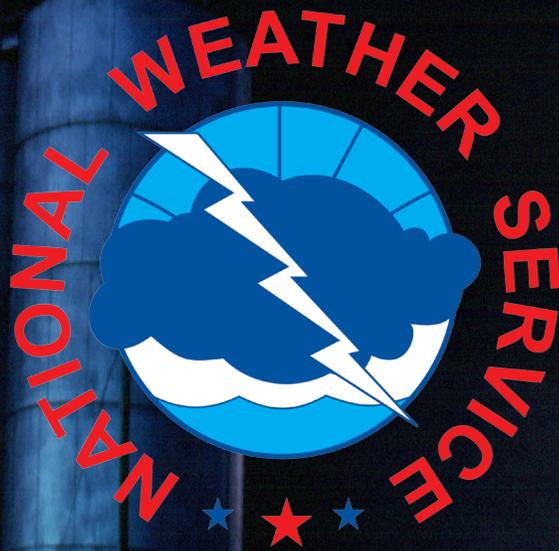


Preparing for the Storm

A Severe Weather Guide for High
Population Facilities



National Weather Service
www.weather.gov/fortworth

Introduction



Hazardous weather is no stranger here in Texas. From tornadoes to flash floods, from drought to ice storms, Texas is at the center of one of the most active weather regions in the world. While some of these events are viewed as “inconveniences”, events such as tornadoes, severe thunderstorms, and flash floods can truly be life-threatening events.

The National Weather Service’s primary mission is to protect life and property by issuing warnings, statements, and advisories in advance of potentially hazardous weather. We spend a great deal of effort working with local emergency managers and media outlets to ensure that our severe weather products are disseminated as widely and quickly as possible. We also engage in a safety and preparedness education campaign with local community agencies, so that people will respond correctly when warnings are issued.

Large institutions such as schools, colleges, hospitals, stadiums, and industrial plants pose a particular concern regarding severe weather safety. These facilities typically house several dozen to several thousand employees and/or visitors, all of whom must quickly be moved to shelter if a storm approaches. Isolated facilities, widespread campuses, and portable buildings magnify the potential vulnerability of these complexes to the effects of severe weather.

This guide is designed to help you evaluate your facility’s severe weather preparedness plan. We will discuss the primary severe weather threats we face, and provide some general safety tips to follow when severe weather is in the area. We will then focus on issues specific to the preparedness plan at your location.

Severe Weather Threats -- Tornadoes

Although tornadoes occur in many parts of the world, these destructive forces of nature are found most frequently in the United States east of the Rocky Mountains during the spring and summer months. In an average year, 800 tornadoes are reported nationwide, resulting in 80 deaths and over 1,500 injuries. Texas leads the nation with over 120 tornadoes reported each year.

A tornado is defined as a violently rotating column of air extending from a thunderstorm to the ground. The most violent tornadoes are capable of tremendous destruction with wind speeds of 200 mph or more. Damage paths can be in excess of one mile wide and 50 miles long.



What Causes Tornadoes?



Above: Seymour, Texas (1979)

During the spring in the Plains, thunderstorms frequently develop along a “dryline,” which separates warm, moist air to the east from hot, dry air to the west. Thunderstorms may form as the dryline moves east during the afternoon hours. If other favorable conditions exist, these thunderstorms can produce tornadoes.

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 strong and violent tornadoes form within this area of strong rotation.

Tornado Classification and Facts

Classification - EF Scale	% of all Tornadoes	% of Tornado Deaths	Lifetime	Wind Speed
Weak EF0-EF1	82%	Less than 5%	1-10 mins	Up to 110 mph
Strong EF2-EF3	17%	Near 30%	20+ mins	110-165 mph
Violent EF4-EF5	1%	Near 70%	Up to 1 hour	166+ mph

