

Setting New Standards

ASSA ABLOY

*Enhancing Life Safety Through
Storm Shelter Requirements*

The global leader in
door opening solutions





*"The United States sees more
tornadoes than any other country,
averaging more than 1,000 a year."*



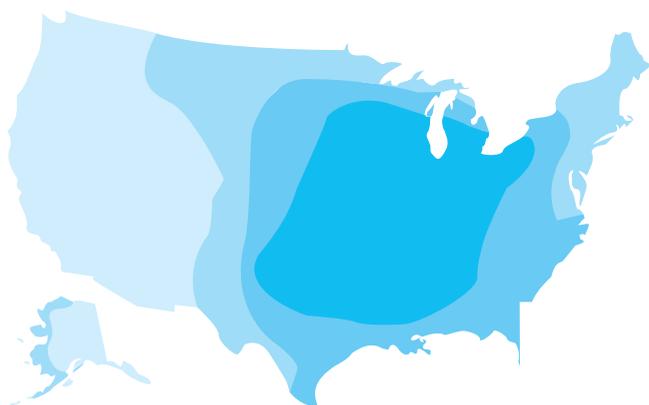
Photo by Kansas City District
U.S. Army Corps of Engineers

Withstanding Nature's Fury

When a tornado struck the southern Missouri city of Joplin in May 2011, it killed 161 people and caused \$2 billion in damage. That storm was just one of the more horrific in a series of natural disasters that regularly tear through America's "Tornado Alley" – a broad swath of the nation's heartland, roughly 500 miles on either side of the Mississippi River, encompassing all or parts of 22 states.

Four years before the Joplin disaster, a powerful tornado struck the town of Enterprise, Alabama. While the death toll and damage were not as severe as in Joplin and the news coverage not as widespread, it was especially sobering in one regard: the storm made a direct hit on the local high school, killing eight students and one other person.

Written by Kurt Roeper



Wind Speeds

- 130 MPH
- 160 MPH
- 200 MPH
- 250 MPH

Notes:

1. Values are nominal three-second gust wind speeds in miles per hour at 33 feet above ground for Exposure Category C.
2. Multiply miles per hour by 0.447 to obtain meters per second.

The Enterprise tornado sparked considerable discussion and subsequent action among those responsible for assuring the safety of students at school. In 2010, the governor of Alabama signed into law legislation mandating the construction of tornado shelters in all new schools built in the state. Since that time, the model building codes of the United States have adopted mandatory requirements bringing similar standards to a much broader portion of the country.

The International Building Code® is a model code developed by the International Code Council® and revised every three years. First published in 2008, ICC 500 – "Standard for the Design and Construction of Storm Shelters" was referenced in the 2009 IBC as the standard for use when people chose to construct a shelter in a public facility. The language remained in place for the 2012 edition of the IBC providing guidance for voluntary construction of shelters.

The next edition, IBC 2015, required that all newly built schools housing 50 or more kindergarten through 12th grade students in the most tornado-prone part of the country be constructed with shelters that can accommodate all occupants of the building, including students, teachers and administrators. These were the first mandatory shelter construction requirements, and have been followed by similar requirements in the yet to be published 2018 International Existing Building Code®.

Violence From The Sky

Tornadoes are nature's most violent storms. Winds can reach 250 miles per hour, and entire neighborhoods can be destroyed within seconds. Unlike hurricanes, for which coastal residents may have two or three days to evacuate, tornadoes arrive with little warning – 20 minutes on average, according to the National Weather Service.

The United States sees more tornadoes than any other country, averaging more than 1,000 a year. Texas, Oklahoma and Kansas, are historically the hardest-hit states, although damaging tornadoes often occur in the Southeast, the Upper Midwest, and the Ohio and Tennessee Valleys – basically the entire area between the Appalachians and the Rocky Mountains.

Every U.S. state, without exception, has been hit by at least one tornado. While hurricanes and earthquakes tend to attract more media attention, the Federal Emergency Management Agency reports that tornadoes and related weather events have caused an average of 57 percent of insured catastrophic losses since 1953.

