



**SCHOOL STORM SHELTER STUDY REPORT**  
**to the 133<sup>rd</sup> Ohio General Assembly**

**Prepared by the**  
**Ohio Facilities Construction Commission**  
**December 2019**

## **Introduction**

In July 2019, Amended Substitute House Bill 166 of the 133<sup>rd</sup> General Assembly included a statutory directive in Section 287.90, titled School Storm Shelter Study:

The Ohio Facilities Construction Commission shall conduct a study to evaluate and make recommendations regarding appropriate requirements for storm shelters for Ohio school buildings. The Commission shall conduct this study in consultation with stakeholders, including school district officials, and submit a report of its findings to the General Assembly not later than December 31, 2019.

OFCC is the central agency responsible for oversight of state-funded public building construction projects, including projects in K-12 schools, state agencies, and state-assisted colleges and universities. Under Ohio Revised Code (ORC) Chapter 3318, OFCC administers the state's facilities assistance to certain public schools for the construction or renovation of its facilities, which to date has exceeded \$12.3 billion. OFCC also provides grants to community and private schools under separate legislative authority. In order to manage state's facilities assistance program, OFCC publishes the Ohio School Design Manual (OSDM), a set of design standards and specifications for schools choosing to participate in its state-funded programs. The manual was developed by Commission staff, in cooperation with architects and nationally recognized educational planners. The design manual is updated annually and sets standards of quality for the state's educational facilities funded through OFCC programs.

## **Consultation with Stakeholders**

Because the OSDM incorporates building code standards, in response to this legislative charge, the OFCC staff consulted with the Department of Commerce's Ohio Board of Building Standards (BBS). BBS is the entity charged with adopting and enforcing rules governing the erection, construction, alteration, and maintenance of all buildings or classes of buildings specified in ORC Section 3781.06 (which is relevant to the school buildings). In addition to the statutory requirements, the rules regulating non-residential buildings are codified in Ohio Administrative Code Division 4101:1 and are collectively known as the Ohio Building Code (OBC). The OBC provides the minimum requirements for the construction of school buildings, and the OSDM provides additional standards, details or options above those required in code.

OFCC staff also met with and sought input from the following stakeholders:

- School district officials suggested by the Buckeye Association of School Administrators (BASA) and the Ohio Association of School Business Officials (OASBO);
- Professional design experts suggested by the American Institute of Architects (AIA) and the American Council of Engineering Companies (ACEC); and
- Representatives from the Ohio Department of Public Safety, Ohio School Safety Center

Based on input from stakeholders, OFCC's findings and recommendations are set forth below.

## **Building Code Requirements for School Storm Shelters**

In July 2000, the Federal Emergency Management Agency (FEMA) published its first edition of FEMA P-361, *Safe Rooms for Tornadoes and Hurricanes: Guidance for Community and Residential Safe Room*. Now in its third edition, this document sets forth design and construction guidance for tornado and hurricane shelters. FEMA also helped develop the International Code Council (ICC) *Standard for the Design and Construction of Storm Shelters*, known as ICC 500, originally published in 2008 and updated in 2014. ICC, in partnership with the National Storm Shelter Association (NSSA), intended the ICC 500 standard to be adopted by government agencies and organizations in creating model codes for storm shelters.

Beginning in 2009 and continuing through the present, the ICC 500 has been referenced in the IBC as the governing standard for storm shelters. The IBC may be adopted by local jurisdictions with or without amendments, and with the timing of adoption determined locally. The current OBC is based on the IBC's 2015 edition and requires certain buildings, based upon building function and geographic location, to include storm shelters.

For building code purposes, structures are classified into one of ten occupancy groups. In 2015, the IBC required the application of the storm shelter requirement to Educational Group E, which includes K-12 schools, among other structures. The IBC further narrowed the requirement to Educational Group E buildings in the geographic locations within the 250 mile per hour (mph) wind speed zone as identified in the ICC 500 standard. This requirement affects 23 U.S. states, including Ohio.

