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May 18, 2004

Mike Rundle
Mayor, City of Lawrence
City Hall, P.O. Box 708
Lawrence, KS 66044

Dear Mayor Rundle:

Warning sirens, on average, give five to seven minutes of preparation time before a tornado strikes. During Lawrence's 2003 tornado, we had nearly twenty minutes of preparation time between the sounding of tornado sirens and when the tornado touched down—an unusually long period due to the unique circumstances of the storm. My family took shelter in a neighbor's basement (three blocks away) during last year's tornado. My husband, our then two-year-old daughter and I were lucky—the neighbors were home, we had prepared our belongings to leave quickly, and the tornado dissipated before it hit our neighborhood. Lawrence was lucky too; no one died. If we hadn't had the long warning, how many of us would have been caught in our cars, on sidewalks, or in homes ill-equipped to deal with strong winds?

Like many families in Lawrence, we live in a slab home. We searched for a home with a basement, but found, to our disbelief, that in Lawrence and in our "first home" price-range, slab houses were the norm. We were told by two different real estate agents, "tornadoes never hit Lawrence." Additionally, when apartment shopping prior to buying our home, we found that only one of the several complexes we considered had any place to go during a tornado.

Thousands of Lawrence children and adults are at risk because of this appalling practice to simply ignore that our community is among the highest risk zones in the country for wind and storm related deaths. With every new slab home or apartment complex built in Lawrence, the number of people in danger only increases. I am also concerned for our school children—schools may have a designated safe area, but will it really protect the kids?

I propose that the city approve a new ordinance for construction or an amendment to the current building code as follows:

> **Every new dwelling and new school built within the City of Lawrence shall include or provide immediate access to an underground storm shelter or safe room meeting FEMA standards.**

With clear guidelines and free plans from FEMA, it is a relatively simple process to build a safe room in a new construction. A storm shelter can be placed under a slab home with an entrance from a closet, or an enclosed room above ground can be reinforced to meet FEMA safe room standards. Alternatively, adding a safe room or shelter to an existing home, apartment complex, or school can be costly and difficult.

People may say, "we can add a storm shelter to our back yard later," but it can be more difficult to come up with improvement financing than a first home loan. Additionally, families may be reluctant to go to a back yard shelter in the rain, wind, or night time hours unless the storm is the "real thing." By then it may be too late.

Lawrence was lucky last year—we had an unusually long amount of time to prepare, and it was a relatively weak tornado, so people were safe in their bathrooms or under stairs. But it was our city's wake up call. Will we heed it?

Respectfully submitted,

Jane K. R. Graves

Cc: Lawrence Planning Commission
Lawrence Journal World

Background and Research

What Is a Tornado?

Tornadoes are categorized by the **Fujita scale**. They 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.

F0 Light: Some damage can be seen to poorly maintained roofs. Unsecured light-weight objects, such as trash cans, are displaced.

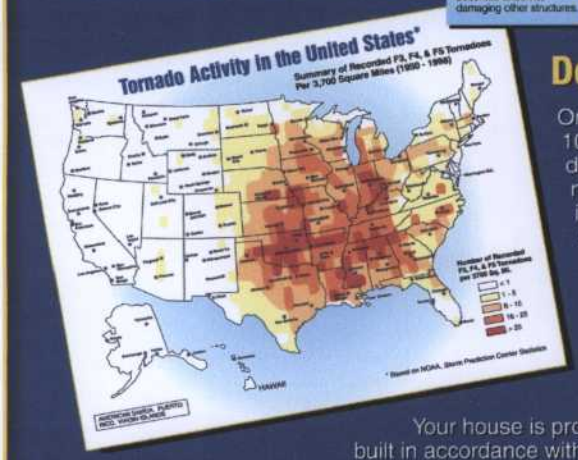
F1 Moderate: Minor damage to roofs and broken windows occur. Larger and heavier objects become displaced. Minor damage to trees and landscaping can be observed.

F2 Considerable: Roofs are damaged. Manufactured homes, on nonpermanent foundations, can be shifted off their foundation. Trees and landscaping either snap or are blown over. Medium-sized debris becomes airborne, damaging other structures.

F3 Severe: Roofs and some walls, especially unreinforced masonry, are torn from structures. Small ancillary buildings are often destroyed. Manufactured homes on nonpermanent foundations can be overturned. Some trees are uprooted.