Corey Schultz is the owner of Schultz Squared Architects in Wichita, Kansas, in the heart of Tornado Alley, and a member of the International Code Council®. He has been designing tornado shelters



Photo by PBA Architects

for schools for more than 20 years. His firm's basic approach in designing one, he says, is to keep the idea of "shelter" in the background.

"Our philosophy is that we're designing educational spaces that are serving as shelters, not shelters that are serving as educational spaces," he says. "We want people to walk into a classroom and say, 'This doesn't look like a shelter to me.'"

This philosophy reflects one of two main concepts on how to design a school with a tornado shelter. One approach is to take a large space, such as a gymnasium or an auditorium, and reinforce the entire structure so that it can withstand a tornado.

Such spaces can be suitable to serve as shelters for several reasons: they can hold a lot of people, they usually don't have exterior windows, and they lend themselves to hardening with concrete walls and roof structures and highly engineered doors.

But gyms and auditoriums also have a drawback: they may be located far from classrooms, possibly on a different floor, and since tornadoes arrive with so little warning, there may not be enough time to get students into the shelter before the storm hits.

Rather than try to direct a couple of hundred third graders to the gym and subsequently account for each one, some shelter designers asked, why not let the classroom serve as a hardened shelter space?

The key to this approach is to install specialized doors, or shutters, which normally stand open against the wall next to a window, but can quickly be swung 180 degrees to cover the window and protect the classroom in the event of a tornado. The face of the shutter can hold a whiteboard or displays of artwork, so the teacher doesn't lose wall space. "When they need it it's there, but day in and day out they don't need it," Schultz says.

"This is one of the unique areas where ASSA ABLOY is expending a lot of effort," says Jim Bell, Windstorm Coordinator for ASSA ABLOY "We want it to look like a classroom, not a bank vault."

Setting New Standards

The International Building Code® by itself does not have an enforcement mechanism. The Council issues and updates its requirements, but the code is not law until a state or local jurisdiction adopts it. Some states and jurisdictions adopt the most recent edition of the code right away, while others may not do so for another three to five years, or they may decide to adopt a version modified by local amendments. Once the final code goes through the local or State legislative process, it is signed into law and becomes mandatory for newly permitted construction.

"There is no such thing as a nationally adopted building code" says Dr. Erin Ashley, a reliability engineer at San Francisco-based design and construction firm URS Corporation, who worked with FEMA to draft the current code requirements. "The building code is adopted by states and local communities." Some states choose not to have a statewide building code and leave it up to the jurisdictions to adopt a code, leaving many without a building code. While other states have a very strong statewide code and reduce or eliminate the ability of the local jurisdictions to weaken the provisions through code amendments. Many states add amendments to the building code or revise the International Building Code® to account for the unique local conditions. For example, Florida has made strides in their code to account for the high risk of wind and flood events. California has made attempts to account for the high risk of seismic events.

What's a Shelter?

The mandatory requirements contained in IBC 2015 are available for adoption by the states. The latest standards reflect an evolution of thought that has transpired over many years.

In the past, a tornado shelter in a public building typically consisted of what was considered to be the best available option, usually an existing interior space with no windows. Frequent fliers could see the result of this approach in airports, where the management might have simply hung a shelter sign on a restroom door.

Then in the 2009 version of the building code, the ICC introduced a requirement that basically said, if you're going to call something a shelter, you have to build it like a shelter – but it didn't mandate the construction of shelter space.

The 2012 edition kept the same language, but the 2015 version says it's no longer optional – any newly constructed school or emergency response center in the affected geography must include a tornado shelter. The changing requirements reflect an evolution in thinking about how to best protect people from tornadoes.

