Hide from the Wind

Tornado Safe Rooms in Central Oklahoma

Prepared by
The Natural Hazard Mitigation Association
for the Federal Emergency Management Agency

This report is especially dedicated to the inventor of the tornado safe room, Dr. Ernst Kiesling, Texas Tech University scientist and founder of the National Storm Shelter Association. He has dedicated his life to helping people stay safe in wind storms and tornadoes.

Acknowledgements

This report and related research about tornado safe rooms in Central Oklahoma was underwritten by a Cooperating Technical Partner grant from the Federal Emergency Management Agency to the Natural Hazard Mitigation Association. NHMA gratefully acknowledges the FEMA assistance. Special thanks also go to the many people who contributed their insights and experiences to this report, including Tom Bennett, Leslie Chapman-Henderson, Dr. Ernst Kiesling, Ed Laatsch, and Claire B. Rubin.

Researchers for NHMA

Ann Patton, principal researcher
Alessandra Jerolleman, PhD, and Tim Lovell, researchers
Edited by Molly Mowery, Erin Capps, Esq. and Edward A. Thomas Esq.
Additional material by Erin Capps, Jeni Farque, Susan Garner and Edward A. Thomas

NHMA graphics by Tom Malmay.
Cover photo by Ann Patton after May 2003 EF4 tornado in Moore, Oklahoma.

Natural Hazard Mitigation Association

P.O. Box 55352, Metairie, Louisiana 70055. Phone: 504-914-6648. Email: nathazma@gmail.com.
www.NHMA.info

Preface to: *Hide from the Wind; Tornado Safe Rooms in Central Oklahoma*

This report is respectfully dedicated to the many heroes, particularly in Oklahoma, who have worked together to significantly expand and refine the development and implementation of tornado warning systems, and storm shelter and safe room locations, that provide refuge from imminent life safety threats due to tornado activity.

Following a series of tornadoes in the early 1990s, several Federal Emergency Management Agency (FEMA) staff began working on research to develop and implement a program involving the construction of safe rooms. At that time, there was little research or other information about the design and construction of storm shelters or safe rooms from tornado activity.

This report, funded by FEMA under the 2014 Cooperating Technical Partner (CTP) Agreement with the Natural Hazard Mitigation Association (NHMA), documents how staff from FEMA, other public agencies, non-government organizations, grass roots organizations, the media, academia and local practitioners have designed standards, and developed and implemented a new program to encourage the construction of safe rooms in areas with a high risk of devastation caused by tornado activity. This program now provides life-saving safe room and storm shelter protection for thousands of people in the United States.

This report briefly summarizes how the program and results were achieved, and how a change in risk perception led to thousands of people and organizations taking action to lessen the risks and consequences of natural events. The findings in this report, describe how a change in perception and in community development action can transform how we as a society deal with *all* natural hazards. Thus, the findings have enormous implications for current national efforts to build a more resilient society in an era of climate uncertainty.

Dr. Dennis Mileti, Former Director of the Natural Hazards Center and Professor Emeritus at the University of Colorado at Boulder, has conducted detailed research on how to communicate the risks and consequences from disasters, and change public perception and behavior so that the potential devastation caused by disasters can be mitigated.

NHMA believes that Dr. Mileti's research findings are supported by the analysis found in this NHMA report, *Hide from the Wind: Tornado Safe Rooms in Central Oklahoma* (NHMA report), and should be applied widely to efforts promoting Disaster Risk Reduction from all other natural hazards. Dr. Mileti's research is widely available and indicates that the following principles should be included in any state-of-the-art public education campaign intent on maximizing results.

A. Be Clear

Generally, experts have difficulty explaining complicated phenomena clearly and in non-technical terms. Therefore, utilize people with well-developed communication skills to work with experts when developing information for the general public. As described in this NHMA report, the Oklahoma Safe Room program followed this recommendation.

According to this NHMA report, after the May 1999 tornado outbreak, then President Clinton said "If you do nothing else, build a safe room in your home." This is just one example cited in the report of a clear, concise, and readily understandable message. Having the message come from the President of the United States, and many other organizations and individuals, was integral to the ongoing success of installing safe rooms in Oklahoma.

B. Use Varied Sources

Information must come from various, relevant sources including authorities, technical experts, scientists, engineers, and from people whose opinions are valued and trusted by a community. Multiple sources can author the same communication and the same communication can come from multiple sources.

For example, the City of Midwest City received a grant from the American Red Cross in the amount of $520,000. Additionally, the National Oceanic and Atmospheric Administration (NOAA), multiple local governments, the State of Oklahoma, local businesses owners, local TV weather forecasters, FEMA, and many other persons and organizations were providing information about the need for storm shelters and safe rooms. Once different entities started speaking with a consistent message about the need for storm shelters and safe rooms, people began listening and taking heed. The grant funds provided for the installation of 208 storm shelters for Midwest City residents.

Oklahoma City, Mustang, Yukon, Moore, Midwest City, and Stillwater began offering tornado shelter rebates and grants as funds became available from FEMA, American Red Cross or other foundations. Additional communities have also started to develop these grant programs as funding becomes more available. Many of these rebate programs are funded by the Red Cross

thanks to donations that came from all over the world after the May 2013 tornadoes in Moore and the greater Oklahoma City area.[1]

The City of Moore also offers the Shelter Moore Storm Shelter Rebate Program.[2] This program is funded by a grant to Moore from the American Red Cross in the amount of 3.75 million dollars. This funding allows for the installation of 1,500 storm shelters in Moore. As part of the program, randomly selected citizen applicants could be awarded up to $2,500 in a safe room rebate from funds provided by the American Red Cross. For those selected and approved, the program will provide a one-time rebate after the applicant has installed, and received approval from the city inspector for a safe room which meets or exceeds the criteria established in FEMA Publication 361 (P-361) .

C. Render Information Consistently, Through Multiple Outlets and Repeat It

Distributed information should be consistent and updates should explain significant changes. Information should be repeated frequently and disseminated through neighborhood networks, community associations, and various media sources including, television and radio stations, billboards, social media, and other media outlets. Multiple communications from diverse media sources distributed over time, including a written document that is direct mailed to people's homes, is often the most effective approach.

Dr. Mileti succinctly states; "Sell it like they sell Coca-Cola: How old were you when you heard your first ad? When did you encounter your last ad? How many ads were you exposed to in-between? What does Coca-Cola know about public behavior?"

It is not just enough to suggest what needs to be done; you must also lead by example. The late Jim Giles, renowned meteorologist from Tulsa, Oklahoma, knew people needed safe rooms designed to meet the criteria developed by FEMA. Giles founded one of the many companies that now offer such services. Giles and many others advocated for a consistent message that safe rooms were needed and that they should be built to the criteria developed by FEMA, including FEMA P-361 and FEMA P-320, which are certified and are built to withstand an EF5 tornado, with winds up to 250 mph.

The repetition of the information is necessary for the information to be effectively understood. Many people in Oklahoma now have safe rooms or are planning to have them built in Oklahoma because the message regarding the need for safe rooms is being broadcast repetitively and effectively. The consistent message regarding the need for safe rooms in areas at high risk of

[1] http://stormsafeshelters.com/grants/
[2] http://www.cityofmoore.com/ShelterMoore

devastation caused by tornadoes is being distributed by TV,[3] YouTube,[4] politicians,[5] government agencies,[6] the International Code Council,[7] and many other entities.

D. Tell People What to Do

The most important information that you can give is to tell people what they can do before, during, and after a disaster. For example, the National Storm Shelter Association (NSSA) website[8] provides free educational tutorials describing how to survive hurricanes and tornadoes. There is also a wealth of information available on safe rooms at the FEMA website,[9] including the mitigation case study "Safe Rooms Save Lives."[10]

E. Support People in Their Search for More Information

If educational efforts are effective, then people typically share the information with others and may seek additional information. Be prepared to support and encourage information sharing and have additional information readily available.

For example, the Oklahoma Office of Emergency Management website offers guidance and preparedness tips to residents regarding tornadoes. For residents who have limited access to the internet, alternative means of information is available through local meetings and television channels.

F. Use Words and Great Graphics

Clear information works best. Use simple language, and support the language with easy-to-understand graphics.

As shown in this NHMA report, the Oklahoma Safe Room Program used clear graphics and effectively conveyed the need for safe rooms, the way safe rooms should be constructed, how to finance safe rooms, how to obtain government financial backing, and how to select contractors.

G. Position Additional Information in the Community

Typically, people search for additional information to validate information they have already received. Therefore, it is important to distribute and well-position additional information throughout the community.

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[3] http:// investigations.nbcnews.com/_news/2013/05/22/18423352-why-arent-there-more-storm-shelters-in-oklahoma
[4] https://www.youtube.com/watch?v=Qu9Swl0ilfA - https://www.youtube.com/watch?v=Qu9Swl0ilfA
[5] http://www.inhofe.senate.gov/services/weather
[6] https://www.fema.gov/safe-room-resources/fema-p-320-taking-shelter-storm-building-safe-room-your-home-or-small-business#shelter
[7] http://www.iccsafe.org/Education/Online/Pages/saferooms.aspx?usertoken={token}&Site=icc
[8] http://www.nssa.cc/pages/educational-opportunities
[9] https://www.fema.gov/safe-rooms
[10] http://www.fema.gov/media-library-data/20130726-1515-20490-6905/okcasestudies.pdf

This NHMA report illustrates many examples of providing information to the community. For example, the Oklahoma City Council discussed the need for safe room in community meetings and newspapers, online and hard copy. In February of 2014, the Oklahoma City Council voted to require storm shelters (ICC 500) in new school buildings through the "Overriding a Building Code Commission" recommendation.[11] The measure would require new school buildings to have tornado-resistant spaces with at least enough room to protect the number of children and teachers for which the building was designed.

Implications of the Safe Room Successes in Oklahoma

The ongoing success of the safe room construction effort in Oklahoma validates the research findings of Dr. Mileti.[12] The Oklahoma Safe Room Program is a successful example for how to protect the rest of the United States from the increasing risk of devastation caused by foreseeable natural events.

There are many obstacles to the development and redevelopment activities in the United States and the rest of the world. Among those many difficulties are the following:

A. Human Risk Perception

Humans have a great deal of difficulty dealing with low probability and high consequence events, as documented in *How Risky Is It, Really?*, by David Ropeik.

Most natural hazards are a low probability at any particular location in any given year. As documented in this NHMA report, the difficulty with risk perception of tornadoes was overcome in the Oklahoma City area with a constant stream of the same message, to build safe rooms. The message to build safe rooms was delivered by multiple respected sources: TV personalities, news media, government, and the American Red Cross.

B. Silos

Most government agencies and professional organizations are organized by silos or "cylinders of excellence" based on fairly narrow interests such as, floodplain management, hazard mitigation, economic development, engineering, architecture, the law, wetland management and

[11] http://newsok.com/oklahoma-city-council-votes-to-require-safe-rooms-in-new-school-buildings/article/3937245
[12] http://www.lhc.ca.gov/lhc/emergprep06/MiletiFeb06_Appendices.pdf

protection, and water quality. In Oklahoma, multiple disparate groups worked harmoniously together to successfully change behavior to promote safety.

To achieve Disaster Risk Reduction on a national level, may require people working together to transform development and redevelopment practices associated with natural hazards in order to achieve a resilient future, rather than our current path of disastrous losses from foreseeable natural events.

A Common Message Growing From a Common Ground

In order to transform existing development and redevelopment practices in locations subject to foreseeable natural hazards, a consistent message about the need for mitigation to achieve disaster risk reduction must be delivered by multiple sources. This message will affect risk perception and mitigation actions of communities and will reduce risk of devastation from disasters.

The ongoing controversy concerning how local governments and developers should conduct development regulation in the aftermath of last year's United States Supreme Court case, *Koontz v. St Johns River Water Management District*, may provide an opportunity for a cross-silo discussion of how to develop and redevelop in ways that leads to a better future for our Nation and the World after a disaster. (*See*, Turning *Koontz* into an Opportunity for More Resilient Communities, by Edward A. Thomas Esq., and Lynsey R. Johnson J.D., in *National Wetlands Newsletter*, March/April 2014, vol.36, no.2).[13]

NHMA strategy is to advance the message of disaster vulnerability reduction, safety, and security, with regional and locally based mitigation suggestions, such as:

- build a safe room in areas subject to high probability of tornadoes;
- carry out community and individual wildfire protection in areas subject to such risks;
- design and retrofit to reduce earthquake damage;
- build with higher freeboard (generally 4 feet or more) in areas subject to floods;
- recognize the need to protect water quality, and threatened and endangered species,
- prevent floods and stormwater management issues through proper low impact design;
- recognize the need for much better floodmapping standards; and much more.

Generally, people agree that the climate is variable, and want to avoid or decrease the waste, loss of life, and environmental despoliation and devastation, which often follows a disaster.

[13] http://www.americanbar.org/content/dam/aba/administrative/state_local_government/land_use.authcheckdam.pdf

Therefore, a common ground can be established among various entities based on the need for safe development to protect future generations. This Common ground is based on:

- The protection of the property and rights of the entire community and nation;
- Proper stewardship of this planet; and
- Protecting society and taxpayers from devastation which is preventable.

The Natural Hazard Mitigation Association is committed to working with everyone in the "Whole Community" to develop and promulgate the Disaster Risk Reduction Message.

Edward A. Thomas Esq.

Edited by: Jeni Farque, Susan Garner, Erin Capps, Esq., Chrissie Angeletti, Esq., and Molly Mowery

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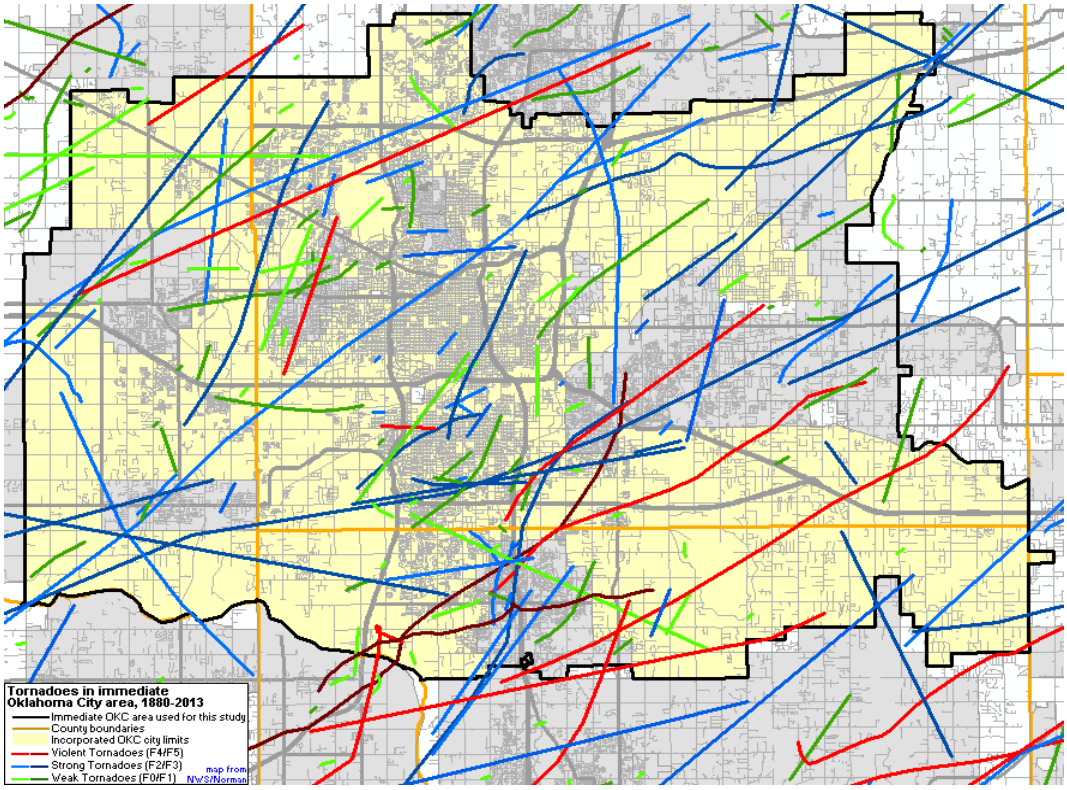
Summary

In recent decades, Central Oklahoma has experienced the nation's highest frequency of tornadoes rated EF2 or stronger,[14] and as a result may have the most prevalent tornado safe room activity in the world. Prepared by the Natural Hazard Mitigation Association (NHMA) for the Federal Emergency Management Agency (FEMA), this NHMA report, *Hide from the Wind: Tornado Safe Rooms in Central Oklahoma* (NHMA) examines the safe room phenomenon in Central Oklahoma, lessons learned, and successful activities that can be applied elsewhere to increase investment in safe rooms and the number of people safely sheltered during extreme natural hazard events.

Tornadoes occur frequently in Oklahoma. The Oklahoma City area has been particularly affected by tornadoes in recent years.

[14] Technical Investigation of the May 22, 2013, Tornado in Joplin, Missouri," National Institute of Standards and Technology, US Department of Commerce, November 2013.

This NHMA report also discusses unresolved safe room issues that obscure consumer selections and public policy decisions. This report traces the safe room experiences in Moore and El Reno, two Central Oklahoma communities hit by frequent violent storms, including the 2013 EF3 tornado in El Reno and the EF5 tornado in Moore. This report summarizes research findings, concludes with ten principal recommendations and sub-recommendations, and provides examples of ways to increase safe room investment and expand safe sheltering in high-risk zones.



The lines on this map represent known tornado tracks in Central Oklahoma, 1880-1913. Oklahoma City is central in this map. The red lines are the most violent storms.

Source: National Weather Service

Tornadoes are considered low probability and high consequence events. It is unlikely that a major tornado will strike any given spot in any given year; but when a tornado hits, it can cause catastrophic disruption, damage, and death.

The terms "safe room" and "storm shelter" have been used interchangeably in past FEMA publications, guidance documents, and other shelter-related materials. FEMA now distinguishes between safe rooms and storm shelters. A safe room is an interior room, a space within a building, or an entirely separate building, designed and constructed to provide near absolute life-safety protection for its occupants from tornadoes or hurricanes. Safe rooms are designed and

constructed to meet the criteria found in FEMA P-361 and FEMA P-320. A storm shelter is defined as shelters that are designed and constructed to meet International Code Council (ICC) 500 criteria.

One of the most important benefits of safe rooms is the peace of mind they afford during times of a tornado threat. As Dr. Ernst Kiesling stated, "This benefit is realized 24/7, 365 days a year. Business interruptions, one of the most costly elements of tornadoes, can be minimized with widespread use of safe rooms."

Workers install a steel prefab safe room in a garage in Tornado Alley
Photo courtesy of Ann Patton

Five Key Study Questions

Five key study questions about safe rooms in Central Oklahoma guided research by the NHMA team. This summary is an overview of the findings.

Questions 1, 2, and 3 deal with numbers of safe rooms that have been built and are summarized here together.

1. How many individual safe rooms have been built in selected communities in the Oklahoma City area since FEMA launched its safe room program in 1998?
2. How many safe rooms are qualified to meet FEMA criteria or ICC 500 standards (current or in place when they were built)?
3. How many safe rooms have been built with private funds?

After extensive interviews and research, the team determined that reliable safe room numbers are elusive and cannot be precisely determined through available sources. Scattered communities now require building permits and voluntary registration, which could yield numerical data, but experts believe would reflect only a fraction of installed safe rooms in most communities.

The NHMA team found the most reliable community data in Moore, Oklahoma. Although the records of safe rooms in Moore are incomplete, the number of privately financed safe rooms is based on speculation by the emergency manager and city manager, who believe any known numbers would underestimate the number of existing safe rooms. As of May 2014, Moore reported 5,500 registered storm shelters, compared to the City's 23,000 residential properties; city officials estimate 80 percent of the registered storm shelters may have been self-funded. (See page 40).

The Oklahoma Department of Emergency Management (OEM) has records to identify most of the state's 13,000 individual safe rooms funded through FEMA grants (See pages 30-35). Some earlier OEM records were inaccessible within the time frame of report research and writing. This NHMA report cites speculation by local emergency managers and OEM about total numbers of safe rooms, including those that may have been built using private funding sources. Dr. Ernst Kiesling, perhaps the nation's foremost expert on safe rooms, said he knows of no source of information on total numbers of privately funded safe rooms.