- ▶ **Tornadoes can occur at any time of the year.**
- ▶ **In Texas, peak tornado occurrence is in March through May.**
- ▶ **A secondary tornado maximum can occur in the fall.**
- ▶ **Tornadoes are most likely to occur between 4 and 10 p.m. but have been known to occur at all hours of the day or night.**
- ▶ **Most tornadoes in north Texas move from southwest to northeast, or from west to east. However, tornadoes can move in any direction.**
- ▶ **The average forward speed is 30 mph but may vary from nearly stationary to 70 mph.**
- ▶ **Dr. T.T. Fujita developed the Fujita scale. The scale roughly correlates the damage caused by a tornado to the strength of the tornado.**
- ▶ **In 2007, meteorologists and engineers introduced a revised version of the Fujita Scale, shown in the table above, called the “Enhanced Fujita” or “EF” scale.**

Severe Weather Threats -- Flash Floods



A flash flood is a life-threatening event. Floods and flash floods are the #1 thunderstorm-related killer, resulting in over 120 fatalities annually. A flash flood is defined as a rapid rise of water, usually during or after a period of heavy rain. Floodwaters may rise several feet in just a few minutes. Flash floods can also result from dam or levee failures.

Several factors contribute to flash flooding. The two key elements are rainfall intensity and duration. Intensity is the rate of rainfall, and duration is how long the rain lasts. Topography, soil conditions, and ground cover also play an important role. Most flash flooding is caused by slow-moving thunderstorms, thunderstorms repeatedly moving over the same area, or heavy rains from hurricanes and tropical storms. When this heavy rainfall occurs over an area covered by concrete and pavement, excessive runoff and flooding can occur.

Occasionally, floating debris can accumulate at a natural or man-made obstruction and restrict the flow of water. Water held back by the debris dam can cause flooding upstream. Subsequent flash flooding can occur downstream if the obstruction should suddenly release.

Vehicle Dangers and Flash Flooding

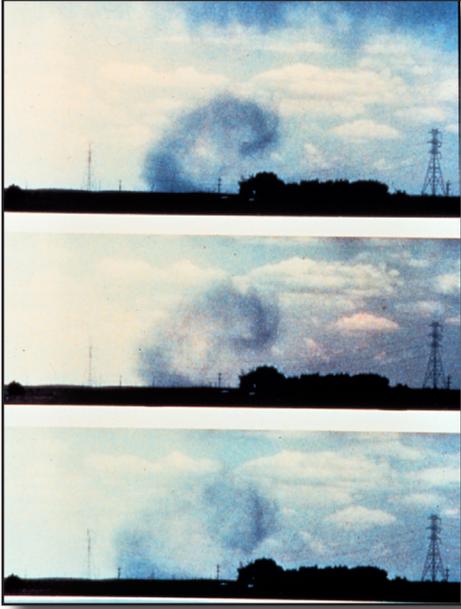
Nearly half of all flash flood fatalities are vehicle-related. In a school bus, truck, or car, look out for flooding at highway dips, bridges, and low areas. Many flash floods occur at night, so be prepared to take quick action.

How can a foot or two of water cost you your life? Water weighs 62.4 lbs. per cubic foot and typically flows at 9 miles an hour. When a vehicle stalls, the water's momentum transfers to the vehicle. For each foot the water rises, 500 lbs. of lateral force are applied to the vehicle. But, the biggest factor is buoyancy. For each foot the water rises up the side of the vehicle, the vehicle displaces 1,500 lbs. of water. In effect, the vehicle weighs 1,500 lbs. less for each foot the water rises. Two to three feet of water will carry away most vehicles. Trucks and buses with large tires are especially dangerous, because the large tires actually help float the vehicle off of the road.



Above: Vehicle stalled in low water crossing.

Severe Weather Threats -- Winds



The “straight line” wind events from thunderstorms are called downbursts. A downburst is a small area of rapidly descending air beneath a thunderstorm. The air strikes the ground and rapidly moves out from the impact point. Downbursts can cause damaging winds in excess of 100 mph, and may or may not be accompanied by rain. In Texas, downbursts are much more common than tornadoes. Most of the wind damage caused by thunderstorms is caused by downbursts. Because of this, the threat posed by “non-tornadic” thunderstorms should be taken as seriously as that posed by tornadoes.