"In the past you just went out and bought a seven-dollar sign and hung it up somewhere, declaring that it was a shelter," says Bell. "Then we went to the idea that if you're going to put a sign on something and direct a large number of people to a space with the implicit direction that you will be safer if you go there, then you have to actually provide a level of safety to them. And from that we've evolved to: You shall provide safety to the occupants in the K12 environment."

The History of Shelters

Some of the thinking behind current shelter construction technique stems from studies done by the Federal Emergency Management Agency starting a dozen or more years ago, after a spate of destructive tornadoes. Omar Kapur, PE, a structural engineer describes FEMA's research.

"As FEMA was doing post-disaster investigations," Kapur says, "they noticed that a lot of the small interior rooms were surviving when the rest of the structure was blown away."

The agency's research culminated in a pair of government publications known as FEMA 320, "Taking Shelter From the Storm: Building a Safe Room For Your Home or Small Business," (first published in 1998) and FEMA 361, "Design and Construction Guidance for Community Safe Rooms" (first published in 2000).

In 2008 the ICC and the National Storm Shelter Association jointly developed a publication, ICC-500, that specified design and performance criteria for shelters. The standards included in the publication, officially titled "ICC/NSSA Standard for the Design and Construction of Storm Shelters," closely resembled those in FEMA 361.

"The FEMA publications are guidance documents," Kapur says. "FEMA does not regulate building construction; that is left to building codes and standards – but the findings that FEMA and others obtain in the wake of major disasters are important to consider as the code and standard process continues to move forward."

Meet The New Standards

An experienced structural engineer should be able to design an adequate safe room, but the IBC 2015 standards will have some new considerations for designers. "You're working with really ramped-up values, particularly in design wind speed," Kapur says. Buildings in Tornado Alley need to be designed to withstand a wind speed of 250 miles per hour, while those in less vulnerable areas might only need to hold up under a 130-mile-per-hour wind.

In tornado language, a "missile" refers to a piece of debris or other loose object picked up by the wind and propelled with enough force to damage or even penetrate walls, doors and windows. Tornado shelter designers need to design for such flying objects. ICC 500 calls for shelters that can resist a 15-pound 2" x 4" board traveling horizontally at 100 miles per hour. "The test missile speed and the requirements on the components are going to be much higher than, say, the Miami-Dade standards" for hurricane protection, Kapur says.

Protecting First Responders

Besides setting standards for tornado shelters in schools, IBC 2015 also contains requirements for protection within emergency response centers, such as 911 call centers and fire and police stations.

"When there is an event, we depend on them," Schultz says. "We depend on the dispatch, on law enforcement, on the fire department, on ambulance and hospital first responders. If those people and their facilities are gone, now what?"

Putting Children First

Corey Schultz recalls the first tornado shelter he designed. It was for an elementary school in the small south-central Kansas town of Hesston, in 1990, a time when construction standards were distinctly lacking.

"The paint had literally no more than dried on the walls when an F4 tornado went right through the playground," he says, referring to the second-strongest category of tornado on the Fujita scale used to measure the storms' intensity. "Luckily it was after school was out, but there was one teacher there. She went down and used that shelter, and she

was kept safe. That was my first one, and the first one of mine that got hit, so there's not too many people that can convince me that shelters aren't worth it."

Schultz surely speaks for all parents when he says they expect two things when they send their children to school. "One is that when they get to school and start their day, they're going to learn something," he says. "And the other thing we expect is that at the end of the day they return to us safely. Enterprise, Alabama, showed us that's not always the case. But as parents, that is our expectation, so that's why I think schools are a good place to start."

From the death of eight students at Enterprise High School in 2007, to the introduction of mandatory tornado shelter requirements in the 2015 IBC, we have witnessed the evolution of new life safety requirements. Coupling the science of engineering and design with the legislative process of code development, we have added a level of safety to the occupants of our educational facilities and for our first-responders.

Kurt Roeper is a Director for ASSA ABLOY Americas and is an active participant in the development process for fire and life safety codes and standards. He may be reached via email at kurt.roeper@assaabloy.com



"We want it to look like a classroom, not a bank vault."

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