Oklahoma's SoonerSafe FEMA-grant program manager, Melissa Moore, was asked if she could report how many non-grant safe rooms have been built in Oklahoma. She responded:

> *"No - and I will tell you why - every year the number is going way up! As far as SoonerSafe, when we called a winner, once in a while, maybe 2 out of 25 would say they had already installed, therefore they were not eligible for our program. This year, when we prepared the winners to send to FEMA for review, out of 1,800 applicants, we had to remove 300-400 applicants because they had already installed.*
>
> *We are not really required to call the homeowner, but we learned our lesson last year. We had 538 rebates, and sent in 1,000 homeowners or applicants as the "winner pool" for FEMA to approve. So many people called us very upset because after the first year, when they were not selected as a winner, they went ahead and installed a safe room. They were not happy. Therefore, we make sure we call all potential winners before they are approved to make sure they have not installed.*
>
> *When I went with the FEMA team to investigate the safe rooms in the damage path, for every address we had to inspect, we would find 3 to 4 safe rooms within the homes surrounding the "listed" safe room that OEM, SoonerSafe. FEMA, NSSA, or Texas Tech did not know existed/was not on our list….*
>
> *As far as homeowners who install without our grant or rebate programs, many homebuilders, especially higher-class homes, will build in the safe room and use it as a selling point, so this may make the above-ground percentage a little higher, but I can't really estimate if they are not using our grant program." (Melissa Moore, email correspondence, March 2014.)*

The question about how many non-FEMA-supported safe rooms in Oklahoma meet FEMA criteria is even less understood, since regulations and enforcement vary from community to community. The lack of unified data regarding non-FEMA-supported safe rooms raises the possibility that non-FEMA-supported safe rooms may not meet FEMA criteria and may be less safe.

Dr. Kiesling states, "There might be additional scrutiny in [FEMA] funded safe rooms because there are supposedly inspections required, and some require building permits,…but when people just spend their own money, the tendency is to go cheapest and quickest." Dr. Kiesling goes on to say, "It's hard to generalize… Safety probably depends first on the jurisdiction… There may be some greater risk in rural areas without building codes. The industry is hopefully stabilizing with a reasonable level of quality control. We started NSSA [National Storm Shelter Association] after the 1999 Oklahoma City tornado, when there were almost no standards. There was no vanguard of quality at that time. We have come a long way. Things are better today."

Question 4. What are incentives and disincentives that affected people's decisions to privately finance and build their own safe rooms?

Literature, interviews, and answers to questionnaires consistently cited similar factors that influence decisions to invest in safe rooms.

Three conditions have to be met before people can consider investing in safe rooms:

1) They believe they and those they care about are at risk from injury or death in a tornado or high wind storm.
2) They know about safe rooms and believe safe rooms offer their best chance for protection.
3) They own their property and have the funds to invest, either for a privately funded safe room or to front-end the cost before a government grant.

Other influential factors include:

- They have been exposed to recent storm experience, either in their community or others that influence them.
- They believe the safe room will enhance their property values.
- They know other people who are investing in safe rooms.
- They can thread their way through the myriad of options and choices to make decisions.
- Even if they believe the probability of a tornado striking their property is low, they believe a safe room is a good investment for peace of mind.

Before people will invest their own money in a safe room, many people need to be convinced that it is a good purchase and that they will not receive a grant in a timely fashion. Many builders and vendors said consumers procrastinate because they hope they might be drawn in a grant lottery, no matter how slim their odds. On the other hand, vendors said offers of a discounted price often convinced people to buy and the idea of a bargain may convince people to make a purchase. For example, one vendor said people were motivated to buy at a fair when they were offered a "senior citizen day" discount.

Factors affecting the purchase of a safe room vary between new construction and existing properties. A home builder's advice is an important factor in decisions to include safe rooms in new construction. For example, one Oklahoma custom home builder requires his customers to sign a waiver saying they decline to include a safe room. Another Central Oklahoma builder includes a safe room, "for free," in his new construction packages. Factors influencing decisions to retrofit a safe room into an existing home or business are more diverse; the factors cited above may all be influential, including whether property owners have an appropriate place in the existing building for a safe room.

The influencing factors were cited repeatedly by those interviewed and responding to the interview questionnaire. Generally, everyone that responded cited: fear of a tornado, especially after recent storm experience or exposure; a desire to protect one's family; and the ability to pay; as reasons people decide to invest in a safe room. Recent storm experience or extensive media coverage of a recent tornado, especially if the news media featured safe rooms, dramatically increased safe room sales and interest in safe rooms.

The influencing factors cited for effective incentives to purchase a safe room include funding from non-profit or public sources, government leadership, tax breaks, and public education. Disincentives included "waiting to be drawn in the grant lottery" and the reported reluctance of appraisers to include safe rooms in property values, which reduces the chance that safe rooms will be seen as adding market value to a property (See Appendix A and pages 46-47).

In a 2006 article by Kevin Simmons and Daniel Sutter, the cost effectiveness of tornado safe rooms is explored using annual probability based on a study of 286 tornados in some of the most high risk states, including Texas and Oklahoma. The cost per life saved for permanent homes in Central Oklahoma is $47.1 million and $11.6 million for mobile homes; whereas in Texas it is $200 million for permanent homes and $49.6 million for mobile homes[15].

There is a need for research specific to the question of motivation for the purchase of safe rooms. The existing academic research focuses primarily on risk perception, protective behaviors, warnings, and flood mitigation.

Question 5. What are specific recommendations for actions that could encourage more privately financed, qualified safe rooms in areas with extreme risk of tornadoes and high winds?

This NHMA Safe Room Report contains detailed recommendations, in 10 categories, on pages 48-63 and the final pages of the executive summary. The recommendations include the supporting research findings.

[15] Simmons, K. & Sutter D. (2006). "Direct Estimation of the Cost Effectiveness of Tornado Shelters," *Risk Analysis* 26(4): 951-953.

Central Oklahoma Experience

Local experts believe 80% of shelters are self-funded, although not all meet FEMA criteria.

Although there is not an accurate number of current safe rooms in Central Oklahoma, the numbers are growing. Researchers found that, although partial data can be obtained through building permits and grant records, there are no detailed records maintained on the total number of safe rooms and shelters. Some communities keep voluntary registration lists but will not make them public. Public records and informal accounts show that tens of thousands of safe rooms have been built in Oklahoma since FEMA launched its safe room program in 1998.

Experts speculate that a highly vulnerable sector of south-central Oklahoma has more safe rooms per capita than any other place in the United States. The Moore City Manager, Steve Eddy, estimates that in the near future one-third of the City's 23,000 households will have access to safe rooms or storm shelters, either their own or nearby in neighboring homes or buildings. Eddy says, most were built with private funds and are less-expensive underground prefab steel units, often in garages. Some Central Oklahoma emergency managers are also encouraging shelters in schools and similar group locations.

Interviews with safe room vendors and builders, emergency managers, consumers, and government officials, revealed most of them believe people are motivated to invest in safe rooms because of a fear of tornadoes; seeking safe shelter for themselves and their families; and feasibility, whether they can afford the shelter and whether it fits into their house and life style. Typically, safe room construction increases after big storms then wanes with time. This finding supports research on the impact of a hazard experience on self-protective behaviors, which indicates there is a correlation and that impacts are only felt for a short period of time following the experience with the hazard.[16] Overwhelmingly, those interviewed said the greatest deterrent to safe room investment is cost, and that some Oklahomans cannot afford a safe room that may provide protection against a disaster that may never affect them. The safe room delivery system is largely market driven, with some FEMA incentive grants, and does not appear to be targeting most vulnerable people and locations, such as mobile home parks or nursing homes where people cannot fend for themselves.

Some residents who self-funded safe rooms indicated that tax and insurance incentives, grant funding, and the inclusion of a safe room cost in a mortgage would motivate people to invest.

[16] Sims, J.H. & Baumann, Duane D. (1983). "Educational Programs and Human Response to Natural Hazards," *Environment and Behavior* 15(2): 165-189. Retrieved on March 1, 2014.

Further economists have conducted studies and surveys of consumers, specifically looking at the perceived effectiveness of a safe room and the protection it may provide. Based on a series of surveys in Tulsa Oklahoma in 2002, they found that while residents find safe rooms beneficial they are not willing to pay the full cost but only $6,000 at a maximum[17].

Oklahoma City resident, Ryan Fuller, invested his own money in a below-ground, 4' x 7' safe room. His first motivation was desire to protect his family. Fuller states, "I believe it will add to the value of my property, so it is a good investment. Of course, affordability is also important; I am fortunate to be able to make this investment, which gives me great peace of mind during storm seasons."

Kelly Brooks lives in Moore and added an above-ground safe room to her home. She believes most people invest their own funds in safe rooms for the same reasons she did: to protect their families and improve their property values. People are discouraged from investing because they can't afford protection, don't have a place of their own, perceive the cost is too high, or don't think they can resolve accessibility issues.

Despite the possibility of widespread devastation in the targeted area, researchers did not find any comprehensive community sheltering plans or strategies for providing safe shelter for entire communities. They did find evidence that in the aftermath of the 2013 storms, many governments, nonprofits, and faith-based organizations are working together to improve the storm safety for people in this very vulnerable part of the world.

[17] Miller, D., Morgan, D., and Womack, C. (2002). "Buying Tornado Safety: What Will It Cost?" *Southwestern Economic Proceedings* 29(1): 35-45.

Introduction

Dr. Ernst Kiesling, Texas Tech researcher and executive director of the National Storm Shelter Association, examines a safe room that survived the May 2003 Moore tornado.
Photo courtesy of Ann Patton

The old and time-tested adage, "Hide from the wind, flee from the flood," is proving to be life-saving advice for residents of Tornado Alley, where the presence of tornado shelters, refuges, and safe rooms has risen dramatically in the past decade.

In 2013, the Federal Emergency Management Agency (FEMA) asked the Natural Hazard Mitigation Association (NHMA) to document safe room development in Central Oklahoma and to recommend ways to encourage greater investment in safe rooms in high-risk zones.

Purpose

NHMA developed this report, *Hide from the Wind: Tornado Safe Rooms in Central Oklahoma* (NHMA report), to examine lessons learned about the increased presence of safe rooms over recent years in Central Oklahoma, one of the world's leading zones for frequent and powerful tornadoes. This NHMA report focuses on the development of residential shelters in selected communities in the Oklahoma City area and documents findings about the incentives and disincentives that effect the decision to invest in a safe room. This NHMA report includes recommendations that may increase the number of people protected by safe rooms in high-risk zones.

Scope

The focus of this NHMA report is on small, individual safe rooms. This report does discuss other shelter options such as school safe rooms, community shelters, or group tornado refuges.

The report includes:

- An overview on safe room development and the process of conducting the study;
- Lists of acronyms and definitions used in the study;
- Profiles of two selected Central Oklahoma communities;
- A timeline of key milestones relating to safe room development;
- An analysis of key issues;
- Recommendations to encourage greater investment in safe rooms; and
- List of references and participants that were interviewed.

The observations in this report are based on insights from storm survivors and storm safety experts, including researchers and officials who have devoted their lives to storm safety, safe room builders, manufacturers, installers, vendors, and others who bring safe room technology to those who live in harm's way.

Acronyms and Definitions

Acronyms

FEMA: Federal Emergency Management Association.

FLASH: Federal Alliance for Safe Homes.

ICC: International Code Council.

NHMA: Natural Hazard Mitigation Association.

NIST: National Institute of Standards and Technology.

NOAA: National Oceanic and Atmospheric Administration.

NSSA: National Storm Shelter Association.

NWS: National Weather Service.

Definitions

Tornado: According to the American Meteorological Society's Glossary of Meteorology, as quoted in *FEMA P-320* (see below), a tornado is "a violently rotating column of air, pendant from a cumuliform cloud or underneath a cumuliform cloud, and often (but not always) visible as a funnel cloud." (https://www.fema.gov/media-library/assets/documents/2009).

Tornado ranking scales: The Fujita (F) and Enhanced Fujita (EF) scales. The strength or force of a tornado was measured by the Fujita scale, which ranked tornadoes F1, F2, etc., with F5 being the most severe. In 2007, scientists began using the Enhanced Fujita scale, which now ranks tornadoes EF1, EF2, etc., with EF5 being the most severe. Scientists believe the EF scale better characterizes damage to buildings during a tornado. An EF0 storm would have winds (3-second gust) of 65 mph to 85 mph; and EF5 winds would be more than 200 mph. (http://www.spc.noaa.gov/efscale/)

Tornado Alley, Dixie Alley, Tornado high-risk zone. Tornado Alley is a nickname describing a band of lands through the Central United States where severe tornadoes are frequent. The exact boundaries are debatable, depending on which criteria are used to measure the frequency and severity of the tornadoes. In general, Tornado Alley stretches from Texas to Iowa and Kansas/ Nebraska to Ohio, an area prone to what are called supercell thunderstorms that can spawn violent tornadoes. Dixie Alley is a nickname describing the band of lands through the Gulf Coast area that stretches from Florida to eastern Texas and reaches as far north as southeast Missouri and southwest Kentucky and sees a prevalence of tornadoes in late fall. (http://www.ncdc.noaa.gov/climate-information/extreme-events/us-tornado-climatology/tornado-alley)

Safe room. This NHMA report uses the term "safe room" in a precise context. It refers to a room or space that is specially anchored and armored to provide "near absolute life-safety protection" for its occupants during a tornado or wind storm. A safe room, regardless of its size, is an enclosure that is designed, built, and installed in accord with specified criteria as set forth by FEMA and, in some cases, also the International Code Council[18].

Residential shelter, family safe room, individual safe room. This report focuses on "residential safe rooms," a storm shelter serving occupants of dwelling units and having an occupant load not exceeding 16 persons. A residential safe room serving an individual or family could be installed inside, under, or near a new or existing building. It may be used for other purposes, such as a

[18] http://www.fema.gov/media-library-data/1430758775177-353770961374f71c45383af7af4385d5/FEMA_P-361_2015r2.pdf

closet or pantry ("multi-use safe room"). A residential safe room could be built on site ("site-built") or fabricated in a factory and installed at the site ("pre-fab").

Community safe room. This term refers to any safe room not defined as a residential safe room. Typically a community safe room is a larger group enclosure to shelter more than 16 persons, such as the populations of schools or apartments. A community safe room may or may not be open to the general public. A community safe room may be intended for use by those who occupy the building, or it may be intended for use by the residents of surrounding or nearby neighborhoods or designated areas. Because of its size, a community safe room must meet different provisions as set forth by FEMA and the International Code Council.

Shelter. FEMA has developed specific terminology to differentiate types of tornado refuge areas from other types of "shelters." The term "shelter" is used in different ways by different agencies and entities. For instance, the American Red Cross uses the term "shelter" to refer to temporary recovery areas. This NHMA report uses the FEMA definition; a storm shelter provides life-safety protection and is designed and constructed to meet ICC 500 criteria.

FEMA P-320. This publication – *Taking Shelter from the Storm: Building a Safe Room for Your Home or Small Business, FEMA P-320*, Fourth Edition, (2014) – provides safe room designs that will show a builder or contractor how to construct a safe room for a home or small business. Design options include safe rooms located in the garage, or in an interior room of a new home or small business. These safe rooms are designed to provide individuals or small groups near-absolute protection from the extreme winds expected during tornadoes and hurricanes and from flying debris, such as wood studs, which tornadoes and hurricanes may create. (http://www.fema.gov/media-library/assets/documents/2009)

FEMA P-361. This publication –*Safe Rooms for Tornadoes and Hurricanes: Guidance for Community and Residential Safe Rooms*, Third Edition (2015) – provides detailed guidance concerning the design and construction of both stand-alone and internal residential and community safe rooms for extreme-wind events. It is used for design criteria and guidance on building larger safe rooms for schools, public buildings, apartments, and other spaces serving larger populations. (http://www.fema.gov/media-library/assets/documents/3140)

Hazard mitigation. Hazard mitigation includes actions that can be taken before, during, or after a disaster to reduce or avoid the effects of that disaster. A safe room is a hazard mitigation measure that can be built or installed before a disaster to reduce loss of life and injury. As defined by FEMA, "Mitigation is the effort to reduce loss of life and property by lessening the impact of disasters. Mitigation is taking action *now*—before the next disaster—to reduce human and financial consequences later (analyzing risk, reducing risk, insuring against risk). Effective mitigation requires that we *all* understand local risks, address the hard choices, and invest in

long-term community well-being. Without mitigation actions, we jeopardize our safety, financial security, and self-reliance." (http://www.fema.gov/what-mitigation#1)

NHMA. The Natural Hazard Mitigation Association represents practitioners, researchers, and others who support hazard mitigation as a means to reducing disaster losses and creating safer, livable, sustainable communities. An NHMA team is conducting this report, *Hide from the Wind: Tornado Safe Rooms in Central Oklahoma* (NHMA report), study for FEMA. (For additional information, see NHMA.info)

NSSA. The National Storm Shelter Association represents people who design, build, manufacture, install, and are otherwise involved in the safe room industry, including auxiliary people who support quality control in safe rooms. NSSA's stated purpose is "to ensure the highest quality of manufactured and constructed storm shelters for protecting people from injury or loss of life from the effects of tornadoes, hurricanes and other devastating natural disasters." (For more information, see NSSA.cc.)

ICC 500 or ICC/NSSA-500. This standard – the *ICC 500-2014: ICC/NSSA Standard for the Design and Construction of Storm Shelter*s – was jointly published in 2014 by the International Code Council (ICC) and the National Storm Shelter Association (NSSA). As summarized in the standard: ICC 500 "provides minimum design and construction requirements for storm shelters that provide a safe refuge from storms that produce high winds, hurricanes, and tornadoes. The magnitude of wind speeds associated with these events requires building occupants and residents to evacuate the area or seek protection in a shelter designed for resistance to extraordinary loads and flying debris. This standard provides design requirements for the main wind resisting structural system and components and cladding of these shelters, and provides basic occupant life safety and health requirements for these shelters including means of egress, lighting, sanitation, ventilation, fire safety, and minimum required floor space for occupants." (http://shop.iccsafe.org/icc-500-2008-icc-nssa-standard-for-the-design-and-construction-of-storm-shelters-2.html)

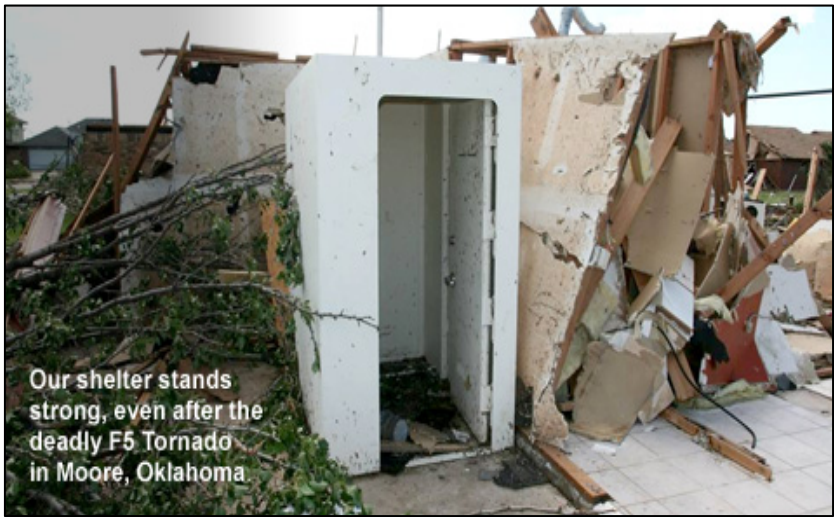
Overview

Study Goals

The goal of this NHMA study and report are to provide information and possible actions that increase access to safe shelter for people in areas of high tornado risk. This NHMA study focuses on one of the nation's highest-risk zones, Central Oklahoma. This NHMA study incorporates research, analysis of available data, and experience including personal interviews and other research techniques to compile information about safe rooms in sample communities. This NHMA report also includes recommendations for future actions.

Key study questions include:

- What is the best estimate that can be made from available sources, for individual safe rooms built in selected communities? How many have been built with private funds?
- What are the incentives and disincentives that affected the decision to privately finance and build safe rooms?



Safe room that survived the May 20, 2013 storm in Moore.
Photo courtesy of Family Safe

- What are recommended actions that can encourage more privately financed, qualified safe rooms in areas with high risk of tornadoes and high winds?

Process of Study

Safe Room Research

Informed by their experience with hazard mitigation and safe room issues, NHMA's study team began with literature and other background research to identify an initial list of key issues and esteemed subject matter experts. The scoping research was balanced with field investigations in high-risk communities in the Central Oklahoma area that offered diversity of demographics and safe room experience. Throughout the study, the team engaged field and academic experts to build a stakeholder and expert advisory team, described in more detail in the following section.