F4 Devastating: Well constructed homes, as well as manufactured homes, are destroyed. Some structures are lifted off their foundations. Automobile-sized debris is displaced and often tumbles. Trees are often uprooted and blown over.

F5 Incredible: Strong frame houses and engineered buildings are lifted from their foundations or are significantly damaged or destroyed. Automobile-sized debris is moved significant distances. Trees are uprooted and splintered.



Do You Need a Shelter?

On the basis of 40 years of tornado history and more than 100 years of hurricane history, the United States has been divided into four zones that geographically reflect the number and strength of extreme windstorms. The illustration below 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.

Your house is probably built in accordance with local building codes that consider the effects of minimum, "code-approved" design winds in your area. Building codes require that buildings be able to withstand a "**design**" wind event. A tornado or extreme hurricane can cause winds much greater than those on which local code requirements are based.

Managing Risk — Damage Color Code

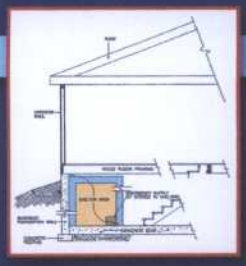
The Threat to Property and Personal Safety Can Be Minimized Through Compliance With Up-To-Date Model Building Codes and Engineering Standards

Property and Personal Protection Can Be Improved Through Wind Hazard Mitigation Techniques Not Normally Required by Current Building Codes

Personal Protection Can Only Be Achieved Through Use of a Specially Designed Extreme Wind Refuge Area, Shelter, or Safe Room

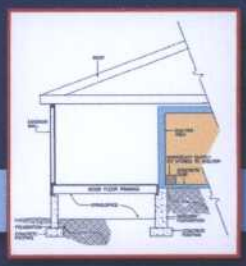
Building Your Safe Room

Tornado and Hurricane Protection



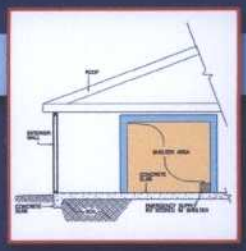
Typical basement foundation with shelter.

Your builder/contractor can use the design drawings in FEMA 320, ***Taking Shelter From the Storm: Building a Safe Room Inside Your House,*** to build a shelter for any of the wind zones. The design drawings provided include the details for building five types of shelters: concrete, concrete masonry, wood-frame, lean-to, and in-ground. Each of these alternatives is expected to perform equally well in resisting material fatigue and connection failures caused by extreme winds.



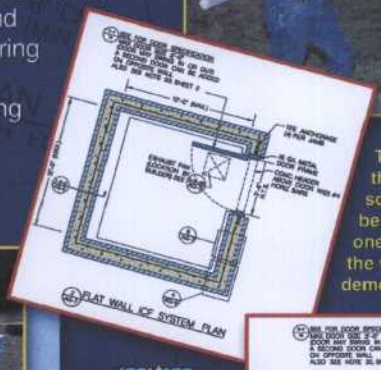
Typical crawlspace foundation with shelter.

The materials and connections were chosen for their "ultimate strength," which means that the materials are expected to resist the loads imposed on them until they or the connections between them fail. The forces of extreme winds may cause cracks or other signs of stress in the materials or connections, and they may cause materials or connections to yield. However, the intent of the designs is not to produce a shelter that will always remain completely undamaged, but rather a shelter that will enable its occupants to survive an extreme windstorm with little or no injury. The shelter itself may need to be extensively repaired or completely replaced after an extreme wind event.



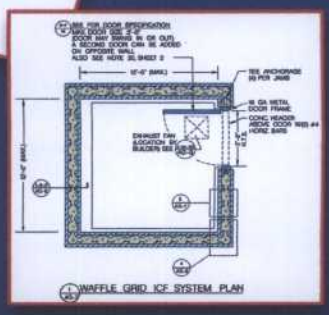
Typical slab-on-grade foundation with shelter.

The shelter size and materials specified in the drawings are based on principles and practices used by structural engineering professionals and the results of extensive testing for effects of missile impact. Before increasing the shelter size or using material types, sizes, or spacings other than those specified in the drawings, review the changes with a licensed professional structural engineer.



The foam panels of the ICF safe room are so light that they can be easily assembled by one or two people, as the worker above demonstrates.

