.org/services/disaster/keepsafe/

Thunderstorms…

Thunderstorms affect relatively small areas when compared with hurricanes and winter storms. Despite their small size, ALL thunderstorms are dangerous! The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10 percent are classified as severe.

1,800 thunderstorms occur at any moment around the world. That's 16 million a year!

What Are Thunderstorms? What Causes Them?

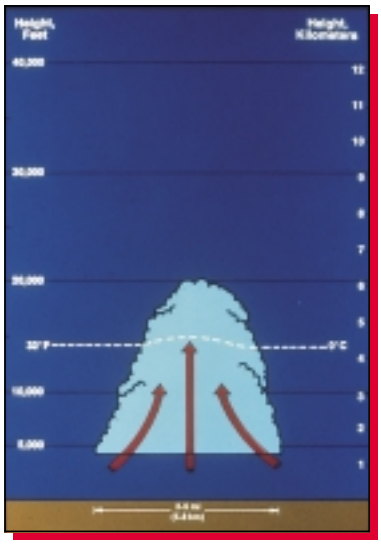
- The National Weather Service considers a thunderstorm severe if it produces hail at least 3/4-inch in diameter, winds of 58 mph or stronger, or a tornado.
- Every Thunderstorm Needs:

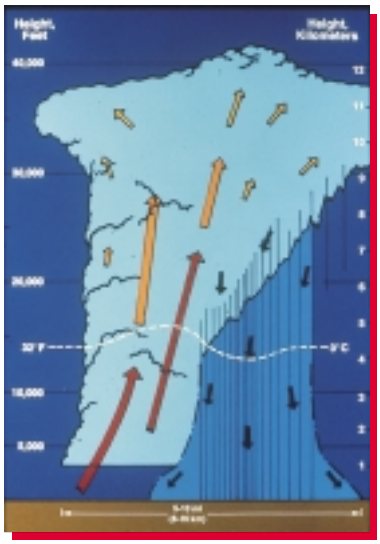
Moisture – to form clouds and rain.

Unstable air – warm air that can rise rapidly.

Lift – cold or warm fronts, sea breezes, mountains, or the sun's heat are capable of lifting air to help form thunderstorms.

Life Cycle of a Thunderstorm





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Developing Stage

- Towering cumulus cloud indicates rising air.
- Usually little if any rain during this stage.
- Lasts about 10 minutes.
- Occasional lightning.

Mature Stage

- Most likely time for hail, heavy rain, frequent lightning, strong winds, and tornadoes.
- Storm occasionally has a black or dark green appearance.
- Lasts an average of 10 to 20 minutes but may last much longer in some storms.

Dissipating Stage

- Rainfall decreases in intensity.
- Can still produce a burst of strong winds.
- Lightning remains a danger.

Tornadoes…

Although tornadoes occur in many parts of the world, they are found most frequently in the United States. In an average year, 1,200 tornadoes cause 70 fatalities and 1,500 injuries nationwide. You can find statistical information on tornadoes at **www.spc.noaa.gov**.

Tornado Facts

- A tornado is a violently rotating column of air extending from a thunderstorm to the ground.
- Tornadoes may appear nearly transparent until dust and debris are picked up or a cloud forms within the funnel. The average tornado moves from southwest to northeast, but tornadoes have been known to move in any direction.
- The average forward speed is 30 mph but may vary from nearly stationary to 70 mph.
- The strongest tornadoes have rotating winds of more than 250 mph.
- Tornadoes can accompany tropical storms and hurricanes as they move onto land.
- Waterspouts are tornadoes which form over warm water. They can move onshore and cause damage to coastal areas.

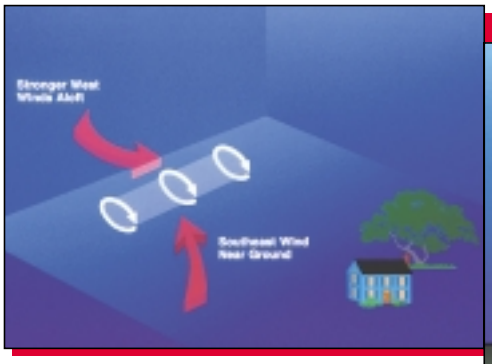
When and Where Tornadoes Occur

- Tornadoes can occur at any time of the year.
- Tornadoes have occurred in every state, but they are most frequent east of the Rocky Mountains during the spring and summer months.
- In the southern states, peak tornado occurrence is March through May, while peak months in the northern states are during the late spring and summer.
- Tornadoes are most likely to occur between 3 and 9 p.m. but can happen at any time.