Additional information was obtained through individual interviews, focus groups, and review of programs and records.

The study team developed a general questionnaire on the incentives and disincentives that affect how and whether people invest in safe rooms. The study team also attended the National Tornado Summit (February 2014 in Oklahoma City) and the annual meeting of the National Storm Shelter Association (October 2013 in Norman, Oklahoma).

Agencies such as the Oklahoma Department of Emergency Management (OEM), FEMA Region VI, and local emergency managers in the focus area participated throughout the study. Local emergency managers helped researchers identify relevant local issues and attitudes.

Vendor safe room display, Tulsa Home and Garden Show, 2014.
Photo courtesy of Ann Patton

The study team sought targeted and broad input through the questionnaire. Dr. Ernst Kiesling announced the study and questionnaire in his presentation to the National Tornado Summit and circulated the questionnaires from the National Storm Shelter Association (NSSA) booth. A major safe room vendor agreed to circulate questionnaires at his safe room booth at the 2014 Tulsa Home and Garden Show, which featured fifteen safe room vendors. Other groups emailed questionnaires to their memberships: NSSA, Oklahoma Emergency Managers Association, and the Oklahoma Home Builders Association. A total of 57 questionnaires were completed and returned to the study team.

The study team conducted structured interviews, documented in digital voice recordings and notes or transcripts. The study team also maintained an active email and phone discussion group that included various parties in addition to the core advisory group.

Advisory Groups and Reviews

Expert advice and counsel was integral to the research process on this NHMA report for FEMA. NHMA was fortunate to have the nation's top experts on storm safety, including:

- Dr. Ernst Kiesling, inventor of the safe room, research professor at Texas Tech's National Wind Institute, and Executive Director of the National Storm Shelter Association.

- Tom Bennett, meteorologist, Executive Weather Producer at Tulsa's KOTV and Oklahoma City's Channel 9, owner of Jim Giles Safe Rooms, past President of the National Storm Shelter Association, and NHMA Board member.

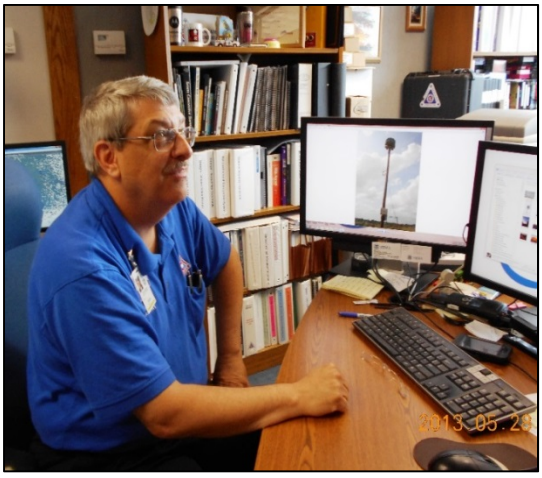
- Leslie Chapman-Henderson, President and CEO of the Federal Alliance for Safe Homes (FLASH)®

- Margaret Lawless, now retired, former FEMA Deputy Administrator for Mitigation in the late 1990s when FEMA introduced safe rooms to the nation.

- Claire B. Rubin, a social scientist, independent researcher, consultant, and educator with 36 years' experience in emergency management and homeland security.

Integral to this NHMA study was the expertise and participation of emergency managers, manufacturers, vendors, installers, builders, and meteorologists, and local, state, and federal officials – people who live and work with tornado risk and protection every day, within Central Oklahoma and the Nation.

The study team continually expanded the stakeholders and advisers group and engaged them in the study on specific issues relevant to their work and expertise.



Moore Emergency Manager Gayland Kitch. Photo courtesy of Ann Patton

The third tier of advisors included consumers, storm survivors, businesses, non-profits, families and individuals. This group was difficult to assemble in a comprehensive way, in part because governments will not release names for privacy concerns. The study team accessed these advisors through venues such as home and garden shows, referrals, and known contacts.

Tornado Alley

Tornadoes have occurred in the United States longer than recorded time, but the science of wind and tornado forecasting, measurement, and mitigation is relatively new and, despite dramatic advances in the past few decades, continues to be challenging. Terminology also complicates communication with the public.

It is well documented that tornadoes tend to happen more often within the area of land popularly known as Tornado Alley, generally east of the Rockies, but there are many different delineations. Based on historical records, it is possible to identify the zones where tornadoes and high winds are most apt to occur, although areas of particularly violent weather continue to shift somewhat over time.

> *"Approximately 64 percent of all fatalities from tornadoes in the United States (1950–2011) have been due to EF4 or greater tornadoes."*
> *– NIST, 2013.*

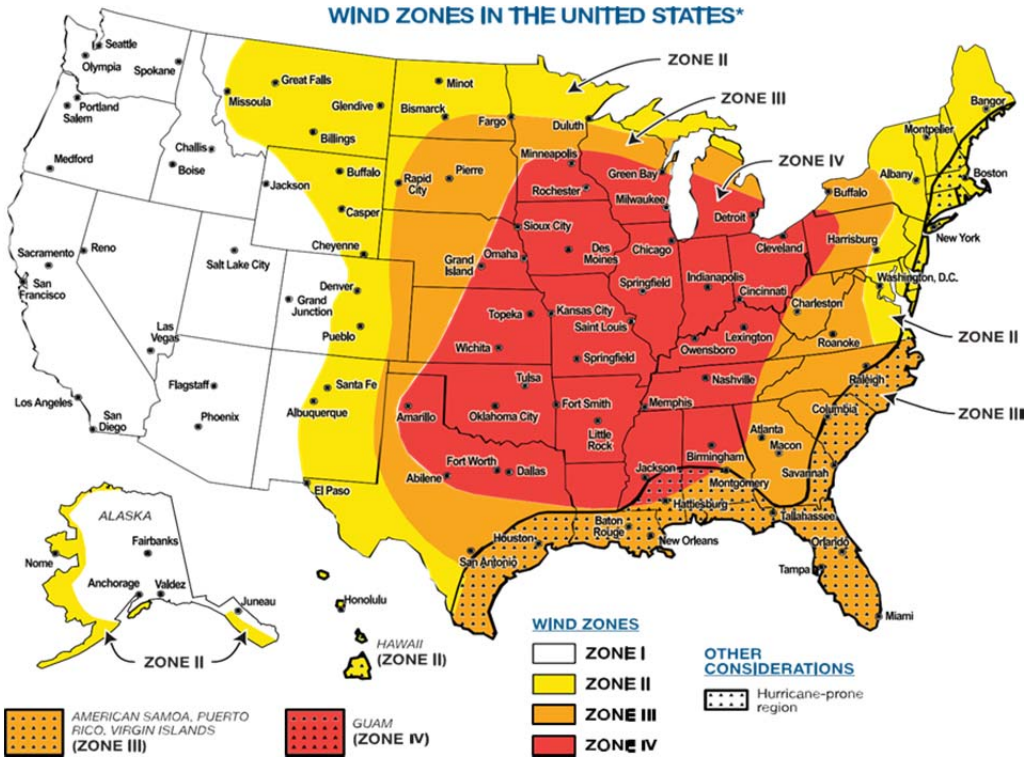
Central Oklahoma has been a recent site of repeated and violent storms, which has prompted intense interest in safe rooms and shelters. However, the events in Central Oklahoma should be viewed in a national context.

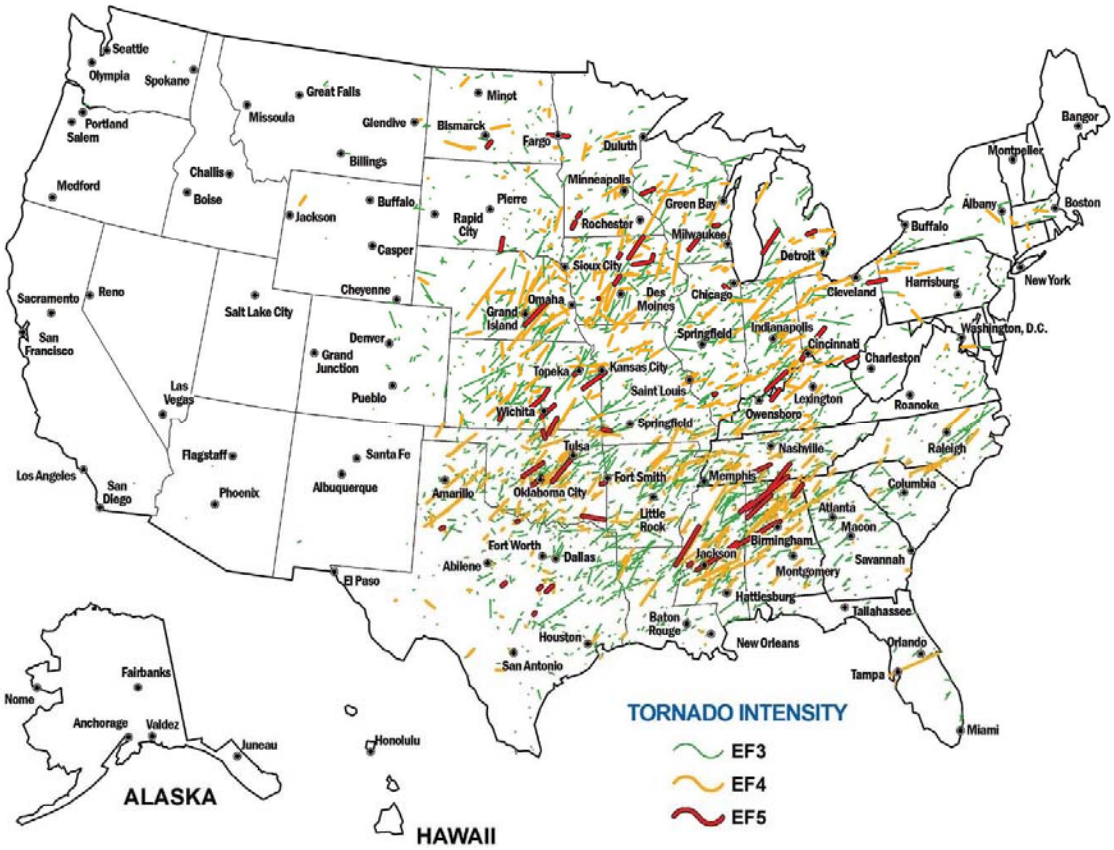
A recent report on the Joplin, Missouri, tornado contains a useful analysis of the national tornado hazard.[19] Based on analysis of NOAA data, National Institute of Standards and Technology (NIST) reports that "As expected, per tornado loss is much greater for stronger tornadoes, especially EF4 and EF5 tornadoes. For example, an EF5 tornado, on average, causes $100 million in losses."

Over two-thirds of all losses are due to EF3 to EF5 tornadoes, while EF1 and EF 2 tornadoes account for approximately 30 percent.

The following maps are from FEMA P-320. The top map shows wind zones in the United States and the bottom map shows recorded EF3, EF4, and EF5 tornadoes in the United States between 1950 and 2013.

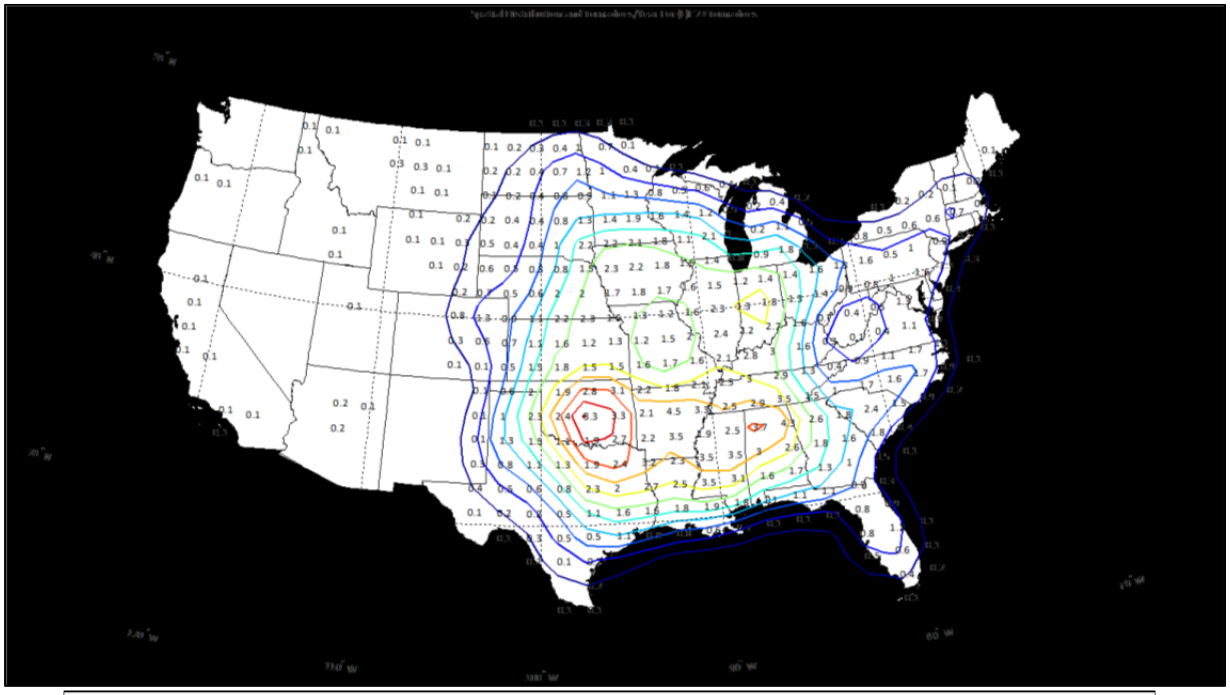
[19] "Technical Investigation of the May 22, 2011, Tornado in Joplin, Missouri," National Institute of Standards and Technology, US Department of Commerce, March 26, 2014. http://www.nist.gov/manuscript-publication-search.cfm?pub_id=915628


WIND ZONES IN THE UNITED STATES*
ZONE II
ZONE III
ZONE IV
ZONE II
ZONE III
ALASKA
ZONE II
HAWAII
(ZONE II)
AMERICAN SAMOA, PUERTO RICO, VIRGIN ISLANDS
(ZONE III)
GUAM
(ZONE IV)
WIND ZONES
ZONE I
ZONE II
ZONE III
ZONE IV
OTHER CONSIDERATIONS
Hurricane-prone region


TORNADO INTENSITY
EF3
EF4
EF5
ALASKA
HAWAII

"A small number of tornadoes, mostly at the high end of the EF scale, have caused a majority of the fatalities… Approximately 64 percent of all fatalities from tornadoes in the United States (1950–2011) have been due to EF4 or greater tornadoes. A total of 86 percent of fatalities have been due to EF3 or greater tornadoes and 96 percent are due to EF2 or greater tornadoes."[20]

The NIST report includes the following map, based on NOAA data over the past three decades, shows a red bull's eye on Central Oklahoma where the highest probability for violent tornadoes.



Probability density of EF2 or greater tornadoes from 1980 through 2011 with annual values for EF2 or stronger tornadoes shown at each grid point. Warmer colors are higher occurrences.

Source: NIST and NOAA.

[20] "Technical Investigation of the May 22, 2011, Tornado in Joplin, Missouri," National Institute of Standards and Technology, US Department of Commerce, March 26, 2014. http://www.nist.gov/manuscript-publication-search.cfm?pub_id=915628

Safe Rooms Take Oklahoma by Storm

This section discusses the development of safe room technology, major issues, Oklahoma's safe room program, and experiences in Moore and El Reno.

Safe Room Timeline

The safe room timeline on the following page traces some safe room milestones relevant to this study and Central Oklahoma.

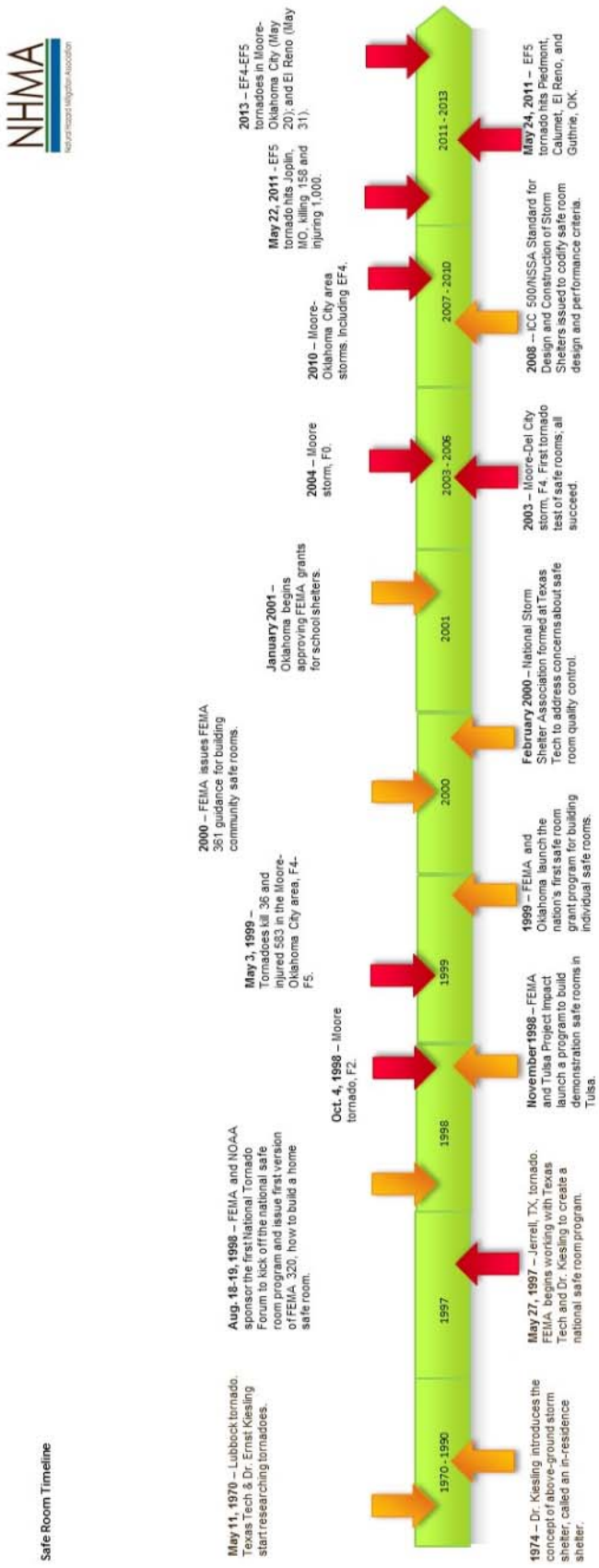
It was a tornado in Lubbock, Texas, in 1970 which prompted Dr. Ernst Kiesling and others to begin the Texas Tech University wind engineering program. Researchers at Texas Tech have conducted field investigations of every major tornado since the Lubbock tornado. They discovered that tornado wind speeds were not as high as believed and that damages and injuries could be mitigated by engineering approaches. Based on the finding that people were most likely to survive in a small central closet, in 1974 Kiesling developed the concept of anchoring and armoring a small central room that could survive the strongest tornado, separate from the house if needed, and offer "near absolute protection" to keep its occupants safe even if the house blew away. The room could be built above or below ground, and indoors or outdoors. Dr. Kiesling called it an in-residence shelter.[21]

FEMA and NOAA launched their safe room program in August 1998 in Washington, DC.
Photo courtesy of *Margaret Lawless*

After an F5 tornado hit Jarrell, Texas, in May 1997, killing 27 people, a national television news program interviewed Kiesling and publicized the Texas Tech research and findings, including the wind cannon they had developed to test protection from wind-driven debris by shooting 2x4 boards at shelters.

