Section III: Building Your Safe Room

Your builder/contractor can use the design drawings provided in this guide to build a safe room for any of the wind zones shown on the map in Figure I-4. The design drawings provided include the details for building five types of safe rooms: concrete, concrete masonry, wood-frame, lean-to, and in-ground. Each of these alternatives is expected to perform equally well in resisting failures caused by extreme winds.

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 intent of the designs is not to produce a safe room that will always remain completely undamaged, but rather a safe room that will enable its occupants to survive an extreme windstorm with little or no injuries. The safe room itself may need to be extensively repaired or completely replaced after an extreme-wind event.

The safe room 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 impacts and wind pressures. Typical and maximum dimensions have been provided on the drawings. The safe rooms have been evaluated for and comply with the design criteria in FEMA 361 and the shelter standard requirements set forth in the ICC-500 for residential and small community shelters (shelters with less than 16 occupants). Before increasing the safe room size or using material types, sizes, or spacings other than those specified in the drawings, the changes should be reviewed by a licensed professional structural engineer.

The information in this section includes the following:

- Design drawings and details for safe rooms in basements, above the ground, and in the ground
- Designs for safe rooms installed on both slab-on-grade and crawlspace foundations
- General design notes and fastener and hardware schedules
- Materials lists with quantities and specifications

If you or your builder/contractor have questions about the design drawings in this guide, call the FEMA Building Sciences helpline at (866) 222-3580 or email saferoom@dhs.gov for technical guidance.

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* IG = In-ground, B = Basement, AG = Above-ground

How to Use the Drawings

- Drawings should not be scaled to determine dimensions.
- If there is a conflict between a dimension shown on the drawings and a scaled dimension, the dimension shown on the drawing should govern.
- If there is a conflict between the drawings and local codes, the local codes should govern as long as the life-safety protection provided by the safe room is not lessened. It is important to note, however, that the structural, wall, and roof systems should not be compromised because that would reduce the level of protection of the safe room. It is also important to note that these designs exceed most building code requirements.
- If there is a conflict among the general notes, specifications, and plans, the order of precedence is notes, then specifications, then plans.

Consumer Guide

While this guide presents FEMA's guidance on the design and construction of residential safe rooms, FEMA does not test or certify materials or systems used in the construction of safe rooms. Vendor claims of compliance with FEMA and ICC criteria should be verified through independent testing or engineering analysis. The National Storm Shelter Association (NSSA) is a non-profit, industry association dedicated to the storm shelter industry. The NSSA "administers testing and engineering evaluation programs to be conducted by certified, independent entities for the purpose of issuing labels to qualified storm shelter producers." In 2001, the NSSA prepared an association standard for the design and construction of storm shelters. The NSSA Association Standard will be superseded, and the new "Association Standard" will be the ICC-500 Storm Shelter Standard. The NSSA is one place a homeowner or prospective safe room owner can go to seek approved product listings (for safe rooms, shelters, or components) or to verify vendor claims of standards compliance for tornado and hurricane safe rooms.

The NSSA is the only non-profit organization with a quality verification process and seal program. This enables safe room consumers to consider the identity of safe room producers with labeled, quality-verified products; have an industry standard that establishes quality requirements; and be informed and educated on the storm shelter industry via seminars, web pages, and responses to inquiries through the NSSA. The standards to which NSSA holds its manufacturers are consistent with the level of protection provided by the ICC-500 design criteria and FEMA 320. Members of the NSSA that manufacture and construct residential safe rooms submit their designs to the NSSA for third party design reviews to ensure association support for compliance with FEMA 320 and continued respect for the storm shelter industry; it is recommended that all plans used for the construction of safe rooms or shelters be subject to a third party review for quality assurance purposes.

The NSSA website (http://www.nssa.cc) contains a wealth of information such as NSSA policies, evaluation procedures, grant programs, shelter news, and guidance on shelter construction, and industry links. The website also contains contact information for the following different member types:

- **Producer Members –** Those who manufacture or construct storm shelters and certify that shelters, designs, construction, and installation or installation instructions are in compliance with the NSSA standard
- **Installer Members –** Those responsible for compliance with installation instructions provided by producer members
- **Associate Members –** Those engaged in the storm shelter industry, but who do not have direct responsibility for storm shelter compliance with the NSSA standard (this includes suppliers and others engaged in the storm shelter industry)
- **Professional Members –** Design professionals who are capable of designing/analyzing shelters to confirm compliance with applicable standards and other professionals who support the mission of NSSA and also contribute to safety from extreme winds
- **Corporate Sponsors –** Corporate entities with business interests in the storm shelter industry who are willing to support the programs of the NSSA

It is recommended that consumers pursue safe rooms or shelters (manufactured, constructed, or installed) that are per the designs provided in this publication or are verified with a seal from NSSA to meet the FEMA criteria. The NSSA is one place that prospective safe room or shelter owners can look to for verification, certification, and compliance.