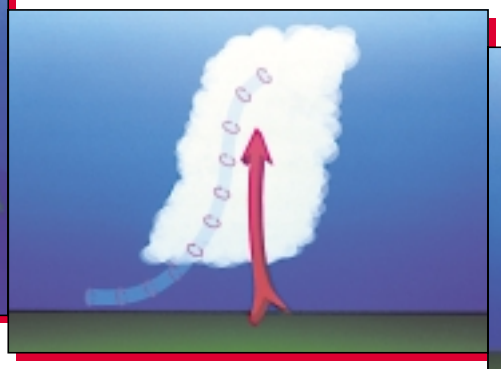
© Greg Stumpf

How Tornadoes Form

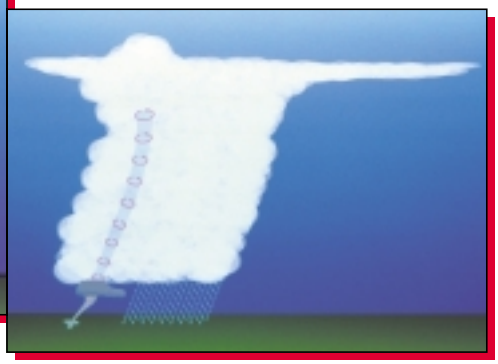
Before thunderstorms develop, a change in wind direction and an increase in wind speed with increasing height creates an invisible, horizontal spinning effect in the lower atmosphere.



Rising air within the thunderstorm updraft tilts the rotating air from horizontal to vertical.



An area of rotation, 2-6 miles wide, now extends through much of the storm. Most tornadoes form within this area of strong rotation.



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Tornadoes Take Many Shapes and Sizes

Weak Tornadoes

- 88% of all tornadoes
- Less than 5% of tornado deaths
- Lifetime 1 – 10+ minutes
- Winds less than 110 mph

Charles Doswell III

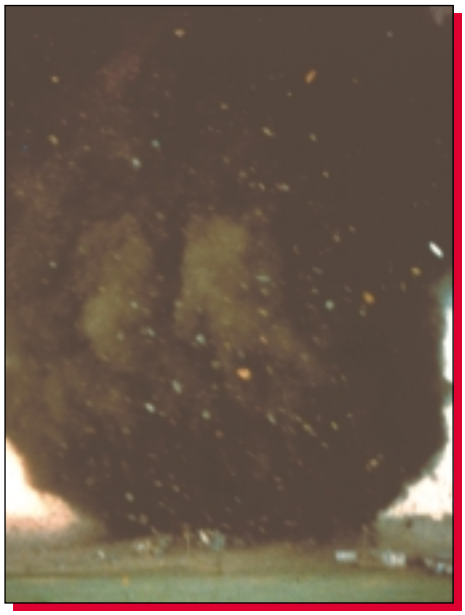
Strong Tornadoes

- 11% of all tornadoes
- Nearly 30% of all tornado deaths
- May last 20 minutes or longer
- Winds 110-205 mph

Mary Hurley

Violent Tornadoes

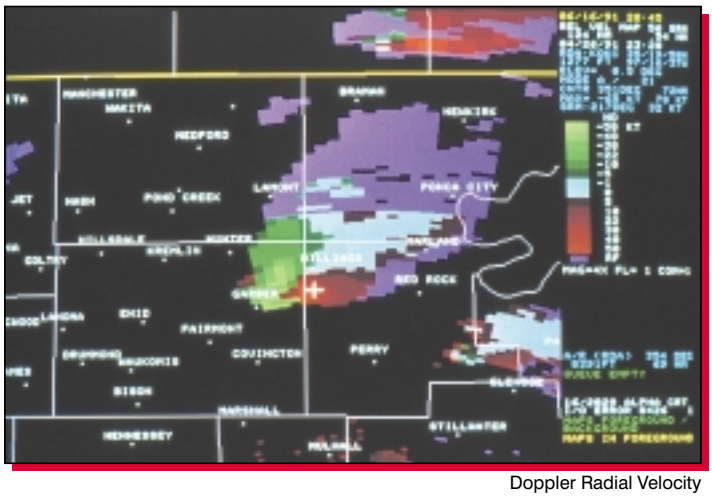
- Less than 1% of all tornadoes
- 70% of all tornado deaths
- Lifetime can exceed 1 hour
- Winds greater than 205 mph