In a project headed by Margaret Lawless and Cliff Oliver, FEMA worked with Kiesling and Texas Tech to develop a homeowners' handbook. In August 1998, FEMA and NOAA sponsored the first National Tornado Forum to begin a national program for what they called "safe rooms." They issued the first version of *FEMA P-320*, a handbook on how to build a safe room in your home, using the tag line that to survive tornadoes, people needed to have "a safe place to go and time to get there."[22]

[21] http://www.depts.ttu.edu/nwi/research/shelters.php
[22] *Taking Shelter from the Storm: Building a Safe Room for Your Home or Small Business, FEMA 320, August 1998*



Timeline for safe room development in Central Oklahoma, 1970-2013.
NHMA graphic by Malmay & Associates, LLC

In the fall of 1998, FEMA provided a $50,000 grant to Tulsa Project Impact to offer community education about safe rooms. A local builder volunteered to help, and in November 1998 Tulsa Project Impact built what is believed to be Oklahoma's first FEMA-supported individual safe room in the Tulsa home of Nancy and Otto Deacon. Tulsa Project Impact volunteers teamed with the Home Builders Association of Greater Tulsa and created considerable community awareness, an array of example safe rooms, and what was said to be the first "safe room subdivision" in the state and perhaps in the nation. By the Tulsa Home and Garden Show in 1999, Kiesling's safe room idea had captured the attention of many throughout the state of Oklahoma.[23]

On May 3, 1999, violent F4 and F5 tornadoes ripped through Central Oklahoma, killing 36, injuring 583, and leaving widespread devastation in the Moore-Oklahoma City area. When he toured the area, President Bill Clinton announced, "If you do nothing else, build a safe room in your home." Working with Oklahoma Emergency Management (OEM), FEMA granted funds for the nation's first individual safe room rebate program, rather than group shelters such as those in schools. In 2000, FEMA issued the first version of *FEMA P-361*, guidance for building community safe rooms. In January 2001, OEM began offering FEMA Hazard Mitigation Grant Program (HMGP) community grants for school shelters.

After Don Stanley lost three homes in five years to Moore tornadoes, he became a safe room vendor.
Photo courtesy of Ann Patton

Research from Oklahoma State University showed that there was an immediate demand for safe rooms following the 1999 storm, but that demand was virtually nonexistent within six months.[24] The researchers found that average consumers were not willing to pay the average cost at that time of $4,000 for an above-ground safe room, and that the FEMA subsidy was oversubscribed and necessary for an increase in safe rooms to occur. However, they did calculate that utilizing the

[23] (*Safe Rooms Save Lives: Oklahoma Safe Room Initiative*, 2003. FEMA.gov.)
[24] Miller, Daniel, et. al. (2002). "Buying Tornado Safety: What Will it Cost?" Southwestern Economic Proceedings, Volume 30.

accepted value of a life, it would not be cost beneficial for the government to subsidize an individual safe room for every residence in the state.

> *"If you do nothing else, build a safe room in your home" — President Bill Clinton, 1999.*

Since the 1999 tornado, Central Oklahoma has been impacted by additional tornadoes, including F4 storm in 2003, EF4 storm in 2010, and EF5 storm in 2013. Although it was only four years after the beginning of the safe room program, research after the 2003 storm in Moore showed that many people survived in safe rooms and shelters, including some that were newly built after the 1999 storm (Patton, Quick Response Report #163). In May 2011, an EF5 storm hit the Piedmont, Calumet, El Reno, and Guthrie communities, near Oklahoma City, again producing examples of survival stories in safe rooms.

2013 tornado damage at Moore.
Photo courtesy of Oklahoma National Guard

In 2013, a Central Oklahoma tornado outbreak began around 6 p.m. on May 19, when tornadoes occurred at or near Edmond, Arcadia, Luther, Carney, Shawnee, Prague, Norman, and Lake Thunderbird. The most intense was an EF4 tornado within Shawnee, where two died.

The next day, an EF5 tornado hit Moore and South Oklahoma City, killing 24, injuring 377, damaging or completely destroying more than a thousand homes, and causing billions of dollars in damage. Among other buildings destroyed was Moore's Plaza Towers Elementary School, where seven third graders were killed. The May 20 tornado path intersected with the previous 1999 path in Moore.

Eleven days later, on May 31, a tornado touched down in nearby Kingfisher, then a second extremely large tornado formed nearby and traveled through rural El Reno, producing widespread panic and killing eight motorists on US Highway 40. More information about the Moore and El Reno tornadoes is contained below in the section on Community Experiences.

In the aftermath of the 2013 storms, people in Central Oklahoma sought to add tornado safe rooms to their homes, businesses, and schools. A large group of builders and prefab vendors converged on Central Oklahoma to meet the growing safe room demand by people who could afford them.[25]

[25] Interview with Tom Bennett, Jim Giles Safe Rooms, April 2014.

Development of a New Industry

In the sixteen years since the first FEMA safe room guidance publication, *FEMA P-320*, was issued in August 1998, FEMA reports that nearly 1 million copies have been distributed to people interested in building safe rooms in their homes. Nearly 25,000 individual or family residential safe rooms have been constructed with federal funding assistance, tens of thousands of safe rooms meeting FEMA criteria have been constructed with private funds, and more than 2,000 community safe rooms have been built with FEMA funding assistance, the agency reported in 2015.

Top: Jim Giles family safe room.
Right: New Day safe room.

In areas of the United States with significant tornado risk, safe rooms have become a booming new industry for manufacturers, installers, home builders, and other related trades.[26] Some builders require people to sign a waiver if they decline to include a safe room, and others are giving away safe rooms for people as an incentive to buy their houses.

In the past, the safe room business boomed after storm events, but went dormant during long periods without storms. Since the 2013 storms in Central Oklahoma, suppliers have been struggling to keep up with demand and report they have long waiting lists. In Oklahoma City, more than 8,000 storm shelter permits were issued between May 2013 and May 2014, as compared to 322 in 2009.[27]

Safe Room Issues

There are many factors which may affect whether or not people decide to purchase a safe room. Some of the factors and challenges are due to physical accessibility limitations of the safe room occupants, affordability for buyers, or too many product choices with no regulation or quality control. These and other factors are often unresolved in terms of public policy. This section will briefly discuss some of the factors and challenges that are particularly relevant to understanding the Central Oklahoma safe room issue.

[26] Interview with Ed Laatsch, April 2014.
[27] Fox News, May 8, 2014.

Safe Room Types

Safe rooms are constructed enclosures that meet safety criteria established by FEMA P-361 and P-320. Safe rooms can be large or small, shelter individuals or groups, and be built inside or outside new or existing buildings. They can be used solely for protection when needed or for multiple uses such as closets, bathrooms, school gymnasiums or cafeterias, even wine cellars. They can be built onsite or pre-fabricated in a factory and installed onsite.

They can be built of wood, steel, or recycled materials. A few use reinforced, vented septic tanks. They may also be above or below ground or even carefully elevated. One of the most popular safe room types in the Oklahoma City area is installed below the garage slab floor.

Above Ground, Below Ground

In frontier days, a typical prairie home might include a root cellar or "fraidy hole" that could offer tornado refuge. Today, only a minority of Oklahoma homes include basements. This practice is attributed to underlying rock, high water tables, cost, or simply the trend to build quickly on concrete slabs. In warm climates such as in Oklahoma, shallow freeze-thaw depths of foundations permit slab-on-grade construction without deep footings that partially form the walls of basements in colder climates.

Texas Tech has investigated every major US tornado since 1970 and has never found a single instance of a properly built above-ground safe room that failed in a tornado.

It is currently debated in some Oklahoma communities whether the only way a safe room is safe, is if it is below ground, especially where the most severe tornadoes have occurred. A number of Central Oklahoma people interviewed adamantly assert that only an underground shelter could be safe and that they did not trust above-ground safe rooms. Yet, it is important to establish, that Texas Tech has investigated every major US tornado since 1970 and has not found a single instance of a properly built above-ground safe room that failed in a tornado. In addition, FEMA's Mitigation Assessment Teams (MAT) surveying damage of major disasters and publishing comprehensive reports, have also not found a failure of a property built above-ground safe room.

Experts interviewed for this NHMA study universally endorsed the safety of above-ground safe rooms and said the mistrust of above-ground safe rooms can lead people to make unwise choices of safe room types or dangerous flight-or-shelter decisions during a warning. The below-ground-only bias appears to be much more prevalent in the Oklahoma City area than in the Tulsa area. Some people interviewed attributed the bias to a very popular Oklahoma City television weatherman who has argued for below-ground-only sheltering since at least 1999.

Generally, Tulsa's television meteorologists are quite influential and have used their leadership positions to encourage broader sheltering options.

Whatever the reason, the bias for an underground safe room or shelter is well-entrenched in Central Oklahoma. One area builder stated, "We do not recommend any shelter above ground. When they provide plans and the design with a structural engineers stamp on them for a shelter that will survive an F-5 direct hit, I will consider above ground shelters…show me the 'design criteria' established by the professional engineers, and I am ready to look at the designs. Until then you are guessing at what will withstand a 6,000 lb. SUV coming thru the air at 300+ miles per hour. We don't have enough knowledge to answer that question. It is not responsible to tell or indicate to the public that they will be safe above ground. They will be safer than in the tub or the closet, but not safe in an F4 or F5 direct hit." (Brenda Love, Elite Quality Homes email dated March 18, 2014).

The below-ground bias became so problematic after the 2013 storms, with rumors circulating about phantom "failures" of safe rooms, that Federal Alliance for Safe Homes (FLASH) issued a fact sheet, news release, and convened a virtual news conference to establish the fact that every properly-built safe room performed perfectly in the storms. Among experts speaking at the conference was Texas Tech's Larry Tanner, who described the finding from the Texas Tech investigations, showing no properly build safe room had failed in any storm.

The Central Oklahoma bias against above-ground safe rooms and storm shelters is unfortunate, because it can prevent some people, including elderly people and those with disabilities, from accessing or investing in above-ground safe rooms or shelters that are safe. For example, during the May 31, 2014 storm, the bias against above-ground safe rooms and shelters caused people to panic if they did not have underground options for shelter and perilously take to the streets.

Residential or Community Safe Rooms

Factors and challenges that affect the decision whether to encourage residential or community safe rooms include risk perception, protective behavior, below-ground bias, and warning-times. Sheltering groups of people or even entire neighborhoods in a single facility is a tempting option because it might simplify financing and management, provide possible economy of scale, and offer potential safety for high-risk, low-budget sites such as mobile home parks.

Underground group shelter in an El Reno mobile home park.
Photo courtesy of Ann Patton

Community safe rooms can shelter a large number of people and have effectively done so in Central Oklahoma. FEMA reported an example from 2011 in the small town of Tushka, Oklahoma: "Nearly 200 men, women, children, and firefighters stood shoulder-to-shoulder in the safe room and rode out winds of up to 165 miles-per-hour. 'The death toll would have been much higher had there not been a safe room to take shelter in.' said Tushka Mayor Brickie Griffin. 'We are thankful we had a safe room on April 14.' The Tushka community safe room was completed in 2005 at a cost of $140,625, including a $105,469 FEMA HMGP grant." The safe room was able to shelter half of the town's population.[28]

Some emergency managers in Central Oklahoma vehemently oppose group shelters because they believe they are dangerous and attract nuisances that will lure people to go out into the storm, at their peril. They tell horror stories of people who left their homes to seek group shelter and were killed on roadways or stranded outside locked or overcrowded community shelters. FEMA P-361 recommends a five minute travel time or half mile radius around a community safe room for those seeking protection during an event and FEMA P-320 recommends that residential safe rooms be within 150 feet door to door from the home.

Temporary school safe rooms installed after 2011 tornado, Joplin, MO.
Photo courtesy of Ann Patton

"We have a public shelter, and it's a challenge," said one emergency manager from a small Central Oklahoma town. "Even with early warning, people delay taking shelter until the last minute, which works with [residential] safe rooms but not with public shelters. Our shelter has a capacity of 1098, but in the 2011 storm, we had over 1200 people in there, with dogs, cats, gerbils, and snakes. We had a hard time shutting the door, and the wind measured 184 mph when we were shutting the door -- and one person was left outside. People came from Oklahoma City, from everywhere. On May 20, we had more than 1100 people in there. We will keep our public shelter, but it is very difficult."[29]

Others believe that community safe rooms may be useful in certain situations, such as within a mobile home park with very short travel times from the homes to the shelter. Emergency managers in a few very small Oklahoma towns supported the idea of centrally located

[28] "Safe Room Saves Hundreds of Lives in Tushka Tornado," FEMA news release, May 4, 2011, http://www.fema.gov/news-release/2011/05/04/safe-room-saves-hundreds-lives-during-tushka-tornado.
[29] COEMA group interview, April 7, 2014.

community safe rooms. In such locations, travel times could be short, it might not be necessary to keep the center locked, and access might be easier. However, risks and challenges remain for people in places who have to travel community safe rooms for shelter.

Moore City Manager Steve Eddy believes the issue is simply the cost of building enough public shelters to meet needs. "We have thousands of people in our community. If we built a 1,000-person shelter, 10,000 people will try to get in."[30]

Home builder Mike Barnett is building a community safe room in Moore within moment's distance from gated neighborhood's homes. "I continue to believe that community safe rooms are a cost-effective way to save lives and provide a multi-use facility that makes the building usable in many ways," he said in an email. "All I have heard from many public and school officials are exaggerated comments regarding the costs involved. I have worked with two structural engineers concerning larger safe rooms and am currently constructing one in Autumn Oaks Addition in Moore, OK. This project will protect up to 150 persons during a tornado and will double as a community center for the neighborhood's use. I was refused any assistance from Moore officials regarding FEMA assistance, so the developer is paying the entire cost himself. This cost amounts to about $1000 per person living in this neighborhood, offers protection within two blocks of every home there, and allows our disabled neighbors access to a secure structure."[31]

One possible policy resolution comes from Texas Tech's Dr. Ernst Kiesling, who advocates building safe rooms for the inhabitants of a single building or enclosure, so people do not need to go out of doors into a storm. For example, a group safe room could be feasible within an apartment building, retail store, or school, if it serves the occupants of the building who could reach shelter very quickly and not need to leave the security of the building.

Forecasting, Warning, and Risk Communication

FEMA and NOAA established their joint 1998 goals of "a safe place to go and time to get there," because agencies are essential to obtaining safe shelter. Forecasting and warning times have made exponential advances in recent years. Additional credit goes to NOAA's National Severe StormsLab and the University of Oklahoma's Weather Center. The issues relating to forecasting, warning, and risk communication are sensitive and continue to evolve as forecasting and warning times increase.

Central Oklahoma emergency managers that were interviewed during this NHMA study, almost universally favored sheltering in place during a tornado – following an old adage: *flee from the*

[30] Steve Eddy interview 4-17-14.
[31] Mike Barnett correspondence, March 2014.

flood, hide from the wind. They said they do not want to issue any communication that could encourage people to leave a secure building, go outside, and take to the streets in their cars, which are one of the most vulnerable places to be during a tornado. Yet, as warning times increase, could it be safe for some people to travel to a group safe room, for example? How can public managers handle communication if according NOAA they only have an average 13 minutes of warning time? Could forecasting soon be precise enough to allow people to outrun a tornado in some instances?

Risk Perception and Protective Behavior

Understanding human behavior as it relates to tornado risk and protection is challenging and affects decisions and choices. There is a great deal of research on the subject of risk perception, including the impacts of educational campaigns on risk perception, and the role that risk perception plays in self-protective behaviors and willingness to heed warnings. While the breadth of that research is beyond the scope of this study some key points have been included.

"Research has shown that people are typically unaware of all the risks and choices they face," wrote researcher Dennis Mileti in 1999. "They plan only for the immediate future, overestimate their ability to cope when disaster strikes, and rely heavily on emergency relief."[32]

The academic research on self-protective behaviors, relative to natural hazards, has largely focused on flooding, earthquakes, and hurricanes. Several researchers have found that the perception, or misperception, of risk plays a significant role on behavior. Unfortunately, homeowners experience great difficulty in assessing the true level of risk they face. They must often rely on limited data and have a tendency to perceive their future risks in terms of the most recent hazard event.[33] Individuals may also apply faulty analysis to the information they have available to them and have a general tendency to assume that their risk is lower than it actually is.

Several personality characteristics also play a role, such as an individual's feelings of personal control and willingness to believe that a catastrophe might occur.[34] A property owner's knowledge and perception of risk is crucial to the owner's engagement in mitigation, and a misperception of risk leads to a failure to alter one's behavior.[35] Considering the personal and financial costs incurred by an individual, perception of risk is a key component to decision making.

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[32] Mileti, Dennis S. (1999). *Disasters by Design: A Reassessment of Natural Hazards in the United States*. Washington, DC: Joseph Henry Press; p. 6

[33] Laska, Shirley Bradway. (1991). *Floodproof Retrofitting: Homeowner Self-Protective Behavior*. Program on Environment and Behavior Monograph #49. Colorado: Institute of Behavioral Science.

[34] Boholm, Asa. (June 2003). The Cultural Nature of Risk: Can there be Anthropology of Uncertainty? *Ethnos*, 68(2): 159-178.

[35] Hinshaw, Robert E. (2006). *Living with Nature's Extremes: The Life of Gilbert Fowler White*. Boulder, Colorado: Johnson Books.

Decision making occurs at three levels: the personal, organizational, and governmental. Both organizational and governmental decision making are influenced by the personal decision making of those individuals involved.[36] Decision making in this context is deeply intertwined with risk perception and various personal characteristics. In addition to the decision making processes, human choice and actions are influenced by social, economic, legal, and other considerations.

Quality Control

Scams and inferior construction occur in the safe room industry, and most consumers are not equipped to make informed decisions. Storms often bring stories of inferior safe rooms that have failed, and publicity often does not mention that they were built below standards. For example, the death of a woman in the April 2014 tornado near Mayflower, Arkansas, was reported in what was a non-standard safe room.

A woman died in a 2014 tornado in this Arkansas safe room, which was reportedly below national standards.
Photo courtesy of Tom Bennett

As the safe room industry burgeoned, Dr. Ernst Kiesling grew increasingly concerned about quality control and in 2000 he was instrumental in forming the National Storm Shelter Association of producers and builders who pledge to maintain high national standards.[37] Dr. Kiesling is the first and currently only NSSA executive director. Through NSSA, Dr. Kiesling helped to create national standards and established the "NSSA seal," a designation that member builders can place on a safe room to give consumers assurance that it meets the national standards. (OEM does not require an NSSA seal on safe rooms receiving grant funds.)

Some locations have adopted ICC/NSSA-500 as part of their building code, which specifies that, if a safe room is built, it must conform to the standard. This provision reads in part:

"R323.1 General (2009 IRC) – "This section applies to the construction of storm shelters when constructed as separate detached buildings or when constructed as safe rooms within buildings.... In addition to other

[36] Mileti, Dennis S. (1999). Disasters *by Design: A Reassessment of Natural Hazards in the United States*. Washington, DC: Joseph Henry Press; p. 6

[37] Ernst Kiesling interview, 2011.

applicable requirements in this code, storm shelters shall be constructed in accordance with ICC/NSSA-500."

Oklahoma has adopted the 2009 residential building code, which includes ICC/NSSA-500. Some jurisdictions require building permits for safe rooms and other do not. The Oklahoma state building code is not binding on local jurisdictions unless they adopt it in whole or in part.

Costs, Benefits, and Insurance

It is challenging to assess the benefits of safe rooms in dollars and cents. Safe rooms mitigate for life safety, not property damage, except for the occasional example when people store personal valuables in their safe room. It is difficult if not impossible to place an accurate dollar value on intangibles such as personal safety and peace of mind. Therefore, traditional cost-benefit analyses are not appropriate.

Difficulty obtaining accurate monetary measurements and accessing reduced-rate insurance incentives complicates the challenges of assessing and publicizing benefits of safe room programs.

Furthermore, safe rooms are of marginal economic interest to many property damage insurance companies, since they do not reduce damage claims. One exception: in Oklahoma is State Farm Insurance, which has a strong partnership with Tulsa Partners Inc., and participates in many safe room promotional activities.

Difficulty obtaining accurate monetary measurements and accessing reduced-rate insurance incentives, complicates the challenges of assessing and publicizing benefits of safe room programs.

Builder Bill Rhees is a leader in safe room development in Oklahoma.
Photo courtesy of Ann Patton

Regulatory Landscape

After severe tornado outbreaks, some people in Oklahoma wonder whether safe rooms should be mandatory in high-risk zones.

The current debate in Oklahoma is centered on school safe rooms. Since the 2013 storms, there have been discussions about whether or how to provide safe rooms in schools. Oklahoma's adopted code now requires safe rooms in new

schools, but cash-strapped school districts are not building many new schools. Governor Mary Fallin favors a constitutional amendment to allow school districts to increase their local bonded indebtedness to pay for school shelters, while former state legislator Joe Dorman, favors increasing corporate taxes to pay for the cost of installing safe room shelters in Oklahoma schools.

Tornadoes are considered to be high-consequence, low-probability events, making it challenging to justify mandatory safe rooms. There are widely differing estimates of the odds of a tornado hitting any one spot, which also vary according to location. For example, the odds would be higher in Central Oklahoma based on higher historical occurrences. One suggestion by Dr. Kiesling was to require community safe rooms in highest-risk zones only for buildings or places where people do not have a choice to obtain an individual residential safe room. Thus, requiring community safe rooms in apartments, public housing projects, shopping centers, institutions, mobile home parks, and similar places; but not in residential homes or businesses, where owners in theory have the option to provide their own safe rooms. "We need to protect people in their facilities, whether school, church, retirement home, or place of business," said Lisa Bradford, an Oklahoma City architectural engineer.