Safe Rooms Save Lives

The Oklahoma Safe Room Initiative and rebate program (http://www.gov.ok.gov/display_article.php?article_id=123&article_type=1) built 6,016 safe rooms after the 1999 tornado. There were no deaths during the 2003 tornado that impacted much of the same area also impacted in 1999; the success directly attributable to the availability and utilization of the safe rooms. The Oklahomans in "Tornado Alley" felt safe and protected knowing that their families had a safe place to go. As of March 2008, this and other FEMA grant programs have provided over $260,000,000 in federal funds towards the design and construction of nearly 20,000 residential and over 500 community safe rooms in 23 states and territories.

Below are just a few examples of how FEMA 320 safe rooms have saved the lives of people impacted by extreme-wind events. With proper installation, storm shelters and safe rooms serve as protection from injury or death caused by the dangerous forces of extreme winds. They can also relieve some of the anxiety created by the threat of an oncoming tornado or hurricane. The decision to build or purchase a safe room should include notifying local emergency managers and family members or others outside the immediate area. This will allow emergency personnel to quickly free the exit should it become blocked by debris. For additional information on these and other safe room "success stories," see the FEMA websites listed below.

Baxter County, Arkansas – On February 5, 2008, when a tornado visited the town of Gassville, Arkansas, Jeanann Quattlebaum felt a certain calmness. Less than 10 months prior, she and her husband, Robert, had purchased a storm shelter. The Quattlebaums had been living in their subdivision for seven years. They purchased their home, which was not equipped with a safe room, from an area builder.

Arkansas is one of several states in "Tornado Alley," a term used to describe a broad area of relatively high tornado occurrences in the central United States. The state ranks fourth, after Texas, Oklahoma, and Kansas, with tornadoes that are F3 and higher.

The Arkansas Residential Safe Room Program assists Arkansas homeowners who choose to install a shelter or safe room on their property. The program covers up to 50 percent of the cost and installation, not to exceed $1,000.00, for shelters or safe rooms built on or after January 21, 1999. The Quattlebaums' storm shelter was purchased at a cost of $2,000.00. The circular concrete structure is 10 feet in diameter and stands 5 feet tall. It has the capacity to seat six to eight individuals. During the tornado event of February 5, 2008, it housed six as the tornado touched the lives of Gassville residents. The tornado left behind one fatality and damages to homes and property, which ranged from minimal to extensive.
http://www.fema.gov/mitigationbp/brief.do?mitssId=5466

Oklahoma City, Oklahoma – When Karen and her husband built their retirement home in 2002, they were determined to build a protective safe room equipped with the necessary amenities and materials in the event of a devastating tornado. Instead of building the room inside their home like most people, they decided to construct it 20 feet away from the house, and to build it large enough for their extended family.

"I believe my pets are part of my family," Karen said, referring to her three dogs – two Airedales and a Blue Heeler – and bird – a Scarlet Macaw. "I wasn't going to run three dogs through the house. Because of weather conditions, I couldn't see running three dogs over the carpet." Also, the house was intended to be their last and they wanted it to be a certain way. "It would have been too much structural change," Karen said. "I didn't want to change my basic plans of the house the floor plan I liked. I didn't want to modify it to accommodate everyone."

While the main house is mostly handicapped accessible, it still would have been difficult to construct a safe room inside the house and have someone in a wheelchair enter it without requiring assistance down the stairs. The safe room has a ramp, making it easily accessible for anyone confined to a wheelchair. "It is a retirement home for my husband and I and one of us could end up in a wheelchair someday, [whether] permanently or temporarily," Karen said. "Based on Murphy's Law, that's when a tornado would hit. We just decided to have everything handicapped accessible."