## WIND ZONES IN THE UNITED STATES\*



In June 2017, BBS adopted an update to the OBC that included a new Section 423.4, requiring buildings to include storm shelters constructed in accordance with ICC 500 in Group E occupancies. This code update, and storm shelter requirement, became effective on November 1, 2017.

The 2015 Storm Shelter code requires a design that buildings provide a space large enough to house all the typical occupants and strong enough to withstand a tornado. More specifically, the code requires:

- Space for at least five square feet per person, based upon total occupancy
- Designed to allow for two hour a minimum of 2 hour occupancy after the tornado
- Shelter envelope components including doors and windows designed for debris missile impact based on a design wind speed of 250 mph
- Protection of any shelter opening greater than 3 ½ sq. in. or 2 1/16 in. diameter
- Sanitation facilities within the shelter, including minimum number of toilets
- Mechanical or natural ventilation
- Design for roof live load of 100 pounds per square foot minimum

The storm shelter code also requires a quality assurance plan, special inspections, and peer review by an independent registered design professional. The peer reviewer provides a signed and sealed report, submitted with the construction documents to the code authority having jurisdiction over the proposed building, prior to the issuance of a permit. The report includes reference to structural design elements, means of egress and accessibility, fire safety, ventilation, and other essential features. The report describes the items reviewed, the compliance of those items, and a recommendation for acceptance or rejection.

The storm shelter code requirement can be met through a stand-alone structure, or as a specifically designed hardened area within the existing building footprint.<sup>1</sup>

### **Storm Shelter Cost Impact on OFCC Projects**

In anticipation of the November 2017 effective date, OFCC contracted with a consulting firm to develop an estimating cost model for the storm shelter requirements. OFCC also compiled a list of its K-12 projects that were then in design and could be affected by the code requirement. Using the estimating model, OFCC staff estimated a potential additional cost of about \$40 million for 68 active projects within 31 school districts, with an estimated additional state share of \$18.5 million. This calculated to an average increase of 3.8% in construction costs or approximately \$589,000 per school.

At its October 2017 meeting, OFCC adopted a resolution authorizing co-funding of project-specific allowances to address the new storm shelter requirement. Because the referenced projects were in various stages of design, it was uncertain whether the requirement would apply to all projects as application of the storm shelter requirement dependent on the date designs were submitted to BBS or other applicable building department. Application of the requirement was addressed on a case-by-case basis in coordination with BBS and local code officials, which BBS later formalized by a BBS Memo on July 13, 2018. See Exhibit A.

Of the original list of 68 projects, two have incorporated the storm shelter code requirement: Fairborn City School District and Dover City Schools. Both projects are currently in construction.

### **2018 Moratorium**

As a result of concerns about costs and uncertainty about implementation that were raised by several school districts and the above-noted school associations, on June 7, 2018, the Ohio General Assembly adopted Substitute House Bill 21, effective September 28, 2018, which included a new ORC Section 3781.1010 enacting a moratorium on the school storm shelter requirement until September 15, 2019. In addition to the September 15, 2019 moratorium requirement, the new language stated that the requirement shall also not take effect if “financing has been secured prior to” September 15, 2019. On May 13, 2019, BBS requested a formal opinion from the Ohio Attorney General (OAG) for interpretation of the “financing has been

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<sup>1</sup> To implement this solution, the designer would need to fortify the foundation, walls and roof of the designated area to provide a continuous load path and provide necessary life safety and anti-panic amenities.

secured” language. On August 7, 2019 the OAG issued Opinion No. 2019-027 providing clarity on the language, including multiple options for a school to satisfy its obligation to secure financing. See Exhibit B.

## **2019 Moratorium and Study Requirement**

On July 17, 2019, the Ohio General Assembly adopted Amended Substitute House Bill 166, which, in addition to the above-noted study directive, amended ORC Section 3781.1010 to extend further the storm shelter moratorium until September 15, 2020.