Market Demand

Producers and builders of safe rooms ultimately follow market demand. Safe room market demand is highly variable and often depends on whether there was a recent tornado in the vicinity or the news. Market variability makes it challenging to develop consistent safe room programs.

The safe room market is also affected by safe room feasibility and affordability. One TV station in Tulsa has sponsored safe room giveaways and has carried a public-education story about safe rooms almost every day since the 2013 storms. This educational program has a significant effect on consumer awareness and demand, and is particularly effective because the person delivering the message, a local television meteorologist, is a popular and trusted member of the community.

Ability to Pay

This NHMA study researched why Oklahomans do not invest in safe rooms, when they live in an area with high tornado risk and without basements. The reason mentioned most consistently in interviews and correspondence was a lack of money to invest in them. The affordability of safe rooms can relate to their accessibility, and therefore people with low-income are often most affected. "The poor are most at risk, and most live in rental property," said Donnell Weatherall,

Emergency Manager of Wayne, Oklahoma, who advocated allowing landlords to use grant funds to put safe rooms in rental property.[38]

The ability to finance a safe room is also an issue. The cost of safe rooms "must be added to appraised value for the mortgage to allow the customer to finance," Oklahoma City builder Eric Cheatham wrote in an email.[39] Jim Case, owner of Oklahoma City's Jim Case Homes, said, "Force appraisers to include the cost of the shelter in the value of the home." Other options such as grants require someone other than the home owner to bear the cost, Case said.[40]

Oklahoma's State Safe Room Program

For residential safe rooms, the OEM has two main programs, a direct rebate program currently known as SoonerSafe and a program that provides grants to local communities.

OEM estimates the agency has provided grants for nearly 13,000 residential safe rooms since 1999. The FEMA database shows 46 local or SoonerSafe OEM residential safe room projects since the May 1999 storm, including nine applications currently pending, for $33.3 million in FEMA hazard mitigation grant program funds, and two pre-disaster-mitigation funded projects for 500 safe rooms each.

SoonerSafe

After the 1999 storm, OEM provided $12 million in FEMA Hazard Mitigation Grant Program (HMGP) funds for statewide safe room rebates, resulting in construction of 6,016 individual safe rooms throughout the state (Moore fact sheet). The program was renewed after the 2003 storms. After Oklahoma's 1999 and 2003 tornados, the OEM worked with FEMA to help fund more than 10,000 small above- and below-ground safe rooms across the state through a rebate program.

[38] Correspondence with Donnell Weatherall, March 18, 2014.
[39] Correspondence with Eric Cheatham, March 8, 2014.
[40] Correspondence with Jim Case, March 10, 2014.

OEM's current program, known as *SoonerSafe – Safe Room Rebate Program*, was started in 2011, with different rules and a new applicant database. In 2012 and 2013, SoonerSafe provided rebates for 1,200 more Oklahoma safe rooms. According to OEM Sooner Safe manager Melissa Moore, OEM plans to offer the rebate program each year, contingent upon federal funding, which depends on hazard mitigation funds from Oklahoma disasters.

By spring of 2014, the total number of OEM-assisted safe rooms had risen substantially, with a dramatic increase in interest after violent May 2013 storms. The City of Moore estimates that the majority of subsidized safe rooms in the City are below ground and are mostly prefab safe rooms, which are often less expensive, easier to place in existing homes, and easier to sync with grant timing requirements that require the safe room to be installed and approved before a rebate can be issued.

The City of Moore also indicated that site-built safe rooms, not depending on grant funds, are often built in newer and more expensive homes. OEM also estimates that many thousands of residential safe rooms have been built in Oklahoma without federal funding. OEM provides funding for direct subsidies to homeowners and for local community programs. The current direct funded SoonerSafe program provides a rebate of up to 75 percent cost for a residential safe room, not to exceed $2,000, to eligible Oklahoma owners of single-family homes who install above- or below-ground safe rooms. OEM estimates that residential safe rooms cost between $2,500 and $8,000, with the popular underground prefabs in the range of $2,200 to $3,000. Applicants pay the balance of the cost beyond the $2,000 rebate and any other expenses such as benches, city fees, etc. Applicants can apply online at any time, and winners are selected by lottery in randomly selected drawings when funds are available.

As of March 2014, 32,000 people were seeking safe room rebates. During the 2012 drawing, OEM spent $1 million in rebates for the 500 people chosen in the drawing.

The number of applicants for the SoonerSafe program far exceeds available funding. As of March 2014, 32,000 people were seeking safe room rebates. During the 2012 drawing, OEM spent $1 million in rebates for the 500 people selected in the drawing. Those selected are paid the rebate after they complete construction and verify that the safe room meets or exceeds federal regulations. OEM conducts historic and environmental reviews, including constraints on floodplain locations. Installers sign a certificate of installation to verify compliance of the design, construction, and installation. The signature effectively shifts the burden of compliance and legal liability to the person signing, according to OEM.

Although virtually all recipients are owners of individual single-family homes, the $2,000 rebate could apply to any type of safe room that meets the federal criteria found in *FEMA P-320* and

FEMA P-361, and the design standards found in ICC/NSSA-500. The rebate is exempt from federal tax. In addition, the Oklahoma Constitution provides that up to 100 square feet of a safe room installed after January 1, 2002, shall be exempt from property tax.

Local Community Rebate Programs

Oklahoma communities may also apply through OEM for FEMA funds to conduct their own safe room rebate programs. Since 1999, a few communities have conducted locally-administered safe room programs with FEMA HMGP funds through OEM.

HMGP funds for local community safe room programs are limited. The funds are available only after a federally declared disaster, and are limited to mitigation funding which is authorized as a percentage of the total federal disaster aid amount. Community safe room programs may give priority to home property owners with damage from a particular disaster.

To qualify for local safe room rebate programs through OEM and FEMA, a local jurisdiction must have an approved hazard mitigation plan and must agree to provide a local 25 percent financial match or collect it from the individuals who receive the rebates. Generally, the grant maximum is $2,000 per applicant, but OEM has raised the ceiling in a few instances, such as $3,000 on grants in one community where expensive rock blasting was required to excavate for the installation of underground units.

The community rebate program must comply with FEMA and OEM rules, including applicant selection by a lottery and the requirement for a certificate of compliance before a rebate is paid. The City of Moore indicated the local community programs had become inactive because of complex rules for historic and archeology reviews, but OEM has been able to streamline the rules so local managers can navigate the process more easily.

Mementos adorn a fence around the remains of Plaza Towers School in Moore, May 2013.
Photo courtesy of Ann Patton

With a community safe room program, applicants seeking a rebate apply to the local jurisdiction that has a community HMGP rebate program. They may also apply through the statewide SoonerSafe program for funding, but are prohibited from receiving rebates from both programs.

Local communities are urged to maintain registers of safe rooms in their jurisdictions, so that emergency personnel can rescue anyone who might be trapped in debris after a storm. Current

state practice is to identify each safe room by specific latitude and longitude. Generally, local communities do not release names or addresses of safe room owners. For example, the City of Moore, will not voluntarily release specific safe room locations or owners, although a note on the City's website says the information would have to be released in the case of an open records request.[41]

In 2013, the City of Moore launched a new safe room incentive program funded by the American Red Cross, and others. This program will be discussed in this NHMA report section on Moore.

School Safe Rooms

To encourage the building of larger safe rooms, OEM also provides federal funds for community safe rooms, with emphasis on school safe rooms. Since 2002, OEM and FEMA have helped install school safe rooms. Oklahoma schools have a total of 1,780 school buildings in 516 school districts. Currently, the 2015 International Building Code requires ICC 500 storm shelters to be incorporated when a K-12 school building, with an occupant load of 50 or more, is constructed in a 250 mph tornado design wind speed zone, with some exceptions. Since seven school children were killed in the 2013 storms, an intense public debate has focused on whether and how to fund additional Oklahoma school safe rooms.[42]

OEM Concerns

Albert Ashwood, Director of OEM, is proud of the state's progress increasing the presence of safe rooms but voiced concerns that more needs to be done. "We are not thinking smart enough…We can streamline these programs," Ashwood said in an interview in April 2014.

Ashwood wants stronger partnerships with federal and local governments and says a lot of the work could be done better at the local level. He recommends providing tax credits and other incentives to encourage people to invest in safe rooms, preparedness, and other kinds of hazard mitigation.

While leery about advocating community shelters that could encourage people to leave secure buildings to seek shelter, Ashwood stated "More people get killed leaving their homes, even three blocks for a community shelter. Or if there is early warning, people evacuate an entire city – but we don't know where a tornado is going."

"We are not thinking smart enough," Ashwood said in an interview in April 2014. "We can streamline these programs."

[41] Safe Room Question and Answer sheet, CityofMoore.com; interviews with Melissa Moore and Albert Ashwood, 2014; and http://www.ok.gov/OEM/Programs_&_Services/SoonerSafe_Safe_Room_Rebate_Program/index.html.
[42] OEM and Moore fact sheets, Melissa Moore interview.

He believes that we need learn how to explain the economic benefits of mitigation, including safe rooms, in ways that convince consumers of the long-range savings of making wise choices. Ashwood stated, "The weather service and warnings are outstanding, but we have raised expectations beyond what we can deliver. Far too many people expect that somebody is going to take care of them. The individual has to have some skin in the game." He also stated, "There is a fine line between an incentive and an entitlement program. I never want to turn this into an entitlement program – we will never have that kind of money…. Somehow we have to get incentives to the individual level (so) people will say: 'I am not going to go another storm season without a safe room'."[43]

[43] Albert Ashwood interview, April 2014.

Community Experiences

Recent tornado experience and high safe room interest in Central Oklahoma provides an area significant for research and analysis of safe rooms. Insights regarding safe rooms can be gleaned from the experiences of people within Central Oklahoma communities.

This section includes stories about two Oklahoma City satellite communities, Moore and El Reno. Both experienced major tornadoes in the spring of 2013, and safe rooms were important to people in both communities and were factors in citizen behavior and storm survival.

Moore, Oklahoma

Some have dubbed Moore the safe room capital of the world. This small city has experienced repeated violent tornadoes in recent years, and leaders are working to make it a safer place. Moore may have more shelters and safe rooms per capita than any place on Earth.

Moore is a densely developed town of 55,000 people covering 22 square miles in Cleveland County. The settlement grew up along the busy U.S. Highway 35 just south of Oklahoma City. A mid-South urban town, Moore's population is 84 percent Caucasian; median family income was $47,773 in 2010.

Moore Oklahoma, May 20, 2013.
Photo courtesy of Ann Patton

"[Moore] is a family town with unusual continuity of leadership," said City Manager Steve Eddy in an April 2014 interview.

Steve Eddy, Moore City Manager
Photo courtesy of Ann Patton

Glenn Lewis has been mayor since 1994. Eddy has worked for the city since 1989 and was appointed City Manager in 1999, and has worked as Moore's lead administrator through the past four major tornado disasters.

"People have great expectations after a storm," Eddy said. "We learned by trial and error in 1999. We have been hit so often, we do a great job of recovery and clean up and making sure things get put back together. I'm not bragging, it's just a fact, we know what to do and how to do it….Mayor Lewis and I went to school together. Now we are leading the community. It is more important to us than a job. This is our home." (Steve Eddy interview April 17, 2014)

Storm History

Moore may be best known nationally for its repeated and especially violent recent tornadoes. The National Weather Service has identified 22 tornadoes that touched down in Moore since 1893. In recent years:

Date	F/EF	Fatalities in Moore	Injuries (storm total)	Path width / length
May 31, 2013	EF0	0	100+*	.5 mi / 500 yd
May 20, 2013	EF5	20	387*	14 mi / 1.1 mi
May 10, 2013	EF4	0	2	220 yd / 24 mi
May 8, 2003	F4	0	134	700 yd / 17.3 mi
May 3, 1999	F5	5	583	1760 yd / 38 mi
October 4, 1998	F2	0	0	30 yd / 1 mi
August 1, 1974	F1	0	0	50 yd / 1 mi
November 19. 1973	F3	2	53	500 yd / 24 mi

**Preliminary information*

Table Source: City of Moore.

The 1999 storm, a violent F5 tornado killed five in Moore and many more throughout the state, injured hundreds, and devastated a wide path through the city. The new safe room concept had just been announced by FEMA, and it spurred shelter development in Moore and elsewhere.

Fourteen years later, the 14-mile-long May 20, 2013, EF5 tornado killed 23 in Moore and nearby Newcastle, including 10 children. More than 350 were injured. The storm followed a path that intersected the 1999 storm path through Moore and did the most severe damage to an older area of Moore where most homes did not have safe rooms. About 1,100 homes were destroyed, as was Moore Medical Center and two public schools. Existing safe rooms saved lives in the neighborhoods where entire subdivisions were leveled. According to the City of Moore website, "It is known that many lives were saved when people sheltered in their residential storm shelter." (See Appendix E, Moore fact sheet)

Moore shelter history

From its beginning in 1999, the state safe room rebate program included funding for Moore shelters and other safe rooms throughout the state of Oklahoma. Through the 1999 program and a subsequent rebate program after the 2003 storm, 722 storm shelters were built in Moore, according to the city's records.

Another 1,400 Moore homeowners applied for a 2011 program, but no funding could be obtained. The demand for safe rooms dramatically increased after the May 20, 2013 storm. Officials believe most of the Moore shelters have been built with private funds, and think most are under ground. Unfortunately, it is not possible to determine precisely how many shelters

have been built without government assistance or were not permitted or registered with the city.

OEM Director, Albert Ashwood, believes statistics identify the increase of safe rooms in Moore and how safe rooms have contributed to saving lives in recent tornadoes. Ashwood indicated that in the 1999 storm, 44 died in Moore; but only 14 were killed in the 2013 tornado, a larger storm. Moore City Manager, Steve Eddy, believes soon one in three of his city's homes will have storm shelters. Local experts believe the majority of shelters are self-funded, although not all of them meet FEMA's safe room criteria or ICC 500. Eddy believes neighbors will share shelter with neighbors to further expand the breadth of safety during storms (interviews with Albert Ashwood and Steve Eddy).

The city's registration list is one source of data. At the time of the May 20, 2013 storm, the city had registered 2,500 shelters. By December, 4,300 were registered. Building permits for shelters also rose dramatically after the storm. Moore permitted 2,165 shelters between the May 20, 2013 storm and May 1, 2014. As of May 2014, Moore reported having a total record of 5,500 registered storm shelters, compared to the city's 23,000 residential properties (Moore fact sheets). Based on the data available, as much as 80 percent of the registered storm shelters may have been self-funded.

Moore Red Cross safe room program

Using funds donated after the May 20, 2013 storm, the American Red Cross has provided a $3.75 million grant to the city of Moore to fund a new safe room rebate program. The city estimates that the funds will allow for installation of at least 1,500 storm shelters in Moore. The city accepted citizen applications between January 20 and February 28, 2014, and received 4,600 applications, including 350 from people assigned priority because they sustained total or substantial property loss in the May 20 tornado.

Moore plans to fund 1,500 safe rooms with help from an American Red Cross grant.

Rebate recipients will be selected by computerized random drawing. Applicants could apply on the OEM website and will also be entered into the statewide lottery, although an applicant could not be selected for more than one rebate grant.

The rules of Moore's Red Cross 2014 rebate program, which is part of a larger safe room initiative by the city, differ somewhat from the FEMA/OEM model.

In the Moore/Red Cross program:

- Single-family homeowners may receive a rebate of up to $2,500 toward the cost of a safe room that meets eligibility criteria, including compliance with FEMA P-361, ICC/NSSA-500, the city's code, and IBC 2009.

- The safe room must be covered by a city building permit and certified by the storm shelter contractor and a city building official.

- The rebate is after the fact, after construction has been completed and accepted. A previously built shelter cannot qualify, with one exception for eligible safe rooms in homes destroyed in the May 20, 2013 storm.

If additional funds become available, Moore plans to continue selecting eligible applicants, according to the city's website notice (See the Moore Fact Sheet at Appendix E).

Central Oklahoma Emergency Managers Association in 2014
Photo courtesy of Ann Patton

Stronger Buildings

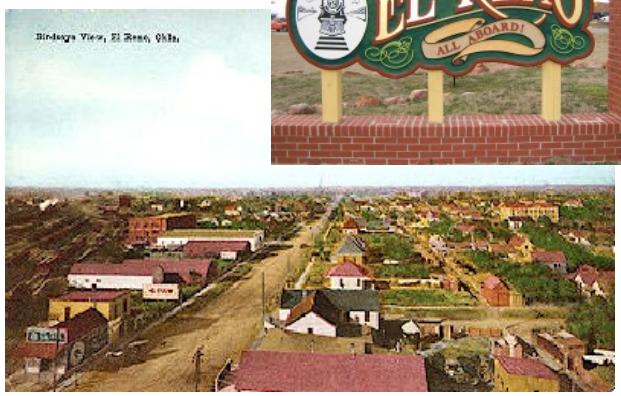
Emergency managers interviewed for this NHMA study all believe that people should not try to outrun a tornado. Instead, many people advocate building stronger buildings that can withstand weaker tornadoes or winds in the tornado fringe, making it safer for people to shelter in place. In May 2014, Moore adopted what they believe is one of the nation's strongest wind codes for residential buildings.

"New homes will have to be wind resistant to 130 mph, versus the 90 mph winds in our current residential code," said City Manager Steve Eddy. "We worked on it for quite a while with home builders. It passed the Council unanimously with no opposition. The home builders knew it had to happen. We are the only city in the State of Oklahoma, and our engineer says we are the only city in the U.S., with this type of code. Every city needs to have it. If it saves one life, it will be worth it." (Steve Eddy interview, April 17, 2014)

El Reno, Oklahoma

It is not surprising that 11 days after the May 20, 2013 tornado that struck nearby Moore, the May 31, 2013 tornado, would panic people who did not have access to safe rooms or storm shelters. The El Reno story is instructive and it shows what can happen when people have high awareness of a tornado hazard and a longer warning time, but do not perceive they have a safe place for shelter.

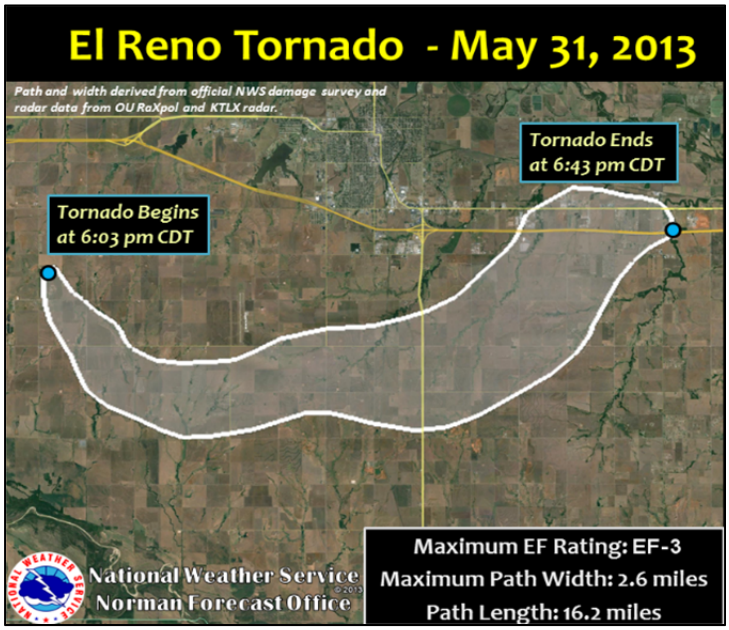
As the home of the Federal Correctional Institution, El Reno and hosting the annual El Reno Fried Onion Burger Day Festival, when an 850-pound fried-onion hamburger is cooked, El Reno is a town of 17,000 people in Canadian County, 30 miles west of Oklahoma City. The city was named for the frontier Fort Reno and in 1935 a medium-security federal prison was built. The town has older housing stock, and a Department of Agriculture research facility. Like Moore, El Reno has many low-income residents; the median family income in 2010 was $39,106. It is largely Caucasian but also includes 12.9 percent Hispanic or Latino and 11 percent Native American residents. Unlike Moore, El Reno is less densely developed, and its 80 square miles contain large undeveloped areas, a fact that proved quite significant in the May 31 storm.