Karen and her husband based their safe room model on FEMA regulations and just added a few additional measures of their own. The room is a reinforced concrete structure with French drains. The front of the cellar faces north and wings are extended on the sides and top to hold back the clay. Four feet of earth also cover the roof of the cellar. Stucco, paint, and water sealer was applied to the concrete and a metal porch was built on top of hickory beams to prevent rain from pouring inside whenever the door was opened. No moisture is likely to leak into the cellar. Karen said she intended to build it that way because she strongly despises a "damp, musty basement."

The project probably cost more than what it normally would have if they had built it inside their home and without all the added weather protection, but Karen was willing to make the sacrifice. She also wanted the room – measured at 10 by 12 feet – to be large enough for her, her husband, and their pets. "I just wanted to take FEMA's requirements [design criteria] and enhance them," she said. "I probably have exceeded their requirements … [so] yes, there was an added expense to have it bigger. But it really didn't add that much. It was worth it to me. That was a personal call. Everybody has to make them."
http://www.fema.gov/mitigationbp/brief.do?mitssId=1345

Autauga County, Alabama – After seeing the destruction of his parents' home, an Autauga County firefighter decided that it is up to him to keep himself and his family safe from storms. Robert Van Valkenburg, 52, decided to look into building a tornado safe room for his home after his parents' home was destroyed by a tornado spawned by Hurricane Andrew. "I grew up in that house and it was lost during Hurricane Andrew, so I take this stuff very seriously," says Van Valkenburg. He adds, "When it impacts your family, and you see how it affects them, you take it seriously and say 'Well if it could happen to my mom and dad, it could happen to me."

Van Valkenburg started the process of building his safe room in 2001. He called his local emergency manager and enrolled in the Alabama safe room program sponsored by FEMA and the Alabama Emergency Management Agency. Actual construction of the safe room took place over 8 months in 2002. FEMA paid 75 percent of the cost to build it, $3,500, through its Hazard Mitigation Grant Program (HMGP). "My local emergency managers came out to look at the safe room while it was under construction and took pictures. I had to show an itemized break down of everything, and show the cost to substantiate what I paid for it. Then they gave me the money," Van Valkenburg stated. He also spent more of his own money to add a second entry way to the room, in the event the other entry is blocked, a drainage system, and a generator in the back of his house that kicks in if there is a loss of power.

The safe room got its first test the following spring. Van Valkenburg, his wife, two children, and three dogs stayed in it when a storm system came through and a tornado touched down in the area. "We heard the sirens and went down there in the middle of the night," says Van Valkenburg "I have my pager from the fire department, and when it goes off I know we have severe weather coming into Autauga County. If they say tornado warning we go there." In 2004, his family used the shelter again, but for protection from two hurricanes. Twice during the summer, his family took shelter in their safe room during Hurricanes Ivan and Dennis.

The safe room is 11-by-12 feet and is below the ground under a new wing that Van Valkenburg built onto his house for his elderly father-in-law. It is built to be a natural extension of the house. "I knew because of my wife being claustrophobic, I had to design it where it looked like a room or she wouldn't go into it," he said. The room is made of reinforced concrete and has steel doors that lock from the inside. Van Valkenburg has also equipped it with a big, sturdy bed, battery powered televisions, water, non-perishable foods, a first aid kit, power tools and the negatives to all family photos. "We can come out of there and we can start life again," said Van Valkenburg. "That's what it is all about, coming out of the safe room and being able to live."
http://www.fema.gov/mitigationbp/brief.do?mitssId=1646

Moore, Oklahoma – Don Staley and his family are no strangers to storms and tornados. Their first home was hit by a tornado in October 1998 and suffered minor damage, but was destroyed by another tornado on May 3, 1999. They rode out both storms inside the house. "It was such a frightening sound," he said. "We decided we weren't going to ride out another one inside the house."

In December 2000, the Staleys' new home was ready. Shortly after moving in, they had an above-ground safe room constructed on the back patio. The concrete room has 8-inch thick walls, an 18-inch thick ceiling, a 10-inch foundation, and a sliding entry door made of 12-gauge steel with 3/4-inch plywood on each side. The safe room is equipped with battery-powered lights and a battery-powered television.

When the warning sirens sounded on May 8, 2003, Don took shelter in the safe room along with his dog and two cats to ride out the storm feeling very protected and safe. "I was watching it on TV in there," he recalled. "I could see it was coming my way and I could hear it coming. I could hear the roar. That's a sound you never forget."