Peter Willing

Weather Radar Watches the Sky

The National Weather Service has strategically located Doppler radars across the country that can detect air movement toward or away from a radar. Early detection of increasing rotation aloft within a thunderstorm can allow life-saving warnings to be issued before the tornado forms. In the figure below left, Weather Service Doppler radar detected strong rotation within the storm where red colors (winds moving away from the radar) and green (winds blowing toward the radar) are close together. The photograph at below right shows a violent tornado in northern Oklahoma at the same time the radar image was taken.



Doppler Radial Velocity

Jim Ladue

Tornado Myths and Truths

MYTH: Areas near lakes, rivers, and mountains are safe from tornadoes.
TRUTH: No place is safe from tornadoes. A tornado near Yellowstone National Park left a path of destruction up and down a 10,000 foot mountain.

MYTH: The low pressure with a tornado causes buildings to "explode" as the tornado passes overhead.
TRUTH: Violent winds and debris slamming into buildings cause most structural damage.

MYTH: Windows should be opened before a tornado approaches to equalize pressure and minimize damage.
TRUTH: Leave the windows alone. The most important action is to immediately go to a safe shelter.

MYTH: If you are driving and a tornado is sighted, you should turn and drive at right angles to the storm.
TRUTH: The best thing to do is to seek the best available shelter. Many people are injured or killed when remaining in their vehicles.

MYTH: People caught in the open should seek shelter under highway overpasses.
TRUTH: Take shelter in a sturdy reinforced building if at all possible. Overpasses, ditches, and culverts may provide limited protection from a tornado, but your risk will be greatly reduced by moving inside a strong building.

Frequently asked questions about tornadoes can be found on the Internet at ***www.spc.noaa.gov/faq/tornado/index.html***.

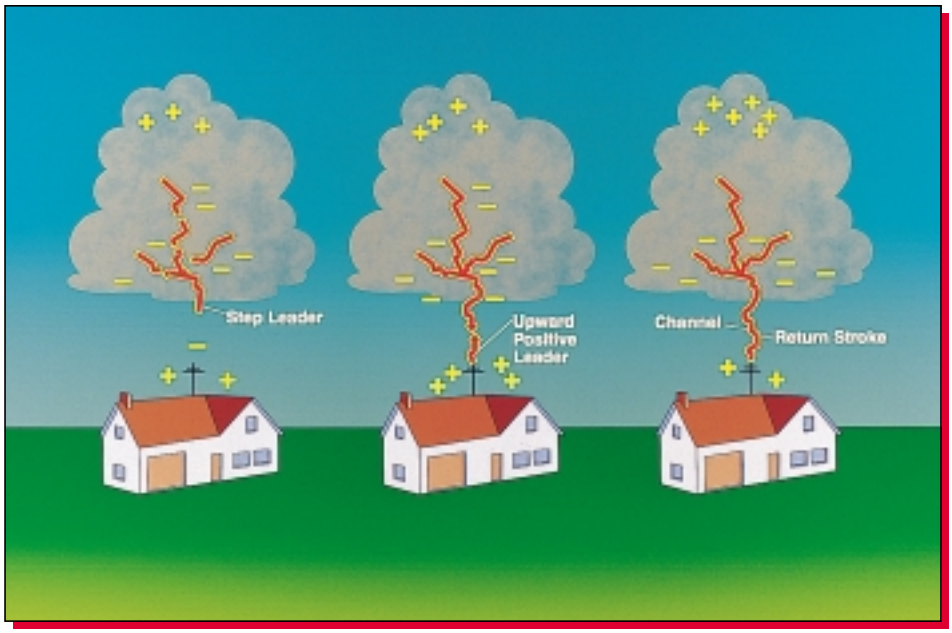
Lightning…

How Lightning Forms

Lightning results from the buildup and discharge of electrical energy between positively and negatively charged areas. Rising and descending air within a thunderstorm separates these positive and negative charges. Water and ice particles also affect charge distribution.