Workers assemble the roof panels which will have rebar and concrete covering it.



Designs using other materials can be found in FEMA 320

Inground Shelters

Figure 6-8. Group shelters at a manufactured home rental community in Wichita, Kansas.

From FEMA 342, see also http://www.fema.gov/mit/bpat

Similar Shelter Areas in Elementary Schools

Figure 6-34.
Northmoor Elementary School, Moore, Oklahoma, place of refuge – corridor with clerestory windows. This corridor offers little protection from tornadoes as shown in a school of similar design in Figure 6-35.

Figure 6-35.
Kelly Elementary School, Moore, Oklahoma, place of refuge – corridor with clerestory windows. These interior corridor walls had brick masonry up to a height of approximately 7 feet. Glass extended from the top of the brick masonry to the top of the wall.

From FEMA 342, see also http://www.fema.gov/mit/bpat

Houses Located Across the Street From Each Other

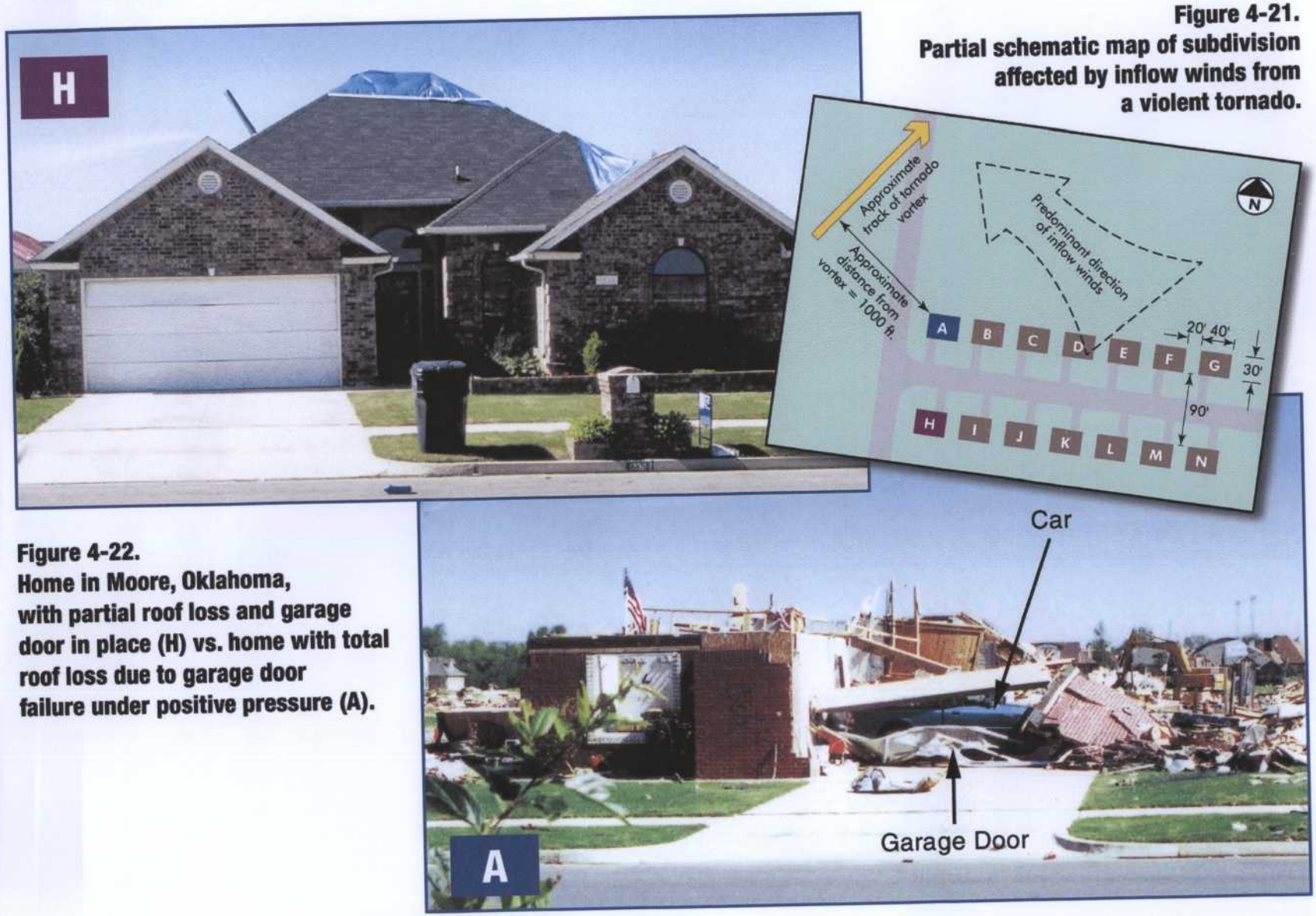


Figure 4-21.
Partial schematic map of subdivision affected by inflow winds from a violent tornado.