Left: Sequence of photos showing a powerful downburst.

Large Hail

Large hail is the most destructive weather element to affect the United States. Each year, hail causes about \$1 billion damage to vehicles, roofs, crops, livestock, and aircraft. The strong rising currents of air within a storm, called updrafts, carry water droplets to a height where freezing occurs. Ice particles grow in size, finally becoming too heavy to be supported by the updraft and fall to the ground. Hailstones can become as large as softballs and can fall at speeds faster than 100 mph. Although fatalities from hail are rare, they can occur.

Right: Large hail collecting on the ground.



Lightning

The action of rising and descending air within a thunderstorm separates positive and negative charges. Water and ice particles also affect the distribution of electrical charge. Lightning results from the buildup and discharge of electrical energy between positively and negatively charged areas. Lightning is extremely powerful. The average flash could light a 100-watt light bulb for more than 3 months. The air near a lightning strike is heated to 50,000 degrees F, hotter than the surface of the sun! Your chances of being struck by lightning are estimated to be 1 in 600,000 but can be reduced by following safety rules. Most lightning deaths and injuries occur when people are caught outdoors, and most lightning casualties occur in the summer months and during the afternoon and early evening. The rapid heating and cooling of air near the lightning channel causes a shock wave that results in the thunder we hear.



Above: Cloud to ground lightning.

Preparing for the Storm

National Weather Service Products

▶ **TORNADO WATCH**

Tornadoes are possible in your area. Remain alert for approaching storms.

▶ **TORNADO WARNING**

A tornado has been sighted or indicated by weather radar. If a tornado warning is issued for your area or the sky becomes threatening, move to your pre-designated place of safety.

▶ **FLASH FLOOD WATCH**

Flash flooding or flooding is possible within the designated area.

▶ **FLASH FLOOD WARNING**

Flash flooding has been reported or is imminent. Take necessary precautions at once.

▶ **URBAN/SMALL STREAM FLOOD ADVISORY**

Flooding of small streams, streets, and low-lying areas, such as railroad underpasses and urban storm drains, is imminent or occurring.

▶ **SEVERE THUNDERSTORM WATCH**

Severe thunderstorms are possible in your area. Remember, thunderstorms are defined as severe if they produce winds 58 mph or stronger, and/or hail 3/4 inch in diameter or larger.

▶ **SEVERE THUNDERSTORM WARNING**

Severe thunderstorms are imminent or occurring. Remember, tornadoes occasionally develop in areas in which severe thunderstorms watch or warning is in effect. Remain alert to signs of an approaching tornado and seek shelter if threatening conditions exist.

Flood Safety

▶ Know your flood risk and elevation above flood stage.

▶ Do your local streams or rivers flood easily? If so, be prepared to move to a place of safety.

▶ Make sure that delivery or bus drivers are familiar with the flood-prone areas along their routes.

▶ Keep a NOAA Weather Radio, a battery-powered portable radio, and flashlights in working order.

▶ Be especially cautious at night when it is harder to recognize flood dangers.

▶ Get out of areas subject to flooding. This includes dips, low spots, canyons, washes, etc.

▶ Avoid already flooded and high velocity flow areas. Do not attempt to cross-flowing streams.

▶ If driving, be aware that the roadbed may not be intact under floodwaters. **TURN AROUND! DON'T DROWN! NEVER** drive through flooded roadways!

▶ If the vehicle stalls, leave it immediately and seek higher ground if you can safely. Rapidly rising water may engulf the vehicle and its occupants and sweep them away. Remember, it's better to be wet than dead!