A cloud-to-ground lightning strike begins as an invisible channel of electrically charged air moving from the cloud toward the ground. When one channel nears an object on the ground, a powerful surge of electricity from the ground moves upward to the clouds and produces the visible lightning strike.

Johnny Autery



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Lightning Facts

- Lightning causes an average of 80 fatalities and 300 injuries each year.
- Lightning occurs in all thunderstorms; each year lightning strikes the Earth 20 million times.
- The energy from one lightning flash could light a 100-watt light bulb for more than 3 months.
- Most lightning fatalities and injuries occur when people are caught outdoors in the summer months during the afternoon and evening.
- Lightning can occur from cloud-to-cloud, within a cloud, cloud-to-ground, or cloud-to-air.
- Many fires in the western United States and Alaska are started by lightning.
- The air near a lightning strike is heated to 50,000°F – *hotter than the surface of the sun!* The rapid heating and cooling of the air near the lightning channel causes a shock wave that results in **thunder**.

How far away is the Thunderstorm?

- Count the number of seconds between a flash of lightning and the next clap of thunder.
- Divide this number by 5 to determine the distance to the lightning in miles.

In recent years, people have been killed by lightning while:

- ✔ boating
- ✔ swimming
- ✔ golfing
- ✔ bike riding
- ✔ standing under a tree
- ✔ riding on a lawnmower
- ✔ talking on the telephone
- ✔ loading a truck
- ✔ riding a horse
- ✔ playing soccer
- ✔ fishing in a boat
- ✔ mountain climbing

Lightning Myths and Truths

MYTH: If it is not raining, then there is no danger from lightning.
TRUTH: Lightning often strikes outside of heavy rain and may occur as far as 10 miles away from any rainfall. This is especially true in the western United States where thunderstorms sometimes produce very little rain.

MYTH: The rubber soles of shoes or rubber tires on a car will protect you from being struck by lightning.
TRUTH: Rubber-soled shoes and rubber tires provide **NO** protection from lightning. The steel frame of a hard-topped vehicle provides increased protection if you are not touching metal. Although you may be injured if lightning strikes your car, you are much safer inside a vehicle than outside.

MYTH: People struck by lightning carry an electrical charge and should not be touched.
TRUTH: Lightning-strike victims carry no electrical charge and should be attended to immediately. Contact your local American Red Cross chapter for information on CPR and first aid classes.

MYTH: "Heat lightning" occurs after very hot summer days and poses no threat.
TRUTH: "Heat lightning" is a term used to describe lightning from a thunderstorm too far away for thunder to be heard.

Robert Prentice

30/30 Lightning Safety Rule

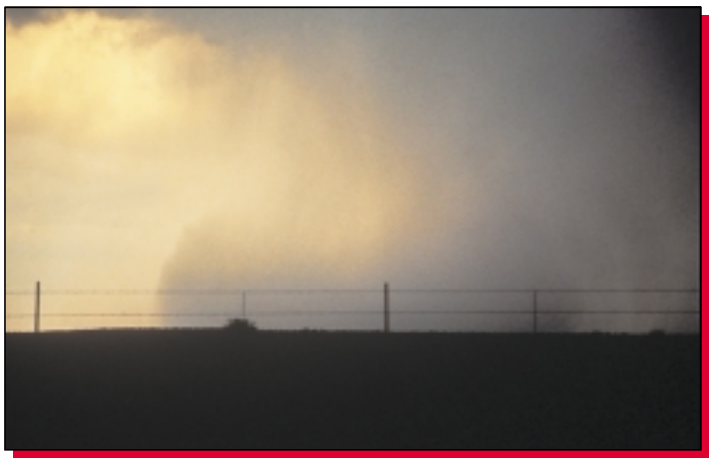
Go indoors if, after seeing lightning, you cannot count to 30 before hearing thunder. Stay indoors for 30 minutes after hearing the last clap of thunder.