Figure 4-22.
Home in Moore, Oklahoma, with partial roof loss and garage door in place (H) vs. home with total roof loss due to garage door failure under positive pressure (A).

From FEMA 342, see also http://www.fema.gov/mit/bpat

In-Residence Shelter History

CONCEPTUAL PHASE

TESTING PHASE

CONTINUAL TESTING AND IMPLEMENTATION

1970's

- When houses are destroyed after violent tornadoes, investigators continue to find small interior rooms that survive.
- Dr. Ernst W. Kiesling of Texas Tech University (TTU) conceives of hardening a small interior room.
- To design this small room, researchers must learn the wind forces (speed) and the type of airborne debris (called missiles) that must be stopped.
- Quick access to a shelter and cost are also important considerations.
- Based on observed tornado damage and engineering analysis, TTU determines that tornadic wind speeds, once estimated as high as 600 mph, have much lower wind speeds. A wind speed of 250 mph winds is used for shelter design.
- The first test for missile impact is developed dropping pieces of wood from a TTU campus building.

Surviving Interior Room

Xenia, OH, tornado, 1974. This is not a shelter but an interior room which survived the tornado even though the rest of the residence was destroyed.

1980's

- Dr. Kiesling builds an in-residence shelter in his home, based on engineering knowledge gained during the 1970's.
- Researchers, Dr. Joseph E. Minor and Dr. Kishor C. Mehta, develop preliminary shelter designs, funded by the Defense Civil Preparedness Agency (a forerunner of FEMA).
- Dr. James R. McDonald, develops a missile impact facility that can launch large missiles at high speeds. Walls, roofs and doors can now be consistently tested.
- TTU develops construction details for in-residence shelters that are available to the public.

The new debris launch facility allows for a greater range of motion of the barrel and more accurate missile impact.

Design missile is 15 lb 2x4 traveling at 100mph. Two laser timing gates provide verification of the recorded missile speed.

1990's

- The Federal Emergency Management Agency (FEMA) studies the technical and economic feasibility of in-residence shelters.
- Pressure and impact tests are conducted for door structure and hardware. Additional designs are developed and tested.
- In 1997, after the Jarrell, TX, tornado, a national news story brings attention to the in-residence shelter. Wind Engineering Research Center personnel receive over 1000 requests for shelter plans within a week.
- ***"A safe place to go – and time to get there"*** is the theme of National Tornado Forum sponsored by FEMA.

Midwest tornadoes of May 3rd, 1999.

- The booklet, ***FEMA 320, Taking Shelter from the Storm***, is published and introduced to the media in August 1998 at the FEMA National Tornado Forum. Two hundred thousand copies of the first edition are distributed. A second edition is published which also incorporates a design for a shelter built using insulating concrete forms.
- FEMA introduces the Project Impact program whose goal is to work with communities to mitigate the damage caused by natural events. The in-residence shelter fits well into this program.
- In May 1999, an outbreak of tornadoes ravages Oklahoma City and numerous counties of Oklahoma and southern Kansas. Two people survive in an above-ground, reinforced concrete shelter located in the path of the tornado. It demonstrates the viability of the concept.
- President Clinton urges families to consider incorporating in-residence shelters when they rebuilt their homes.

Workers lift insulating concrete form (ICF) section into place over concrete slab foundation.

NOW

- The success of the above ground in-residence concept in Oklahoma gives rise to a new industry of shelter manufacturers across the nation. Texas Tech University is instrumental in the formulation of the "***National Storm Shelter Association (NSSA)***" in order to provide an industry standard of quality consistent with the Texas Tech and FEMA guidelines.
- FEMA publishes ***FEMA 361, Design and Construction Guidance for Community Shelters***, which is used to design community shelters in apartment complexes and schools.