Tornado Safety

- ▶ Keep a NOAA Weather Radio, a battery-powered portable radio, and flashlights in working order.
- ▶ Quickly move to the pre-designated shelter area.
- ▶ If an underground shelter is not available, move to an interior room or hallway on the lowest floor. Crouch down against a wall or get under a sturdy piece of furniture.
- ▶ Do not try to outrun a tornado in a bus, truck, or car; instead, abandon it for a strong building.
- ▶ Portable buildings or classrooms, even if tied down, are poor shelters from tornadoes and should be abandoned.
- ▶ Consider holding visitors and employees at the facility if severe weather is an imminent threat.
- ▶ Overpasses offer little protection from tornadoes and should not be used as shelters.
- ▶ If caught in the open, take cover in a ditch or low spot. Remember, though, that this will not provide the same protection as a solid building.
- ▶ Occasionally, tornadoes develop so rapidly that advance warning is not possible. Remain alert for signs of an approaching tornado. Flying debris from tornadoes causes most deaths and injuries.
- ▶ Stay away from windows.

Thunderstorm and Lightning Safety

- ▶ Remember: if you can hear thunder, you are close enough to the storm to be struck by lightning. Go to safe shelter immediately! Remain in shelter until 30 MINUTES after the last thunder is heard.
- ▶ Move to a sturdy building. Do not take shelter under isolated trees, or in convertible automobiles.
- ▶ If no sturdy building is available, or if there is not sufficient room inside, then move under cover away from power poles, large or solitary trees, and metal objects.
- ▶ Light standards and metal stadiums are excellent lightning targets and conductors of electricity. Review plans for quickly getting spectators to safe areas.
- ▶ Turn off air conditioners. Power surges from lightning can overload the compressors.
- ▶ Telephone 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.
- ▶ If lightning is occurring and a sturdy shelter is not available, get inside a hard top automobile and keep windows up. Use caution, though, because vehicles offer poor protection from downburst winds and only fair protection from hail.

Review Questions

Storm Preparation



▶ **WHAT ARE THE MAIN WEATHER THREATS WHICH MAY IMPACT MY FACILITY?**

▶ **WHERE ARE THE FLOOD-PRONE AREAS NEAR MY FACILITY?**

▶ **WHEN (TIME OF DAY AND TIME OF YEAR) ARE TORNADOES MOST LIKELY TO OCCUR IN MY AREA?**

Six Steps to Build Your Institution's Preparedness Plan

▶ **DESIGNATE SHELTER AREAS**

Interior rooms and hallways provide the best protection from tornadoes or downburst winds. If hallways are used, only use areas which are well away from external doors or classrooms with windows. Meeting halls, gymnasiums, and other structures with high, wide-span roofs do not offer good protection. Portable buildings are poor shelters and should not be used.

▶ **PRACTICE REGULARLY**

As with fire drills, the severe weather safety plan should be practiced regularly. Regular practice will enable staff members to become more familiar with their duties. In addition, the practices will allow administrators to identify and correct any flaws in the plan (i.e., too long to get people into shelter areas, traffic flow problems in the hallways).

▶ **HAVE RELIABLE, REDUNDANT MEANS TO RECEIVE WEATHER INFORMATION**

If you are in broadcast range, NOAA Weather Radio is the best way to receive information from the National Weather Service. NOAA Weather Radio is a broadcast of weather information that originates directly from our forecast office in Fort Worth. NOAA Weather Radio receivers have an alarm feature that will activate only when watches or warnings are issued for your county. Information on NOAA Weather Radio is available online at <http://www.srh.noaa.gov/fwd/radio.html>

The Emergency Managers Weather Information Network (EMWIN) is another means of receiving NWS products. EMWIN is a nationwide satellite-based system that broadcasts watches, warnings, forecasts, and summaries from NWS offices. EMWIN requires a satellite dish, a signal demodulator, display software, and a PC. The display software features alarming and printing capabilities when specific products are received. Once the receiving station is established, there are no recurring costs for the data. For more information on EMWIN, point your web browser to <http://iwin.nws.noaa.gov/emwin/index.htm>

Commercial radio, TV, Internet, alphanumeric pagers, and two-way radio systems are all ways of getting information. Have as many of these methods available as possible. Each should have a battery backup, in case the electricity goes out.