Straight-line Winds…

- Straight-line winds are responsible for most thunderstorm wind damage.
- Winds can exceed 100 mph!
- One type of straight-line wind, the downburst, is a small area of rapidly descending air beneath a thunderstorm (see center of photograph below).
- A downburst can cause damage equivalent to a strong tornado and can be extremely dangerous to aviation.
- A "dry microburst" is a downburst that occurs with little or no rain. These destructive winds are most common in the western United States.

Brandt Graham

Bill Bunting



Bill Bunting

Flash Floods / Floods…

© Warren Faidley, Weatherstock

- Flash floods and floods are the #1 cause of deaths associated with thunderstorms...more than 140 fatalities each year.
- Most flash flood fatalities occur at night and most victims are people who become trapped in automobiles.
- Six inches of fast-moving water can knock you off your feet; a depth of two feet will cause most vehicles to float.

For more information, refer to the Flash Floods and Floods...The Awesome Power brochure on the Internet at ***www.nws.noaa.gov/om/brochures.shtml***

Large Hail…

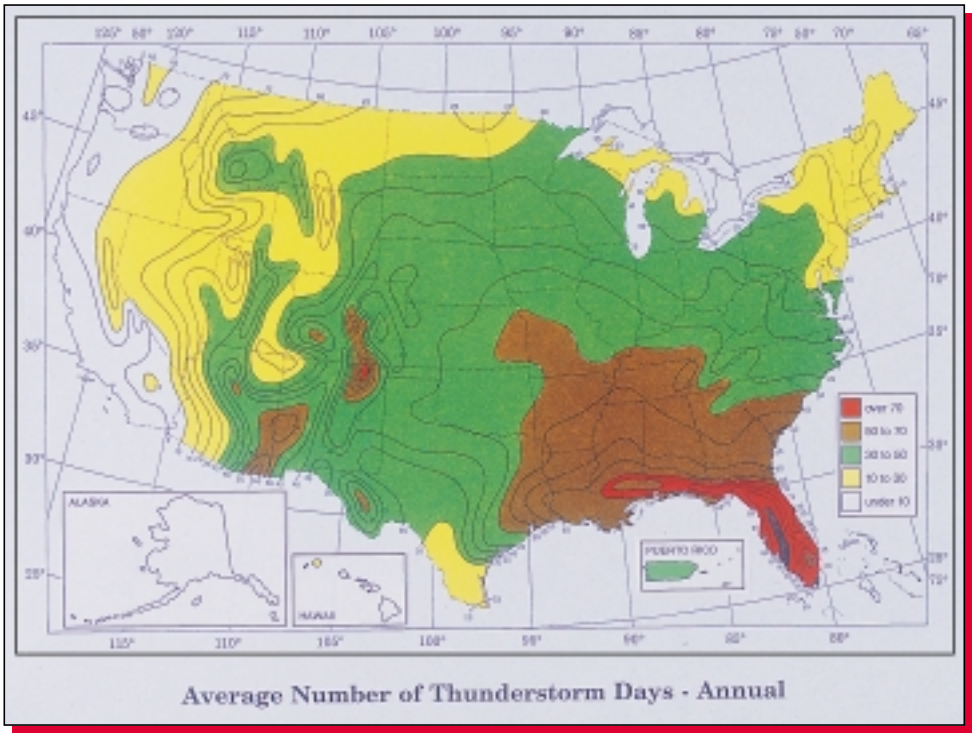
National Center for Atmospheric Research

- Causes more than $1 billion in damage to property and crops each year.
- Large stones fall at speeds faster than 100 mph.

- Strong rising currents of air within a storm, called updrafts, carry water droplets to a height where freezing occurs.
- Ice particles grow in size, becoming too heavy to be supported by the updraft, and fall to the ground.

National Severe Storms Laboratory, NOAA

Who's Most At Risk from Thunderstorms?



National Climatic Data Center, NOAA

From Lightning

- People who are outdoors, especially under or near tall trees; in or on water; or on or near hilltops.

From Flash Flooding

- People who walk or drive through flood waters.

From Tornadoes

- People who are in mobile homes and automobiles.

Be Prepared…

It's Up to YOU!

Each year, many people are killed or seriously injured by tornadoes and severe thunderstorms despite advance warning. Some did not hear the warning, while others heard the warning but did not believe it would happen to them. The following preparedness information, combined with timely severe weather watches and warnings, could save your life. Once you receive a warning or observe threatening skies, YOU must make the decision to seek shelter before the storm arrives. It could be the most important decision you will ever make.