El Reno also has a long tornado history, with 19 touchdowns reported in or near the city since 1875, including seven outbreaks since 1998. Some have been killer storms, but the El Reno record does not contain the double-digit deaths recorded over Moore's history, and most of the El Reno tornadoes have been rated F3 or less, with notable exceptions. An EF5 tornado killed nine in the area in 2011; and eight were killed by the 2013 storm, which was rated EF3.

May 31, 2013, tornado

The 16-mile-long El Reno tornado of May 31, 2013, was a particularly unpredictable storm, hard to categorize, and quite informative in a safe room discussion. It exploded to 2.6 miles wide in a span of 30 seconds, with 295-mph wind speeds clocked in the tornado. It is said to be the widest tornado ever recorded and one of the most powerful ever sampled on radar. The National Weather Service in Norman called it "the most dangerous tornado in storm observing history." (http://www.srh.noaa.gov/oun/?n=events-20130531)



The EF3 El Reno tornado of May 31, 2013, was 2.6 miles wide with 293-mph winds. **Source: NOAA.gov.**

The looming tornado was highly publicized by television media and produced widespread panic in the Oklahoma City area, where fear was still fresh after the May 20 storm. One of the most popular and influential television meteorologists emotionally warned people that if they could not get underground, they must "head south." His advice contradicted the long-recommended plan of local emergency managers to seek shelter in interior rooms if no safe room is available. As mentioned earlier, the area has few basements.

Thousands took to their cars, and interstates filled with rush hour traffic became parking lots as people fled for their lives to escape the tornado. It was reported that many people were driving over center medians and driving the wrong way on roads. The advice to drive into the storm placed thousands of people on roadways at the height of the storm, and estimates were that hundreds of people could have been killed if the fierce storm had taken another path.

El Reno tornado, May 31, 2013.
© Photo by Kimberly Fuller Dehart, used by permission.

The eight people who died in the El Reno tornado were in cars; in an indirect, related death, a child drowned in a drainage ditch where the family sought shelter.[44]

[44] "Frightened Oklahoma Residents Opt to Flee Tornadoes," Associated Press, June 1, 2014. http://bigstory.ap.org/article/damage-assessment-begin-after-fatal-okla-storm.

It was fortunate that the El Reno tornado passed largely over open ground. It was originally rated EF5, then downgraded to EF3, but the rating remains controversial.

In the aftermath of the storm, hazards experts struggled to correct the very dangerous public perception that "the only safe place is underground," and if no underground shelter is available, then the perceived next best option would be to try to outrun the tornado.

Numerous rumors circulated that above-ground safe rooms had been wrested from the ground by the storm; but Texas Tech researchers corrected the record. They found no failure in any properly constructed safe room in any of the Oklahoma City storms and, reported that they had never found any case of failure of a properly constructed safe room, above or below ground, anywhere in the United States.[45]

Additional Safe Room Initiatives

Since the 2013 storms, a number of other safe room initiatives are under way in Central Oklahoma.

"There are a lot of shelters going in out there (eastern Cleveland County) that have been paid for by faith-based groups, but it hasn't been enough," according to Cleveland County Emergency Manager, George Mauldin. In addition to the $3.75 million grant to Moore, as of May 2014, the American Red Cross had awarded more than $6.5 million in safe room grants to survivors in Norman, Cleveland County, Newcastle, Midwest City, Shawnee, Pottawatomie County, Canadian County, the Caddo Nation of Oklahoma, and the Citizen Potawatomie Nation. The Red Cross also provided a $48,000 grant to Central Oklahoma Habitat for Humanity for purchase and installation of 20 storm shelters in new Habitat homes for storm-affected people.

Moore's Agapeland Learning Center after 2013 tornado.
Photo courtesy of Ann Patton

A few safe rooms have been given away in contests by the news media, and there are reports that a few private builders are including a free safe room with a house purchase. Private businesses and institutions are adding safe rooms, although there is no consistent way to track this trend.

For example, Cactus Drilling converted parts of its drilling rigs into tornado safe rooms in 2010. "We

[45] NOAA/NWS "The Tornado Outbreak of May 20, 2013." Wikipedia "Moore, Oklahoma. "2013 El Reno Tornado." "The May 31-June 1, 2013, Tornado and Flash Flooding Event," NWS. Kiesling interview. Patton, Quick Response Report #163.

are kind of a laughingstock," Cactus official Kathy Willingham told *The Oklahoman*. Within a year, the EF3 El Reno tornado "destroyed a $20 million rig, but all 13 guys on site hid in the change house (safe room). They all walked away." Other drilling companies are adding or requiring safe rooms on site, such as Oklahoma City-based Continental Resources Inc., which requires all drilling contractors it works with to have a storm shelter at every drill in its 3-state territory, according to *The Oklahoman*. Continental estimates that storm shelters cost about $400 a day per rig, compared to the company's total day rates of $30,000 to $60,000 per day. "You can't put a price on safety and people's lives," a Continental official said ("Rig Safe Rooms," *The Oklahoman*, May 31, 2014).

After the Agapeland Learning Center in Moore was completely destroyed by the May 20 storm, the national nonprofit Save the Children sponsored a new safe room to be built in its previous location. Tanya Weinberg, with Save the Children stated: "Many were inside the shelter when it (the center) was completely destroyed in last year's tornado. Although staff did everything they could to protect the children, they were still afraid with a new tornado season here and wanted to be able to protect the children even more." (http://www.normantranscript.com/news/local_news/learning-center-breaks-ground-for-new-safe-room/article_25cdf69e-6d6a-5169-bb94-dc6cd1ebfde5.html)

A Sampling of Interviews and Opinions

For this NHMA study, researchers conducted structured interviews with nine safe room experts, specialists, officials, and others knowledgeable about safe room issues; conducted group interviews with members of the National Storm Shelter Association and the Central Oklahoma Emergency Managers Association; collected information through many email and phone contacts; and sampled opinions on key issues through an interview guide questionnaire returned by 59 people. This section summarizes that process and gives highlights of the results.

As one step in the research process and to help guide collection of ideas and insights, the project team developed a general interview guide and questionnaire with six main questions plus a number of sub-questions, and opportunities for respondents to offer their comments and ideas. Here are very general summaries of the questions, which are discussed below in more detail.

1. Respondents were asked to categorize their experience with safe room issues, whether as a storm survivor, vendor, installer or builder, researcher, nonprofit or government official, or other.
2. What factors motivate people and communities to invest in safe rooms? Respondents were asked to tag options such as affordability or fear of tornadoes and encouraged to add their own ideas.
3. Why don't people invest in safe rooms? Options offered include cannot afford, deny risk, or procrastinate.
4. What incentives would encourage people to invest in safe rooms? Example options include grant funds and tax incentives.
5. What disincentives discourage people from investing in safe rooms, such as perceived high cost or different priorities?
6. What can governments do to encourage more investment in safe rooms? Examples include quality-control building codes, educational programs, and low-interest loans.

Respondents were offered the opportunity to provide their names and contact information, which was not required.

The first use of the questionnaire was as a guide to help with interviews and discussions. The questionnaire also proved useful for sampling opinions of a larger group, mostly accessed by email with cooperation of some key professional groups. Three major groups emailed the questionnaire to their entire membership lists in March of 2014. Questionnaires were returned from each: National Storm Shelter Association, six questionnaires; Oklahoma Home Builders Association, 18; and Oklahoma Emergency Managers Association, 22. In addition, questionnaires

were obtained from a thirteen Oklahoma consumers. Most responses were returned by email. Researchers also followed up with additional discussion with some respondents.

The result was not a scientific survey, but the process yielded a useful sampling of opinions on a central list of questions. A more rigorous survey in the future might yield additional information.

Most of the completed questionnaires were from people who live in Central Oklahoma or who do business there. Therefore, the sample was skewed to an area where people have experienced several recent violent tornadoes, in which safe rooms have received very extensive publicity since 1999. Results from an area without that saturation tornado publicity might show very different results, since fewer people might know about safe rooms or their potential for protection.

Among highlights from the completed questionnaires:

- Regardless of category, nearly all respondents believed that people are motivated to invest in safe rooms by fear of tornadoes, a desire to protect their families, and understanding that safe rooms can offer protection.
- Most respondents believe the single greatest deterrent to safe room investment is cost. People who do not have the money cannot invest in safe rooms, many respondents said. These opinions may reflect the fact that many people in the target area have lower incomes and cannot afford the cost or perceived cost. Several respondents also cited procrastination, other priorities, no place for a safe room in the home, or waiting to be drawn in the government grant lottery. A few builders said some appraisers do not include safe rooms in appraisals, so people cannot fold safe room costs into their home mortgage or document that safe rooms add home market value.
- To address those constraints, many respondents ranked fiscal incentives as most important, in order to help people afford safe rooms. Those incentives included grant funds, tax and insurance incentives, and incorporating safe room cost into home mortgages. Some respondents also recommended streamlining grant programs to make non-FEMA investment easier.

The full survey results are available at Appendix D of this report.

Recommendations

This chapter describes ideas that might increase investment in safe rooms and thereby increase the number of people safely sheltered from tornadoes in high-risk zones. Many of the ideas have been used in Oklahoma to foster storm safety, others are untried and speculative.

There are many potential options including incentives, regulations, education, planning, and philanthropy. Some of those options are discussed here in the context of ten questions for consideration in zones that have very high tornado risk.

The recommendations affect interrelated fields of safe rooms, other shelters, forecasting and warning, preparedness, mitigation, operations, and human behavior. The issues inherent in the recommendations are also interrelated, and therefore implementation of the recommendations would need to be comprehensive, not just sequential. In many instances, difficult unresolved issues need to be addressed.

A difficult fact affecting safe room issues is the finite limitations of federal grant programs and the current research that establishes tornadoes as relatively low-probability events at any given location -with high consequences.

Bullet points after each question provide ideas and considerations for proceeding in each category.

In summary, the issues discussed include re-examining comprehensive goals, local and state sheltering plans, sharing responsibility, aiding those who cannot afford safe rooms, considering mandatory safe rooms and group shelters when appropriate, retooling incentives, re-examining FEMA programs, resolving procedural issues, expanding public education, continuing to improve quality control, and seizing post-disaster opportunities during rebuilding and recovery.

Re-examine Local, State, and National Goals for Tornado Sheltering

Increase tornado safety by more comprehensive safe room planning through action at the local, state, business and industry, individual and national levels.

- The nation's safe room program has grown enormously over the past twenty years driven by periodic post disaster follow-up, storm by storm.
- The safe room delivery system is disjointed, scattered among private and public entities, driven in part by market forces and in part by government incentives, education, and recommended standards.

- In contrast to the flood hazard, for example, there is no National Tornado Program. Federal safe room programs support emphasizes technical standards, education, and grants.
- The tornado hazard is similar to earthquakes, and most other natural hazards, in that tornadoes are infrequent but catastrophic. Unlike earthquake construction, which is now widely accepted and endorsed, mitigation for tornadoes is still subject to debate. It has seldom been based on comprehensive analysis of mitigation goals, priority needs, and phased implementation.
- An excellent example of a Disaster Risk Reduction goal was articulated by the Moore City Manager, who said he hopes soon the town will have enough safe rooms to give everyone quick access to safe shelter within their homes, with neighbors, in malls or schools or similar places.
- It is possible that scarce resources could be more effectively allocated if safe room programs were based on local, state, and national tornado sheltering plans for high-risk areas.
- Options could include:
  - Convene broad-based workshops and discussions about risk and priorities.
  - Consider developing local, state, and national policy goals and plans for tornado sheltering that address multiple disciplines, agencies, and issues. Consider developing a multi-agency, national tornado framework and strategy, if needed.
  - Consider expanding FEMA's safe room role beyond technical assistance and emergency management and consider whether safe room issues are also community development issues.

Team with stakeholders and partners such as IAEM and NHMA.

Expand the Tent

Continue to expand nationally, the work currently underway in Oklahoma to bring more stakeholders to the table and encourage individuals, communities, states, nonprofits, foundations, federal agencies, and other non-FEMA groups to assume greater responsibility for tornado safety.

- Thousands of safe rooms would need to be built across Tornado Alley to provide quick shelter for all at risk. Carrying out a comprehensive safe room strategy would demand the widest possible collaboration among many factors, public and private.
- Central Oklahoma's safe room story illustrates that sustained actions by a myriad of public and private entities are needed to address a community problem such as tornado safety in a high-risk zone.

- Many noteworthy examples of partnerships, for safe rooms and other projects, can provide models for expanding support beyond FEMA funding that could be available for safe rooms.

- Among many options:
  - Develop community pilot projects to foster community champions and public-private partnerships in carefully selected cities, then document and share lessons learned.
  - Sponsor pilot programs with non-FEMA agencies.
  - Expand national partnerships and peer-to-peer learning. Integrate safe rooms into other programs, such as HUD housing and resilience programs.
  - Capitalize on volunteers, donations, and foundations. Consider convening workshops to explore ways volunteers can help with safe rooms, perhaps based on the Seattle volunteer program to train homeowners to retrofit their homes for earthquake mitigation.
  - Compile lessons learned among state and local programs. Consider a national summit of state and community safe room interests or integrate the issues into existing conferences of emergency managers, city managers, nonprofits, etc.
  - Sponsor training and workshops for community-based partnerships. In communities with high risk or tornado and without a history of recent storms, help foster risk assessments and awareness, coupled with understanding of feasible mitigation options for protection.
  - Document noteworthy non-FEMA projects and share with helping agencies. Consider sponsoring a national awards program, perhaps sponsored by a foundation.
  - Consider working with Chambers of Commerce to explore ways to expand, document, and publicize business and institutional initiatives, such as the Oklahoma trend to add safe rooms to drilling rigs in high-risk zones.
  - Partner with nonprofits, United Way agencies, faith-based groups, academia and nongovernmental organizations and initiatives, such as the Red Cross safe room program in Central Oklahoma after the May storms, and with businesses such as the Home Builders Association.
  - Inform communities of opportunities such as the HUD resiliency initiative and encourage community participation. Participants should include elected officials, professionals, academicians, and the general public.

Provide Assistance to Those Who Cannot Afford Safe Rooms

How can the nation equitably meet the sheltering needs of at-risk people who cannot afford safe rooms?

- In many high-risk communities, income is the great divide between those who have safe rooms and those who do not. In interviews for this study, nearly all interviewed said that, by far, the single largest constraint to having a safe room in Central Oklahoma was the ability to afford one.
- Market-driven strategies work only if consumers have the resources to invest in their protection.
- Central Oklahoma safe room rebate programs do not consider income or ability to pay. In fact, in cases where the homeowner is expected to pay the match, some could not take advantage of a grant or low-interest loans.
- The technology now exists to provide near-absolute protection in even the fiercest tornadoes, but the safe-room delivery system is disjointed, largely market driven, and operates to the benefit of those who can afford shelter.
- Some options:
    - Consider developing a comprehensive national policy framework and strategy for sheltering people who cannot afford individual safe rooms in high-risk zones. Consider one or more national workshops for developing the framework and building consensus across federal agencies, nonprofits, faith-based groups, and other entities.
    - Consider a tested pilot program and focused initiative with Habitat for Humanity and other projects that build housing for low-income people. Test whether volunteers can safely build safe rooms in accordance with FEMA criteria or whether prefab units or professional safe room builders would be needed.
    - Develop guidance on the prudent role of volunteer builders in providing safe rooms.
    - Encourage local and state plans, with measurable outcomes, for sheltering the poor in high-risk zones, to be adopted as part of local comprehensive plans. Issues to be addressed include how to mobilize non-government support and when or whether to use group shelters, volunteer construction, and public-private partnerships.
    - Consider giving grant priority to those who cannot afford shelters, public housing projects, recreation centers in poor areas, and similar places that serve low-income people.
    - Involve more of the foundations involved in mitigation research and programs, including storm shelter education and incentive grants.

- National Voluntary Organizations Active in Disasters (NVOAD) and other groups representing nonprofits and social service agencies could be partners in these activities.
- Encourage construction of site-built shelters following FEMA P-320 designs with groups such as Habitat for Humanity and USDA Rural Housing that utilize "sweat equity." Encourage and support NVOAD concept to assist following major disaster events. Involve FEMA funding to invoke FEMA requirements for quality control.

Consider Requiring Storm Protection in Cases of Extreme Risk

When should safe rooms be required?

- One way to increase investment in safe rooms would be to require them in certain cases. Making safe rooms mandatory could shift costs from FEMA grants to the providing entity, whether homeowner, businesses, local government, or others; raising the question of tradeoffs and who should pay for tornado safety.
- Safety standards and regulations are widely used in construction projects, based on common recognition of risk and mitigation measures. But even in high-risk zones, tornadoes are considered to have a low probability of striking in any given spot, although tornado consequences can be quite high.
- Cities and states concerned about tornado and windstorm safety will need to weigh when and if protection is best provided by codes and strengthening buildings or safe rooms.
- Among options:
  - Consider providing guidance to states and local governments for safe room requirements if local communities decide their risk warrants making safe rooms mandatory in certain instances.
  - Strongly encourage states, large municipalities, and code jurisdictions to require storm shelters in new schools, emergency response facilities, etc. Adopt the 2015 edition of the International Building Code that requires ICC 500 storm shelters in these facilities, if they are located in the 250 mile per hour (mph) tornado design wind speed zone.
  - Encourage more extensive participation of young investigators in universities in research and design programs. Instigate and fund long-range programs that make it possible for young faculty to see a future in disaster mitigation. Lo-budget activities such as competitions should be instigated. Funding sources might include National Science Foundation and federal agencies.

- Document and disseminate best practices about how prototype communities are managing their safe room regulation programs.
- Publicize success stories of successful implementation of new, mandatory safe rooms.
- Evaluate whether and when risk may justify requiring safe room in cases of high risk, such as mobile home parks, public housing projects, correction facilities, schools, shopping malls, apartments, and other places where people are gathered and cannot take direct responsibility for their personal safety.
- Evaluate whether safe rooms should be required in critical facilities in high-risk zones.
- Evaluate how tornado sheltering is handled in federal building construction and consider mandating safe shelter in high-risk zones, by executive order or other means.
- The Natural Hazard Mitigation Association (NHMA) might be a useful partner in these activities, in conjunction with FEMA's Building Sciences Division.

Expand Incentives

Additional incentives can encourage greater investment in safe rooms and increase the number of people safely sheltered in at-risk zone.

- One example of an incentive is Oklahoma's ad valorem tax waiver on individual safe rooms. Other examples of incentives could include low or no fees on building permits or accelerated processing, rebates, or income tax credits for safe room investments and donations.
- As Albert Ashwood, OEM Executive Director, said, "There is a fine line between an incentive program and an entitlement program that can actually raise false expectations for government-funded safe rooms. Incentives need to be carefully tailored to local conditions that may vary from place to place and time to time."
- The other side of the incentive coin is that disincentives can prevent people from investing in safe rooms. Some builders interviewed said appraisers refuse to include safe rooms in home appraisals, making it more difficult to market safe rooms, include them in home mortgage payments, or obtain financing.
- Options:
  - Develop a package of mitigation incentives and test them for potential funding by purchasers, governments, or the private sector.
  - Target market-driven strategies for those who can afford safe rooms.
  - Develop and test pilot programs for encouraging incentives (including tax incentives) or addressing disincentives on sustained investment by nonprofits, foundations, and faith-based groups; stronger local and individual responsibility; and creative approaches and leadership by the design and building community.

- Resolve the issue of how to include safe rooms in home appraisals, by training or other means, to facilitate financing.
- Consider awards or recognitions programs for developing workable incentive programs using non-FEMA funds.
- Among many possibilities, local governments could waive building permit fees and publicize that fact, to encourage people to obtain permits; sponsor consumer training on selecting safe shelters; partner with home builders and safe room vendors to hold tornado expos and information fairs; and create public service announcements and media events in conjunction with elected officials.
- Encourage use of HUD's Community Development Block Grants to erect quality housing, including storm shelters and illuminate success stories.
- FEMA's Mitigation Division could be a leader in this task, perhaps in partnership with a local community.

