

In-Residence Shelter History

CONCEPTUAL PHASE

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.

TESTING PHASE

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.

CONTINUAL TESTING AND IMPLEMENTATION

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.
- 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.



Midwest tornadoes of May 3rd, 1999.



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.