What YOU Can Do Before Severe Weather Strikes

- Develop a plan for you and your family at home, work, school, and when outdoors. The American Red Cross offers planning tips on their Internet site: **www.redcross.org/services/disaster/keepsafe/**
- Identify a safe place to take shelter. Information on how to build a Safe Room (shown in the photos below) in your home or school is available from the Federal Emergency Management Agency at **www.fema.gov/hazard/tornado/to_saferoom.shtm**
- Have frequent drills.
- Know the county/parish in which you live or visit. The National Weather Service issues severe weather warnings on a county or parish basis.
- Keep a highway map nearby to follow storm movement from weather bulletins.
- Have a NOAA Weather Radio with a warning alarm tone and battery back-up to receive warnings.
- National Weather Service watches and warnings are also available on the Internet. Select your local National Weather Service office at **www.nws.noaa.gov/organization.html** or go to the National Weather Service Home Page at **www.nws.noaa.gov**.
- Listen to radio and television for weather information.
- Check the weather forecast before leaving for extended periods outdoors. Watch for signs of approaching storms.
- If severe weather threatens, check on people who are elderly, very young, or physically or mentally disabled.

FEMA

NOAA

What YOU Can Do When Threatening Weather Approaches

Lightning Safety Rules

- Postpone outdoor activities if thunderstorms are imminent. This is your best way to avoid being caught in a dangerous situation.
- Move to a sturdy building or car. Do not take shelter in small sheds, under isolated trees, or in convertible automobiles. Stay away from tall objects such as towers, fences, telephone poles, and power lines.
- If lightning is occurring and a sturdy shelter is not available, get inside a hard top automobile and keep the windows up. Avoid touching any metal.
- Utility lines and metal pipes can conduct electricity. Unplug appliances not necessary for obtaining weather information. Avoid using the telephone or any electrical appliances. Use phones ONLY in an emergency.

NOAA

- Do not take a bath or shower during a thunderstorm.
- Turn off air conditioners. Power surges from lightning can cause serious damage.

If Caught Outdoors and No Shelter Is Nearby

Todd Heitkamp

- Find a low spot away from trees, fences, and poles. Make sure the place you pick is not subject to flooding.
- If you are in the woods, take shelter under the shorter trees.
- If you feel your skin tingle or your hair stand on end, squat low to the ground on the balls of your feet. Place your hands over your ears and your head between your knees. Make yourself the smallest target possible and minimize your contact with the ground. DO NOT lie down.
- If you are boating or swimming, get to land and find shelter immediately!

Remember, if you can hear thunder – you are close enough to be struck by lightning!

Tornado Safety Rules

- In a home or building, move to a pre-designated shelter, such as a basement.
- If an underground shelter is not available, move to a small interior room or hallway on the lowest floor and get under a sturdy piece of furniture. Put as many walls as possible between you and the outside.
- Stay away from windows.
- Get out of automobiles.
- Do not try to outrun a tornado in your car; instead, leave it immediately for safe shelter.
- If caught outside or in a vehicle, lie flat in a nearby ditch or depression and cover your head with your hands.
- Be aware of flying debris. Flying debris from tornadoes causes most fatalities and injuries.
- Mobile homes, even if tied down, offer little protection from tornadoes. You should leave a mobile home and go to the lowest floor of a sturdy nearby building or a storm shelter.