Provide Assistance and Encourage Development of Safe Room Grants

- Consider further improvements to FEMA's existing safe room programs.
- FEMA's safe room program began in 1998, when few or none knew about safe rooms. In a remarkably short period of time, a huge number of Oklahomans knew about safe rooms and wanted one. That transformation is due in large part to the FEMA safe room grant program.
- In a very short few years, FEMA grants in Oklahoma have served to popularize the safe room technology, empowered many people to understand they can take actions to improve their storm safety, increased the level of safe sheltering for many thousands, and have saved lives and reduced personal injuries.
- Any critique of past and present grant programs, or consideration of changes, should note the remarkable benefits of these grants and other FEMA safe room programs.
- Many local officials interviewed said they want to see FEMA safe room grant programs "streamlined." Some said the 1999 program was workable, but now they avoid applying for OEM's safe room local grant programs because they believe the requirements cannot be managed.
  - Problems they cited include: the application process, historic and floodplain reviews, and rebate issues.
  - One official said, "The way the State has their program set up, you must have the exact properties identified at the time you send in the application. There is no telling how long after the application is submitted the grant might be approved and funded. It could be several years. This means you would have to do your local lottery to determine the winners. Then do all the research on each property and submit the

application. So we would have to advertise the lottery and select the winners without any idea when the grant would be funded."

  - OEM agrees that the procedures were cumbersome but say they have been able to streamline the process and make it workable again, dramatically reducing processing time to historic and floodplain reviews, for example.
  - Vendors and builders, and some local officials, believe the individual safe room grant program encourages procrastination. "People don't want to invest their own money because they think they're going to get a grant, but their odds of being drawn in the safe room lottery are miniscule," one vendor said.
  - One official also said he believes the individual safe room grant program, as currently managed, sends a signal in Oklahoma that safe rooms are a government responsibility, rather than individual and community responsibility.
- Since grant programs have been funded largely by post-disaster monies, they have typically given grant priority to survivors with destroyed or damaged homes. Reconstruction offers unparalleled opportunities to build back better by adding safe rooms, but the selection process has focused on seizing opportunities based on past damage, rather than local comprehensive evaluations of the most critical future needs.
- Among options:
  - Consider requiring, incentivizing, or piloting local and state sheltering plans that include clearly articulated community goals and prioritized needs for safe sheltering and multiple funding partners. What are the most urgent needs, and how can they be addressed?
  - Consider a variety of cost-sharing options, with possible bonuses for higher local or state cost shares.
  - Document best practices and lessons learned in diverse safe room programs in states and selected communities, and share with state and local program designers and managers.
  - Consider encouraging peer-to-peer sharing among safe room program designers and managers through workshops, conferences, and similar groups. Compile their recommendations for streamlining regulations and evaluate for potential implementation or explain why current regulations are needed.
  - Consider requiring designation of a local safe room or tornado/wind-storm manager as a condition for safe room grants. These designated officials could form a basis for a peer-to-peer sharing and targeted education network.
  - Evaluate cost-benefit calculations that may favor damage reduction more heavily than life safety.

- Have local building officials assess hazards of building tornado shelters in floodplains. Carefully consider exceptions to FEMA's blanket policy against building tornado shelters in floodplain locations.

Addressing Unresolved Issues

We must correct misunderstandings surrounding safe rooms and resolve troubling issues that remain unresolved and cloud decision making.

- Among examples of public and often even expert disagreement: Are above-ground safe rooms safe? What are the safest choices for travelers caught outside in a tornado? When are group shelters appropriate? Is tornado evacuation a valid option as public policy? Should safe rooms be required and if so, in what circumstances?
- These issues affect building science, meteorology, forecasting and warning, and behavioral science. Confusion regarding policy and procedure can be fatal, as shown in examples in the 2013 El Reno tornado and other storms.
- Another difficult issue is whether and when to provide public shelters (in consideration of warning time, operational issues, and other challenges). Can we safely provide more group shelters, versus continued proliferation of individual shelters, and what are criteria for making the determination?
- Most Central Oklahoma emergency managers interviewed were vehemently opposed to community shelters; as they defined that term, it meant encouraging people to leave a secure building in a storm to seek shelter that might or might not actually be available, assuming they were able to arrive in time.
- Forecasting and warning times, travel times, shelter capacity, and operational issues are among the issues that need to be resolved or reconciled in deciding whether individual or group shelters are the more effective choices.
- Improved public education and communication hinges on resolution of the kinds of unresolved issues cited above.
- Among options:
  - Consider convening experts in one or more workshops with a goal of identifying these challenges and issues and recommend resolution policies and procedures.
  - Widely disseminate workshop recommendations among agencies, nongovernmental organizations, and news media.
  - Promote the guidance found in FEMA P-320 which defines where community shelters are appropriate and emphasize the importance of operational plans.
  - The NHMA, the American Meteorological Society, and the National Storm Shelter Association could be leaders in developing the recommendations and disseminating them.

Expand Public Education and Communication Strategies

We should increase safe room investment by expanded public education and communication programs.

- As is shown in Central Oklahoma's experience, a trusted television meteorologist may be among the most influential speakers on weather-related issues, and they may issue instant warning or evacuation notices.
- People who do not recognize the risks may make foolish decisions and people with very high awareness of the tornado risk may make dangerous choices if they have no preplanned, safe place to seek shelter and a clear understanding of what can keep them safe.
- Tornado risk communication is a delicate business. An effective education and communications program must balance the need for risk awareness, preparedness, and mitigation; whether that includes a safe room, next-best place of refuge, or evacuation, as in the case of a dangerous floodplain. Tornadoes may require instant response, but conditions may vary from place to place, and warning times may greatly change the situation.
- Each instance of public communication about tornadoes can reinforce or undermine investment in safe rooms. The trend to publicize inaccurate stories about so-called failed safe rooms, as with the 2014 Arkansas storms when a woman died in a non-standard "safe room," is particularly damaging. Correcting misinformation in public understanding of safe rooms after the fact is difficult if not impossible.
- Among many options:
    - Consider developing, in addition to the guides on FEMA's website, a guidance for the public directed at multi-agency communications such as, "Talking about Tornadoes," that can give clear messages, universally accepted, that can be delivered in unison by a variety of voices. Development would require a collaboration process among many agencies and include resolution of sticky issues such as whether or when evacuation could be an appropriate safety response to tornadoes. For example, the 1990s "Talking about Disasters" report, which was developed by a broad coalition of agencies and served well as a communications handbook.
    - Consider a targeted public education program on one or more of the most urgent topics, such how to select a "*safe"* safe room or perhaps advice on how to "hide from the wind." One possible model would be the "Turn around, Don't Drown"® public education program developed by FLASH and the National Weather Service. The selected message could be targeted to children and could be used in emergency warning messages, too.

- Consider adapting more lessons learned.
- Consider adapting ideas on partnerships from the Project Impact program. One example: Tulsa Project Impact teamed up with vendors and builders to create a no-budget, year-long safe room expo in a shopping mall, where people could come and pick up literature and tour many safe room types.
- In addition to addressing real risks and mitigation options, public education about tornado safe rooms should carefully address unrealistic expectations about government grants and outside assistance and encourage individual and community responsibility.
- Harness the power of TV meteorologists, community champions, local leaders, and peer-to-peer inspiration. Inform and educate the news media.
- Work with NOAA, the American Meteorological Society, and others to include selected messages in warning and education programs.
- Continue to expand education for targeted groups, including architects, builders, engineers, meteorologists, local officials and building officials, and the news media.
- Document and publicize success stories showing individual responsibility and appropriate behavior.
- Sponsor competitions and presentations of effective use of social media for information dissemination and exchange. Involve more social scientists and behavioral scientists. Encourage sessions in meetings such as the National Tornado Summit and emergency managers meetings. Herald successes at large meetings.
- Consider making the name *safe room* more distinct, to try to distinguish it from non-standard enclosures. One option: safe room. The term should be used only to refer to safe rooms that meet FEMA Criteria and ICC standards.
- Consider a distinctive, easy-to-remember designation for safe rooms that meet the FEMA criteria. A model is the Energy Star program.
- The American Meteorological Society could be a strong partner in public education planning and execution.

Continue Focus on Quality Control

Further support consumers and communities to make wise choices for safe rooms, regulations, and management practices.

- Safe room quality control remains a vexing problem, despite recent national standards, stronger model codes and the diligent work of the National Storm Shelter Association, FEMA's Building Sciences Division, and others.
- Is it wise to encourage lower-cost shelters to save monies and if so, when?
- Some options:

- Include funding in state and local grants for consumer and builder education about safe models and construction.
- Educate Architects, Engineers, Builders and others involved in Community Development on proper "Standards of Care" based on the primacy of public safety. As the American Society of Civil Engineers (ASCE) so wisely observed in its Report on Hurricane Katrina: "The first Fundamental Canon of the American Society of Civil Engineer's (ASCE) Code of Ethics states that: "Engineers shall hold paramount the safety, health, and welfare of the public…it must be applied with…rigor to every aspect of an engineer's work…in America, and throughout the world."
- Develop model language for consumer education pieces in utility bills, homeowner association newsletters, and new media outlets.
- Encourage training and incentives for code administrators and others.
- Consider incentives or requirements for communities and states to manage quality through codes, management practice, education programs, etc.
- Groups providing leadership on quality control include FEMA's Building Sciences Division, the National Storm Shelter Association, and FLASH. The NSSA seal is the most effective way to communicate a safety standard and could be used more effectively in safe room programs.
- Offer or require special training for safe room inspectors, responding to demands created by increased emphasis on inspections in revised standards and guidelines.
- Make known that educational grants can be made through FEMA Pre-Disaster Mitigation Grants and post-disaster Hazard Mitigation Grants.
- Improve awareness of all means of funding safe room construction including SBA post-disaster loans and the many other forms of federal, state, local and non-government assistance both pre- and post- disaster documented in the Patchwork Quilt (http://nhma.info/uploads/PatchWork/THE%20PATCHWORK%20QUILT.pdf).

Continue to Seize Post-Disaster Rebuilding and Recovery Opportunities

Use the post-disaster recovery period to encourage expanded safe room investment in high-risk zones.

- As Moore and some other Central Oklahoma communities illustrate, frequent disasters in an area encourage people to recognize their risk and can give great urgency to preparedness and mitigation where leadership is strong. Since procrastination is the enemy of safe room investment, frequent tornadoes can be powerful motivators. It's hard to argue "It can't happen to me," when it just did.
- The post-disaster recovery period may also offer more national attention and greater resources, such as federal and state disaster assistance, an influx of volunteers, and an

outpouring of private donations. Additional construction options for mitigation may be available in rebuilding damaged or destroyed buildings.

- Some options:
  - Pilot grants programs (government or private) for pre-disaster recovery planning for safe rooms after a disaster. Consider conditioning public assistance and recovery grants for community-wide shelter planning.
  - Mobilize faith-based and nonprofit groups and volunteers builders, with careful attention to quality control, to help with safe room construction.
  - Partner with home builders, vendors, and others to help build safe rooms.
  - Work with FEMA's historic Preservation Officer to smooth out any historic preservation issues with respect to safe room construction to the maximum extent possible.
  - FEMA's long-term recovery and mitigation programs should continue be used effectively and for safe room and other Disaster Risk Reduction activity, in partnership with the National Home Builders Association, private non-government disaster relief organizations, foundations and the US Department of Housing and Urban Development.

Encourage Use of Widespread Media Options

Our closing recommendation comes from Dr. Ernst Kiesling, who urged that safe room supporters offer encouragement, through widespread use of media. Dr. Kiesling commends the progress that has been made in safe room and storm shelter technology and implementation in a relatively short period of time.

He cites as examples:

- Vastly improved severe weather prediction and warning systems;
- Much improved storm shelter designs;
- Development of National and International design and construction standards;
- Huge increases in numbers of storm shelters built;
- Development of programs to encourage shelter construction; and
- The documentation of so many success stories in storm shelters saving lives.

Dr. Kiesling so brilliantly concluded: "Challenges still exist, but progress has been remarkable!"

Appendix A: Annotated Bibliography of Tornado Safe Room Research and Literature

Doswell, Charles A., Harold E. Brooks, 2002: Lessons Learned from the Damage Produced by the Tornadoes of 3 May 1999. *Weather Forecasting*, 17, 611–618.

This article discusses the results of the Building Performance Assessment Team's (BPAT) evaluation following the May 3, 1999, tornadoes. The authors focus on tornado preparedness in Kansas and Oklahoma in the context of the BPAT's findings. They note that the preparedness efforts of many public and private institutions played a large role in reducing casualties, but that many building deficiencies were present. Other findings include the need to improve preparedness for public facilities and the fact that the damages from these storms could have been mitigated through relatively simple and inexpensive construction enhancements to reduce projectile loading.

Eeing, Bradley T. & Kruse, Jaime Brown. (2006). Valuing self-protection: income and certification effects for safe rooms. Construction Management and Economics, 24(10): 1057-1068.

The authors utilize survey data from Tulsa, Oklahoma, residents in order to analyze the impacts of income on willingness to pay for safe rooms and whether certification standards make the safe room investment more desirable. The authors found that the mean willingness to pay for a safe room was $2,500, and that certification by a national organization increased willingness to pay by an average of $600. The researchers did not find a direct effect from income.

Merrell, David, Kevin M. Simmons, Daniel Sutter, 2002: Taking Shelter: Estimating the Safety Benefits of Tornado Safe Rooms. *Weather Forecasting*, 17, 619–625.

In this article, the authors analyze historical data from Oklahoma in order to provide an estimate of the potential casualties that tornado shelters could prevent. They then utilize that data to calculate a cost per fatality avoided in single-family homes of $29 million, and a cost per fatality avoided for mobile homes of $2.6 million.

Merrell, David., Simmons, Kevin M. & Daniel Sutter. (2005). The Determinants of Tornado Casualties and the Benefits of Tornado Shelters. *Land Economics*, 81(1): 87-99.

The authors calculate an average cost per life saved for shelters in permanent homes and in mobile homes. They utilize data from Oklahoma including storm intensity, time of day and population density. They find a cost per life saved of around $30 million for permanent homes.

Miller, Daniel, et. al. (2002). "Buying Tornado Safety: What Will it Cost?" Southwestern Economic Proceedings, Volume 30.

This article looks at willingness to pay for safe rooms in newly built homes and in homes being refurbished. The authors also look at whether there is a correlation between higher income and willingness to pay. The authors find a willingness to pay figure which is lower than the average safe room construction costs incurred by builders. They recommend that rebate programs continue to be utilized in order to promote safe rooms.

Simmons, Kevin M. & Sutter, Daniel. (2007). Tornado Shelters and the Housing Market. *Construction Market and Economics*, 25(11): 1119-1126.

This article examines the impacts of tornado shelters on home sale prices. The authors find an increase to mean price of 3.5 go 4%.

Suls, Jerry. Et. Al. (2013). Optimism Following a Tornado Disaster. *Personality and Social Psychology Bulletin*, 39(5): 691-702.

The researchers studied the impacts of exposure to severe weather on the perception of future vulnerability. Among their findings, they found that respondents felt their risk was lower than that of their peers and that risk estimates became more optimistic over time.

Appendix B: Selected References

Canfield, Kevin, "Tulsa councilors to weigh school storm shelter requirement," *Tulsa World*, Feb. 5, 2014.

Goforth, Dylan, "Tornadoes: Oklahoma second highest in the nation for 2013," *Tulsa World*, Feb. 6, 2013.

King, Michael, "Winners and Losers in State's Lottery for Home Storm-Shelter Grants," *Tulsa World*, Oct. 15, 2013.

Mulkins, Phil, "Association certifies storm shelter safety," *Tulsa World*, Oct. 16, 2013.

National Institute of Standards and Technology, Technical Investigation of the May 22, 2011, Tornado in Joplin, Missouri, Draft Final Report, November 2013.

Oklahoma Department of Emergency Management, "Safe Room Programs," PowerPoint presented by MichelAnn Ooten in Norman, OK, Oct. 31, 2014.

Patton, Ann, "Surviving the Storm: Sheltering in the May 2003 Tornadoes in Moore, Oklahoma," Quick Response Report #163, Natural Hazards Research and Applications Information Center, University of Colorado, 2003.

"Rig Safe Rooms," *The Oklahoman,* May 31, 2014.

Rubin, Claire, and Ann Patton, Oklahoma Tornado Prompts Discussions on Surviving, Rebuilding," *Emergency Management Magazine*, July 15, 2013.

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"The Tornado Outbreak of May 20, 2013," "The May 31-June 1, 2013 Tornado and Flash Flooding Event," and "Tornadoes in or near El Reno, Oklahoma (1875-present)," and Tornadoes in or near Moore, Oklahoma (1875-present)." NOAA/National Weather Service. Accessed 2-6-14.

"El Reno lab tapped for climate research," News Ok.com. http://newsok.com/el-reno-lab-tapped-for-climate-research/article/3930697. Accessed 2-6-14.

International Code Council, "Storm Shelters, Safe Rooms Save Lives when Tornados, Hurricanes Strike," http://www.iccsafe.org/newsroom/Pages/05232013-NR-SafeRoom, accessed 2-5-14.

http://www.emergencymgmt.com/disaster/Devastating-Oklahoma-Tornado-Surviving-Rebuilding.html Accessed 2-6-14.

Taking Shelter From the Storm: Building a Safe Room for Your Home or Small Business, FEMA P-320, Fourth Edition, (2014) (http://www.fema.gov/media-library/assets/documents/2009)

Safe Rooms for Tornadoes and Hurricanes: Guidance for Community and Residential Safe Rooms, *FEMA P-361*, Third Edition (2015) (http://www.fema.gov/media-library/assets/documents/3140)

NOAA web page "Violent Tornadoes (F4/F5/EF-4/EF-5) in Oklahoma (1950-Present)" (http://www.srh.noaa.gov/oun/?n=tornadodata-ok-violent) (accessed 3-12-14)

Safe Rooms Save Lives: State of Oklahoma Safe Room Initiative (2003) http://www.fema.gov/media-library/assets/documents/3791?id=1787

http://www.foxnews.com/us/2014/05/08/twister-fears-rouse-interest-in-shelters-and-safe-rooms-in-oklahoma-but-waiting/

http://www.ok.gov/OEM/Programs_&_Services/SoonerSafe_Safe_Room_Rebate_Program/

http://www.normantranscript.com/headlines/x2117405185/Learning-center-breaks-ground-for-new-safe-room

Additional Resources from FLASH

Tale of Two Homes: Tornado
http://www.youtube.com/watch?v=RdHoSGLAE3Q&list=PLR7GhNEQT6T_5wL9Ob3EkFEMlsV8miIPa

Harrison's Story on our Blog: Protect Your Home in a FLASH
http://protect-your-home.org/2012/05/22/a-tale-of-two-homes-tornado-one-familys-personal-account-of-how-safe-rooms-save-lives/

Virtual News Event Media Advisory – file:///C:/Users/sarah/Downloads/6-4-13%20Final%20Final%20Tornado%20News%20Advisory%20(2).pdf

Virtual News Event PowerPoint Presentation – file:///C:/Users/sarah/Downloads/6-5-13%20Virtual%20News%20Conference%20Presentation.pdf

Commentary Prepared for Build Strong's 2nd Annual National Thought Leaders Forum – http://www.flash.org/building-codes.pdf

2010 Tornado Safe Room Report –
http://www.serri.org/publications/Documents/FLASH%20Tornado%20Safe%20Room%20Final%20Report%20-%2018%20October%202010%20(Vaughn).pdf

Appendix C: Selected List of Those Interviewed

Albert Ashwood, Executive Director, Oklahoma Emergency Management Department, April 17, 2014.

Tom Bennett, National Storm Shelter Association and Jim Giles Safe Rooms, Oct. 31, 2013, and April 10, 2014.

Steve Eddy, City Manager, Moore, OK, April 17, 2014.

Leslie Chapman Henderson, Federal Alliance for Safe Homes and International Code Council's Foundation, Feb. 9, 2014.

Dr. Ernst Kiesling, Texas Tech University and National Storm Shelter Association, Oct. 31, 2013, and Feb. 9, 2014.

Ed Laatsch, Chief of Building Science Branch, Risk Reduction Division, Federal Insurance and Mitigation Administration, FEMA.

Margaret Lawless, Federal Emergency Management Agency (retired), Jan. 31, 2014.

Vince Mims and Ted Hope, safe room vendors, Feb. 19, 2013.

Melissa Moore, manager, Oklahoma's SoonerSafe program, Mar. 3, 2014.