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Six Steps to Build Your Institution's Preparedness Plan

▶ **HAVE RELIABLE, REDUNDANT MEANS TO RELAY INFORMATION**

If severe weather threatens your facility, you may have only seconds to activate your plan and get the people to shelter. Utilize as many methods as possible, with battery backup in case of commercial power loss, to get people to shelter. The school intercom, walkie-talkies, cell phones, and a battery-powered bullhorn are all possibilities.

▶ **ENSURE THAT STAFF MEMBERS ARE FAMILIAR WITH RESPONSIBILITIES**

This is where some of the tougher questions must be asked. Who in your building is responsible for developing or modifying the severe weather plan? Who will be assigned to monitor conditions during potentially severe weather? Who has the lead role in authorizing/activating the plan? Are backup assignments in place in the event that severe weather strikes while key staff members are absent? Do you have the authority to hold people at the building if severe weather threatens?

▶ **WHEN SEVERE STORMS THREATEN, ENACT YOUR PLAN IMMEDIATELY!**

We at the NWS try to have all tornadoes and severe storms preceded by a warning. However, in some cases, the "lead time" between when the warning is issued and when the storm hits will be quite short. The warnings we issue are typically on a county-by-county basis. If a warning is issued for your county, listen closely to the entire warning message. We will specify precisely where in the county the storm is located, and we will usually list a number of communities near the storm's projected path. If you are near the path of the storm, enact your plan well in advance of the storm's expected arrival time.

In rare cases, a storm may strike before a warning is issued. It is recommended that one or more of your staff members receive storm spotter training and become familiar with the cloud structures suggestive of severe weather. If a trained spotter observes a potentially tornadic or severe storm approaching the building, then activate the safety plan immediately.

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Review Questions

Preparedness Plans



- ▶ **LIST AT LEAST 3 METHODS WE CURRENTLY HAVE FOR RELAYING HAZARDOUS WEATHER INFORMATION WITHIN THE FACILITY.**

- ▶ **WHO IS RESPONSIBLE FOR DEVELOPING AND MODIFYING OUR SEVERE WEATHER PLAN?**

- ▶ **WHO IS RESPONSIBLE FOR MONITORING THE WEATHER SITUATION? WHO IS THEIR BACKUP?**

- ▶ **WHO IS RESPONSIBLE FOR ACTIVATING THE SAFETY PLAN? WHO IS THEIR BACKUP?**

- ▶ **WHO IS RESPONSIBLE FOR HOLDING OR RELEASING PEOPLE? WHO IS THEIR BACKUP?**

- ▶ **HOW MANY OF THE FACILITY STAFF HAVE ATTENDED SPOTTER TRAINING WITHIN THE LAST 3 YEARS?**



Useful Internet Sites

NATIONAL WEATHER SERVICE -- FORT WORTH/DALLAS OFFICE

Monitor conditions across North Texas including warnings, forecasts, and radar imagery.

www.weather.gov/fortworth

NATIONAL WEATHER SERVICE -- RADAR DATA

National Weather Service radar imagery from across the nation.

www.nws.noaa.gov/radar_tab.php

ONLINE PREPAREDNESS TRAINING

Spotter training, safety tips, and downloadable guides.

www.srh.noaa.gov/fwd/skywarn.html

ONLINE MEDIA GUIDE FOR NORTH TEXAS

National Weather Service products and services

www.srh.noaa.gov/fwd/media

NATIONAL WEATHER SERVICE SOUTHERN REGION HEADQUARTERS

Links to all National Weather Service office in the southern United States

www.srh.noaa.gov

STORM PREDICTION CENTER

National severe weather watch information.

www.spc.noaa.gov

NOAA WEATHER RADIO INFORMATION

www.srh.noaa.gov/fwd/radio.html

EMWIN INFORMATION

<http://iwin.nws.noaa.gov/emwin/index.htm>

<http://www.srh.noaa.gov/fwd/emwin.html>