Bill Bunting

NOAA

Flash Flood Safety Rules

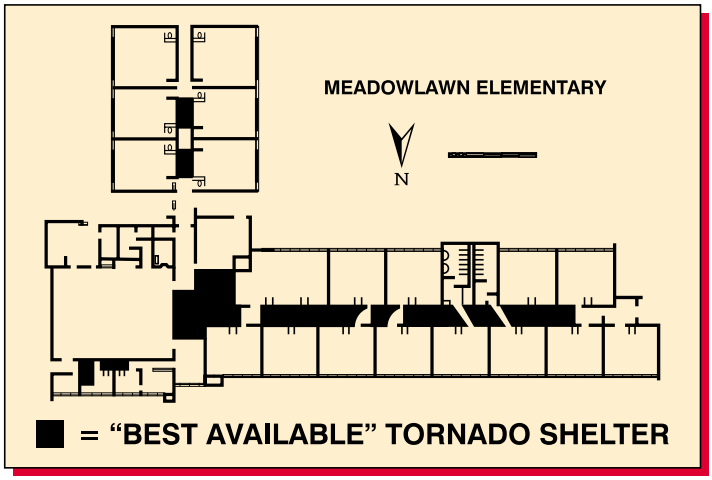
- Avoid walking, swimming, or driving in flood waters.
- Stay away from high water, storm drains, ditches, ravines, or culverts. If it is moving swiftly, even water six inches deep can knock you off your feet.
- If you come upon flood waters, stop, turn around, and go another way. Climb to higher ground.
- Do not let children play near storm drains.

Occasionally, tornadoes develop so rapidly that advance warning is not possible. Remain alert for signs of an approaching tornado such as a dark, often greenish sky, large hail, or a loud roar similar to a freight train.

Tornado Safety in Schools…

Every School Should Have a Plan

- Develop an action plan with frequent drills.
- Each school should be inspected and shelter areas designated by a registered engineer or architect. Basements offer the best protection. Schools without basements should use interior rooms and hallways on the lowest floor and away from windows.
- Ensure students know the protection position (shown at right).
- Each school should have a NOAA Weather Radio with battery back-up.
- If the school's alarm system relies on electricity, have an alternative method to notify teachers and students in case of power failure.
- Make special provisions for disabled students and those in portable classrooms.
- Delay lunches or assemblies in large rooms if severe weather is anticipated. Gymnasiums, cafeterias, and auditoriums offer no protection from tornado-strength winds.
- Keep children at school beyond regular hours until threatening weather passes. Children are safer at school than in a bus or car.



NOAA

Hospitals, nursing homes, and other institutions should develop similar plans.

The National Weather Service, the Federal Emergency Management Agency, and the American Red Cross educate community officials and the public about the dangers posed by tornadoes and severe thunderstorms. YOU can prepare for this possibility by learning the safest places to seek shelter when at home, work, school, or outdoors. Learn basic weather terms and danger signs. Your chances of staying safe during severe weather are greater if you have a plan for you and your family, and practice the plan frequently.

Stay Informed… Use NOAA Weather Radio

NOAA

NOAA Weather Radio is the best means to receive warnings from the National Weather Service

The National Weather Service continuously broadcasts warnings and forecasts that can be received by NOAA Weather Radios, which are sold in many stores. The average range is 40 miles, depending on topography. Purchase a radio that has a battery back-up and a Specific Area Message Encoder feature, which automatically alerts you when a watch or warning is issued for your county or parish.

When conditions are favorable for severe weather to develop, a severe thunderstorm or tornado WATCH is issued. Weather Service personnel use information from weather radar, spotters, and other sources to issue severe thunderstorm and tornado WARNINGS for areas where severe weather is imminent. Severe thunderstorm and tornado warnings are passed to local radio and television stations and are broadcast over local NOAA Weather Radio stations serving the warned areas. These warnings are also relayed to local emergency management and public safety officials who can activate local warning systems to alert communities. If a tornado warning is issued for your area or the sky becomes threatening, move to your pre-designated place of safety.

Check with your local National Weather Service office or visit the Internet site **www.nws.noaa.gov/nwr/** to determine if your county is covered by NOAA Weather Radio. National Weather Service watches and warnings are also available on the Internet by selecting your local National Weather Service office at **www.nws.noaa.gov/organization.html** or by going to the National Weather Service Home Page at **www.nws.noaa.gov**.

What to Listen For...

Tornado Watch: Tornadoes are possible in your area. Remain alert for approaching storms. Know what counties or parishes are in the watch area by listening to NOAA Weather Radio or your local radio/television outlets.

Severe Thunderstorm Watch: Tells you when and where severe thunderstorms are likely to occur. Watch the sky and stay tuned to know when warnings are issued.

Tornado Warning: A tornado has been sighted or indicated by weather radar.

Severe Thunderstorm Warning: Issued when severe weather has been reported by spotters or indicated by radar. Warnings indicate imminent danger to life and property to those in the path of the storm.