During National Storm Shelter Association meeting, Oct 31, 2013:
Dirk DeRose, New Day Safe Rooms, Tulsa, OK
Garrett Howerton, Thunderground storm shelters, Oklahoma City, OK
Jack Price, Global storm shelters and safe rooms -- Council Bluffs/Omaha, OK
Mike Vaughn, Vaughn Concrete Products, Amarillo, TX
Jay Williams, Budget Box, Jenks, OK
Matt Williams, Survive-a-storm Shelters, Thomasville GA
Dale A. Zogleman, Protection Shelters LLC, Wichita, KS
Oscar Scott, Red Dog Mobile Shelters, LLC, Amarillo, TX
Karen Olsen, Missouri Storm Shelters

During Central Oklahoma Emergency Managers Association meeting Oct. 30, 2013
Gayland Kitch, emergency manager, Moore, OK
David Grizzle, emergency manager, Norman, OK
EM Jerry Smith, emergency manager, Canadian County, OK
Jon Tankersley, emergency manager, Newcastle, OK

Appendix D: Questionnaire Results

This questionnaire was distributed through the Oklahoma Home Builders Association (HBA), the Oklahoma Emergency Management Association (EM), and the National Storm Shelter Association (NSSA), as well as to selected consumers (CSM). We received 59 responses—HBA: eighteen, EM: twenty-two, NSSA: six, CSM: thirteen.

1. How are you involved in safe room issues – interest, job, experience, etc.
   a. __9__ Storm survivor
      HBA= 3 EM= 1 NSSA= 1 CSM= 4
   b. __20__ Safe room vendor, installer, contractor, builder
      HBA= 15 EM= 1 NSSA= 3 CSM= 1
   c. __17__ Government official
      HBA= EM= 13 NSSA= CSM= 4
   d. __4__ Researcher/academic/educator
      HBA= EM= 1 NSSA= CSM= 3
   e. __1__ Nonprofit official
      HBA= 1 EM= NSSA= CSM=
   f. ___Other (describe)_____
      HBA
      - Land Developer selling new lots for new construction of single family homes
      - Homebuilder.
      - Own Homebuilding Company.

      EM
      - Retired emergency manager/ current hazard mitigation planner.
      - Emergency Manager (three respondents)
      - Assistant Emergency Manager
      - Emergency Preparedness Coordinator at Hospital
      - Oklahoma Council on Firefighting Training.

      NSSA
      - Manufacturer of shelter components (doors and shutters)
      - Windstorm damage structural engineer
      - Work in architectural firm designing community safe rooms for clients.

      CSM
      - User
      - Homeowner (2)
      - Working with Oklahoma Safe Schools 101 Program
      - Citizen, Former Government Official who still wants to help to educate about safe rooms; shelters
      - Board member with groups involved in hazard mitigation.

2. What are some of the factors that motivate people and communities to invest in safe rooms? Please add categories or other ideas.

a. _57__ Protect your family
HBA= 18 EM= 23 NSSA= 5 CSM= 11

b. _52__ Fear of tornado (perception of risk)
HBA= 16 EM= 20 NSSA= 4 CSM= 12

c. _47__ Recent storm experience
HBA= 15 EM= 18 NSSA= 4 CSM = 10

d. _28__ Safe room awareness (aware that technology exists for a mitigation measure)
HBA= 6 EM= 9 NSSA= 3 CSM = 10

e. _39__ Awareness (knowledge that safe rooms can offer greater security)
HBA= 6 EM= 17 NSSA= 5 CSM = 11

f. _24__ Affordability (ability to invest)
HBA= 9 EM= 4 NSSA= 3 CSM= 8

g. _35__ Possibility of government grant
HBA= 8 EM= 15 NSSA= 4 CSM= 8

h. _20__ Enhanced property value
HBA= 4 EM= 4 NSSA= 3 CSM= 9

i. __19_ Community education (consumer and builder education)
HBA= 2 EM= 6 NSSA= 4 CSM= 7

j. _17__ Marketing, advertising, media campaigns
HBA= 3 EM= 5 NSSA= 3 CSM= 6

k. _8__ Government requirement
HBA= 3 EM= 0 NSSA= 1 CSM= 4

l. _9__ Peer pressure (knows people investing in Safe rooms)
HBA= 1 EM= 3 NSSA= 1 CSM= 4

m. ___ Other (describe) _____

EM
- Severe Weather Coverage by media.
- Lost loved ones or friends.

NSSA
- Concern for safety of students in school- highest priority
- Need to protect people in their facilities, whether school, church, retirement home, or place of business.

CSM
- Need.
- It adds property value and other uses.
- Recent experience is probably biggest motivator, but it is a balance of all of these.

3. Why don't people invest in safe rooms? Please add your ideas, too.

a. _55__ Can't afford

HBA= 17 EM= 21 NSSA= 6 CSM= 11

b. __21_ Deny risk

HBA= 6 EM= 4 NSSA= 3 CSM= 8

c. _30__ Other priorities

HBA= 9 EM= 12 NSSA= 2 CSM= 7

d. __7_ Do not believe safe room can reduce tornado risk

HBA= EM= 1 NSSA= 1 CSM= 5

e. _32__ Putting off until a better time

HBA= 11 EM= 8 NSSA= 5 CSM= 8

f. _23__ Don't have the right place in the home

HBA= 8 EM= 7 NSSA= 2 CSM= 6

g. __13_ Not sure about builder or vendor

HBA= 1 EM= 5 NSSA= 2 CSM= 5

h. _17__ Waiting to be drawn in government lottery

HBA= EM= 10 NSSA= 2 CSM= 5

i. _4__ Need more information

HBA= EM= 2 NSSA= 0 CSM= 2

j. ___Other (describe) _____

HBA

- Don't believe it will happen to them.
- Not one size fits all. Some want in garage, others don't. Outside and others don't. Above ground concrete structures are more costly and harder to configure in homes under 1800 sq. feet affordable homes.

EM

- Waiting for funding assistance; want/expect public shelters to be available; some of the population won't even spend $30 on a Weather Radio.
- Not a priority in their personal budget.
- Rental Property.
- Largest issues are cost and level of income in area.

NSSA

- Deny risk of injury from a tornado.

CSM

- ADA accessibility for elderly, disabled family members.
- Rental property.

k. Comments

EM

- The poor are the most at risk and most live in rental property.

NSSA

- Tight economy and desire for expensive home amenities preclude safety considerations.

- Our clients have a limited amount of money and are trying to get as much of a building that meets their needs as they can afford. It is a balancing game…more space to house everything in one location.

CSM

- Manual should show how to do it, with as many cases and variations as possible.
- Unfortunately, many rural community residents have one of two attitudes. 1) It hasn't happened to me in the XX years I've lived here, so I'm not concerned. (It won't happen to me). 2) Urban legends about geo/topo/historical/tribal/etc reasons they're protected.

4. What are incentives that could encourage people to invest in safe rooms?
   a. _46__ Grant funds
      HBA= 14 EM= 19 NSSA= 5 CSM= 8
   b. _45__ Tax incentives
      HBA= 16 EM= 16 NSSA= 5 CSM= 8
   c. _40__ Tax rebates
      HBA= 14 EM= 14 NSSA= 4 CSM= 8
   d. __22_ Low-interest loans
      HBA= 6 EM= 6 NSSA= 4 CSM= 6
   e. _17__ Reduced or waived building permit fee
      HBA= 7 EM= 4 NSSA= 2 CSM= 4
   f. _27__ Include cost in home mortgage
      HBA= 11 EM= 8 NSSA= 3 CSM= 5
   g. _31__ Insurance incentives
      HBA= 13 EM= 10 NSSA= 2 CSM= 6
   h. ___ Other (describe) _____

      HBA

      - Must be added to appraised value to allow customers to finance.
      - What would be insurance incentive?

      EM

      - All of the above (2 respondents)
      - Allow grant funds for landlords to put safe rooms in rental property.

      NSSA

      - Legislative encouragement of public.

      CSM

      - All of the above…Hard to say which is most important.
      - Been There.
      - Security.
      - Graphic (Pictorial) Awareness Campaign
   i. Comments

      NSSA

- Anything that could help. Usually the process to get FEMA funds takes longer than the client wants to wait.

CSM

- These incentives all help.
- Price; Better education about them; Include in homebuilding as an automatic option, maybe.
- Testimonials from survivors.
- Often, people need to be shaken out of their lethargy/apathy with graphic pictures of damages/death/injuries to get their attention.

5. What are the disincentives that discourage people from investing in safe rooms?
   a. _46__ Not enough funds to invest
      i. HBA= 15 EM= 17 NSSA= 4 CSM= 10
   b. _44__ High cost (or perceived high cost)
      i. HBA= 14 EM= 13 NSSA= 6 CSM= 11
   c. _17__ Lack of awareness of safe room options
      i. HBA= 1 EM= 5 NSSA= 3 CSM= 8
   d. _31__ No feasible retrofit location in home
      i. HBA= 11 EM= 9 NSSA= 2 CSM= 9
   e. _19__ Landlord does not provide for Safe room
      i. HBA= 4 EM= 10 NSSA= 1 CSM= 4
   f. _21__ Other priorities
      HBA= 7 EM= 8 NSSA= 2 CSM= 4
   g. ___ Other (describe) _____

HBA

- FEMA mitigation through local government very difficult.

EM

- All of the above
- Waiting for grant funds.
- Length of waiting period, order it today installed 6-8 months
- Poverty
- (It) is a rental property and owner will not allow.
- Just cannot afford them.

NSSA

- Denial of threat of injury of tornado

   h. Comments

HBA

- I took a proposal to Moore's Emergency "Director" and all I got were reasons why we could not get any help with the cost. Not once did he offer to assist us with the project. This was after I was told at the regional office in Denton that our project was great.

NSSA

- I deal in community safe rooms, so some of those don't apply.

6. What can governments do to encourage safe room investment?
   a. _16__ Adopt quality-control codes with reduced or waived building permit fees
      HBA= 4 EM= 5 NSSA= 2 CSM= 5
   b. _31__ Encourage low-interest loan programs
      HBA= 9 EM= 10 NSSA= 5 CSM= 7
   c. _38__ Co-sponsor grant programs
      HBA= 9 EM= 17 NSSA= 4 CSM= 8
   d. _36__ Streamline grant programs to facilitate investment
      HBA= 10 EM= 14 NSSA= 5 CSM= 7
   e. _26__ Sponsor awareness and education programs
      HBA= 4 EM= 11 NSSA= 4 CSM= 7
   f. _21__ Sponsor training programs for builders, volunteers, homeowners, etc., in how to build code-compliant Safe rooms
      HBA= 4 EM= 5 NSSA= 3 CSM= 9
   g. ___ Other (describe) _____
      HBA
      - Get appraisers to give full credit.
      - Add to appraised value for mortgage
      - Force appraisers to include the cost of the shelter in the value of the homes. All other options you suggest require someone other than the home owner to bear the cost or at least some of it.
      - Hire employees that are willing to invest some of their time assisting those trying to build viable projects rather than showing lack of interest and denying any help at all. I continue to believe that community safe rooms are a cost effective way to save lives, and provide a multi-use facility that makes the building usable in many ways. All I have heard from many public and school officials are exaggerated comments regarding the costs involved. I have worked with two structural engineers concerning larger safe rooms, and am currently constructing one in Autumn Oaks Addition in Moore, OK. This project will protect up to 150 persons during a tornado, and will double as a community center for the neighborhood's use. I was refused any assistance from Moore officials regarding FEMA assistance, so the developer is paying the entire cost himself. This cost amounts to about $1000.00 per person living in this neighborhood, offers protection within 2 blocks of every home there, and allows our disabled neighbors access to a secure structure.

      NSSA
      - Sponsor public announcements, infomercials about safe rooms.

      CSM
      - All of the above, but especially a grassroots campaign.
   h. Comments
      CSM

- Best way: Small grant program (say $1000 to push folks into getting aboard and doing it. Small grant programs work. One of the most successful programs I have been associated with was a Small Grant Program in State of CT in the 1970s-80s...give out grants to folks who come in with definite plans, have them reviewed and approved. When completed (Certificate of occupancy) they get full amount, say $1000 or whatever amount will pull them into market. The grant program should have as little bureaucracy as possible...so what if some of them fail...the amounts are so small, they can be affordable losses. In a CT State of CT program that I evaluated there was 96% compliance and satisfaction.
- FEMA compliant safe room door costs need to come down.
- While I'm not sure reduced building permit fees would encourage safe room building, quality control codes are essential to increasing the effectiveness of safe rooms that are built. Grant programs will have to be timely, transparent and user-friendly to be effective.

Appendix E: City of Moore Fact Sheet

FACT SHEET
City of Moore, Oklahoma
May 20, 2013, Tornado, By the Numbers

Initial damage path began 4.4 miles west of Newcastle and ended .3 miles east of Air Depot Road in OKC. It began at 2:56pm and ended at 3:36pm.

The tornado was 1.3 miles wide at its greatest width and was on the ground for 39 minutes over a 17-mile path.

The storm had wind speeds up to 210mph.

The storm vacillated between EF3 and EF5 strength as it passed through the city limits of Moore.

Damage Intensity:
- *Numerous structures in the damage path showed EF5 level damage including:*
  - *Briarwood Elementary School.*
  - *Westmoor residential subdivision*
  - *Neighborhoods east of South Santa Fe Ave.*

- *EF4 damage occurred at numerous locations including:*
  - *Plaza Towers Elementary School and surrounding neighborhoods*
  - *Moore Medical Center and surrounding neighborhoods*
  - *Highland East Junior High's Gymnasium*
  - *Homes in the tornado path on the east side of I-35*

According to the AP, meteorologists using real-time measurements tracked energy released during the May 20th storm, estimating it at up to 600 times the power of the Hiroshima bomb.

For More Information, You May Contact:

Deidre Ebrey, City of Moore Spokesperson
debrey@cityofmoore.com
405-793-5224

(CityofMoore.org)

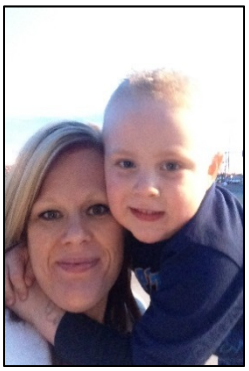
Appendix F: What Can Happen Without a Safe Room An Interview with Abby Larsen

What can happen in a tornado without a safe room? Abby Larsen, a Moore child care center owner, recalled how she and her staff sheltered their children in a bathroom as the May 20, 2013 storm destroyed their building:

As the storm started to grow and I could see the funnel starting to drop, I told all the teachers that were busy singing with the kids to move them to the bathroom. It wasn't the center of the building. I knew by the size of the funnel we needed to put as many walls as we could between us and this mass of destruction.

This horse went airborne above Abby Larsen's child care center. Contributed photo.

My staff still remaining calm for the 13 children and 10 adults we had. I offered for any of them to leave; they weren't held there by my account. Each one of those remarkable ladies stayed. My assistant and I stood at the front of my center looking out the window that faced west. As it got closer we knew we weren't going to avoid this. We tossed in the foam naptime mats for the teachers to put over the kids, we climbed in. I told them all that they needed to hold on very tight and whatever they do, don't let go. We said a prayer, and as it was coming to an end, we lost electricity. The roof sucked off the building and the next 30 seconds to a minute I thought we were all going to die. I was at the front of the impact. I was just sure I could keep the bathroom door shut, but wasn't so lucky. As the tornado went through our building, my assistant and I weren't thinking clearly and lifted our heads to look out. The building was gone. I saw a railroad tie go past my head, and she saw a horse fly past her. We quickly grabbed each other and put our heads back down.



Abby Larsen and her son. Contributed photo.

After the destruction we all started attempting to get out but couldn't. I said, on the count of 3 we all lift together. We did that and immediately they started grabbing the kids. We took them all to an area, and they started checking for injuries. A retired fireman came quickly to our rescue along with two ladies, none of whom we will probably ever be able to thank. We were transported to area hospitals where we were so fortunate. We had two children with a few staples in their heads. Some children didn't even have a bruise or cut on them. Some of our kids had

their shoes sucked off of them. One teacher had a broken finger and I had a broken rib and a lot of stitches across my back. There are so many details I could tell you but it would take forever. The weather channel informed us that we took a direct hit and the tornado was an F5 when it hit us. Emergency plans will save lives, and it did that day. (Abby Larsen, A Step Above Child Care Center, April 30, 2014)

Appendix G: Interview with Scott Lewis – Moore, OK

Scott Lewis in his Moore garage safe room that saved him and his son Zack on May 20, 2013. Ann Patton photo.

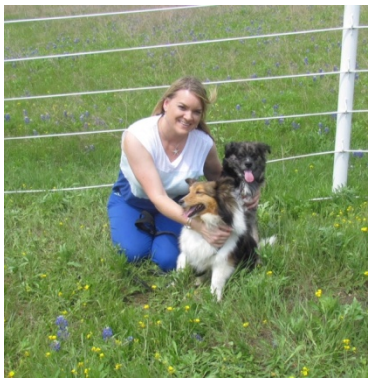
When Scott Lewis heard that a tornado was headed toward his Moore neighborhood on May 20, 2013, he rushed to a nearby elementary school and grabbed his 9-year-old son, Zack. One of Zack's friends tried to come with them, but Scott knew they didn't have room for him.

Scott and Zack dashed the two blocks home, dropped into the blackness of their tiny steel safe room under the garage floor, and slammed the rusty door shut. They had just one minute to spare before the massive tornado obliterated their home down to the slab, like the rest of their neighborhood.

Scott and Zack Lewis were safe. But back at Plaza Towers Elementary School, many were not so lucky. Even though teachers took students to the safest places and shielded them with their own bodies, there was simply no tornado-safe place in the school. Seven of the second- and third-graders, including Zack's friend, were among the 24 who died when the powerful tornado roared through Moore that day.

(Interview with Scott Lewis, May 22, 2013)

Appendix H: Interview with Lisa Jennings



Lisa Jennings with her dogs. Contributed photo

Lisa Jennings is used to weighing risk, cost, and benefit in anything she does. She has worked for FEMA's Region VI for two decades and is now a senior specialist in the flood program. So it was just second nature to her to look at the tornado risk at her home and decide last year that she wanted a safe room.

"Here in Denton, Texas, we're in the same path of Tornado Alley as Oklahoma, and we have had a lot of storms," she said. "We get a lot of straight-line winds and have had a lot of storms when we could see the funnel clouds in the sky. And a few years ago we had a microburst in my neighborhood that did a lot of damage. I live alone, and I wanted a safe place for me and my two dogs."

Once she determined her risk, she began to research options. Her evaluation scale toward action tipped during 2013, when tornados hit in nearby Granbury and throughout Central Oklahoma. She learned that the North Central Texas Council of Governments was going to sponsor a FEMA-funded rebate program with funding for 100 safe rooms in her county. FEMA staff would be eligible, the same as any other citizen, but would have to compete just like everybody else.

Lisa Jennings' Safe Room. Contributed Photo

"I went online to apply at 2 a.m. on the day the enrollment opened," she said. "When I got to work the next day, some co-workers were trying to apply – but it was too late. They closed the application period at 6 a.m. – there was that much demand."

The safe room she selected is an above-ground steel "Mighty Mite" bolted to her garage slab. As the rules required, she paid the approximately $4000 cost up front and, after extensive documentation and several months for approvals, received about half that back in the rebate program.

"I got a small disaster kit together and keep it in the safe room," she said, "with bottles of water, some food, and a little doggie kit with water and treats for them. You have to remember to keep things stocked so it will be fresh when needed.

"And I have to make sure that I can get to it, have to keep the garage pathway open – they are no good if you can't get to them."

The important difference for her, now, is that she has the security of knowing she can be safe even in a severe storm. "I have a place to go now," she said. "The difference is – peace of mind. I feel better because I have a safe place to go now."

(Interview with Lisa Jennings, August 20, 2014.)

Appendix I: A Story for Everyone – The Importance of Installing Safe Rooms at or Above the BFE

On May 13, 2015, Tom Leatherbee, the Director of Community Services for the City of Del City, Oklahoma, shared the following story regarding the importance of ensuring the location for a safe room is not a Special Flood Hazard Area (SFHA) or at risk to flood or other hazards:

> *About two years ago a resident applied for a storm shelter permit in his garage. I denied the permit because the house was located in the Special Flood Hazard Area. He then applied to put it in the back yard, and I denied again for the same reason, with the suggestion that he install a safe room with elevated floor in the house or build up an area in the back yard for an above ground shelter. He argued for months, got a lawyer involved to argue, went over my head to the City Manager, spoke at the City Council meeting about how I was personally putting him and his mother at risk, called the Water Board and FEMA Region. The City held firm and refused to issue the permit.*
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> *This resident called the City Manager's office yesterday to say thank you for not allowing the shelter to be installed. He said that he had two feet of water in the back yard and garage during the recent storm, all of which came up while the tornado sirens were still going off, and that had he installed the shelter he believes his mother would have been trapped inside with no way to get out.*

While safe rooms are beneficial, this story is an important reminder of the benefits of issuing permits before a safe room can be installed to prevent a situation that may lead to injury or fatality if a safe room is not installed properly.