When he emerged from the shelter, he found his house in shambles with the roof ripped off. Other houses on the street were also heavily damaged or destroyed. The Staleys used their safe room following the tornado to store and protect belongings they had salvaged. The Stayleys' home was among the more than 300 homes destroyed in the city that day. Whereas a severe tornado hit the city in May 1999 and claimed 44 lives, there were no deaths in the 2003 tornado. The absence of fatalities is being attributed to community preparedness, improved early warning systems, and the many safe rooms and shelters that have been built. Staley sums it all up, "The safe room saved my life, it came through with flying colors. It's worth a million bucks to me."
http://www.fema.gov/mitigationbp/brief.do?mitssId=761

Lowndes County (MS) – North of Columbus, Mississippi is the community of Caledonia. Recently, that town has experienced a bit of growth; folks have moved in and built smaller homes to enjoy a more relaxed country atmosphere. And several United States Air Force retirees have settled there, following a tour of duty at Columbus AFB.

But there have been several storms in that area. In November 2002, a tornado struck and damaged homes and property there as well as other county locations. The State of Mississippi had already recognized the need for storm protection earlier and had instituted a tornado safety program, "A Safe Place to Go". With this declaration, several storm shelter installations were funded by a FEMA Hazard Mitigation Grant. The Wayne Duncan family in Caledonia applied and were reimbursed according to FEMA/MEMA guidelines. An underground safe room was located just outside the carport in the backyard, providing welcome peace of mind.

About 2:00 pm, January 10, 2008, the storm roared across Columbus AFB and a tornado touched down in Caledonia, again. It nearly destroyed the local school, causing damage to several homes. Mrs. Lena Duncan, with her daughter, son-in-law, and the grandbaby, ran from the house into the underground safe room and waited for the winds and rain to stop. The house was heavily damaged, but the family was safe in their shelter.

The Hazard Mitigation Grant Program (HMGP) remains in effect in Mississippi, following the Katrina declaration. Lowndes County is participating in this Grant. This summer, the Duncan family plan to relocate, down the road, in a new home. This new house will be built with a planned inclusion of a safe room, following the guidelines of FEMA 320. Still working in the Lowndes County Courthouse, Lena Duncan encourages anyone who asks about tornado safety to go talk with the Lowndes County Emergency Management officials about tornado preparedness and safety.

One final example discusses the program that funded several of the Oklahoma safe rooms mentioned above:

Oklahoma City, Oklahoma - On May 9, 2003, tornadoes swooped across Oklahoma City's "Tornado Alley." The tornadoes' path was virtually the same as the one that struck 4 years prior. Oklahoma has historically been subject to destructive and deadly tornados and high winds. After the 1999 tornado, 44 persons died, 800 were injured and over 6,000 homes were damaged or destroyed.

In order to make Oklahoma a safer place to live, the state launched a Safe Room Initiative Program. Oklahoma was the first state to promote and implement a Statewide residential safe room initiative to build safer communities. The safe room initiative was implemented by the State of Oklahoma with mitigation funds made available by FEMA through the HMGP. This program funded the building of 6,016 safe rooms across the state.

The three basic objectives to help ensure a successful program were public education, financial assistance, and quality control. First, the State of Oklahoma and FEMA kicked off an extensive Public Education Campaign that encompassed a wide range of outreach projects using public service announcements through radio, television, and print. Books, resources, and educational materials were distributed to the residents and communities, while speakers and meetings were used to reach the general public.

Next, the safe room had to be financially affordable to the people. Federal and State agencies developed a first-in-the-Nation safe room rebate program called "Oklahoma Can Survive" to help cover the cost of constructing safe rooms. A $2,000 rebate was offered to property owners for the building of a safe room [Editorial note: At the time of this program, FEMA estimated the safe room cost of an above-ground safe room was approximately $3,500.] The rebates were given in three phases. Phase 1 provided rebates to those people whose homes were destroyed or substantially damaged in the designated disaster area; Phase 2 provided rebates to people with damaged homes in the designated disaster area; and Phase 3 rebates were provided to anyone in the state who wanted a safe room.

Finally, minimal performance criteria guidelines were enforced for proper safe room construction. FEMA 320 was used as a construction guideline to provide all the information a contractor needed to build a safe room. FEMA then used performance criteria based on FEMA 320. An engineer was retained to assist the state in technical support, and help contractors and educating the general public about choosing a safe room construction contractor and helping homeowners with complaints against contractor performances.