## **Study Findings**

### **Tornadoes as a Risk Factor**

Tornadoes are among the most destructive weather events on Earth. Although tornadoes occur worldwide, the United States has by far the most tornadoes of any country, averaging more than 1,200 annually. Since tornadoes are short-lived and unpredictable, many are never seen or recorded. While most tornadoes do not result in fatalities, they are responsible for an average of 80 deaths and 1,500 injuries annually in the U.S.<sup>2</sup>

In an average year, Ohio experiences 17 tornadoes causing four fatalities. Since 1950, every county in Ohio has experienced at least one tornado, with 14 counties experiencing more than \$100 million in cumulative damages from 1950-2017. While Ohio is not among the top states for numbers of tornadoes, it ranks among the top 20 states for fatalities, injuries, and dollar losses.<sup>3</sup> And although tornadoes have struck school buildings in Ohio, including in the spring of 2019, there has been just one recorded fatality (1887).<sup>4</sup>

Other states have not been as fortunate. Part of the reason for the storm shelter requirement addition to the 2015 IBC was the finding that even schools built to modern building codes are susceptible to collapse during tornadoes. For example, in 2013, seven school children died in Oklahoma at the Plaza Towers Elementary School during a tornado. The children were taking refuge in the hallway, which was their designated tornado safety area, when the masonry hallway walls collapsed on them.

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<sup>2</sup> National Oceanic and Atmospheric Administration, National Centers for Environmental Information, retrieved November 25, 2019 at <https://www.ncdc.noaa.gov/climate-information/extreme-events/us-tornado-climatology>

<sup>3</sup> Grazulis, Thomas P. (1993). *Significant Tornadoes 1680-1991: A Chronology and Analysis of Events*. St. Johnsbury, VT: The Tornado Project of Environmental Films. pp. 139–40.

<sup>4</sup> Ohio Department of Public Safety, Ohio Emergency Management Agency, *2019 State of Ohio Enhanced Hazard Mitigation Plan*, February 2019, Section 2.3.

## **Stakeholder Feedback**

Throughout the meetings with the stakeholder groups, all participants noted the desire to ensure appropriate safety needs in schools, and there was universal recognition of the potential risk that tornados pose to building occupants.

Understanding that student and staff safety is a paramount concern for building construction and renovation, stakeholder feedback noted two primary issues regarding implementation of the school storm shelter code requirement: (1) uncertainty about the conditions under which the storm shelter requirement would apply for school building renovations and additions, and the (2) cost impacts to school building construction and renovation.

From the school district official perspective, participants noted that school districts plan for and address a multitude of health and safety issues daily. Among the issues facing school administrators are active shooter situations, fire, bomb threats, bullying and cyberbullying, physical health outbreaks, and mental health issues. Each of these health and safety issues requires the allocation of resources – money, people, planning time– to reduce risk and provide the best, safest educational environment for students and staff.

In addition, while physical safety was important to all school districts providing input for this report, participants reported that tornado safety was not among the top concerns expressed by citizens, parents and staff to school administrators. When factoring in cost-effectiveness, participants suggested that the school districts would prefer the flexibility of an optional storm shelter requirement. Recognizing, however, that building code requirements typically are not options, participants indicated that should the storm shelter requirement remain in place after the expiration of the September 2020 moratorium, school district officials encouraged the code officials and design professionals to work to provide the enhanced safety requirements at the least possible cost.

Representatives of the professional design community expressed confidence in designing spaces to meet any current storm shelter requirement. ICC 500 requires thoughtful design and configuration of known building materials and techniques, rather than the application of untested technologies or materials. Design officials noted, however, that much of the professional experience with these storm shelter requirements currently lies out of state, as there is limited real-world experience with building ICC 500 compliant storm shelters in Ohio. Based on this limited experience and the information provided, OFCC staff notes that there is not currently one specific path for designing a cost-effective and compliant storm shelter.

While there are many potential compliance paths, the goal would be to provide the most cost-effective solution to meet the requirements for a particular school's design. The design industry was open to any avenues for clarification of the code's requirements. During the meeting discussions, questions were raised about the applicability of the code and whether the requirements extended beyond tornadoes to the hurricane requirements of ICC 500 (which have additional hardening requirements and cost impacts). Though it was later clarified that the hurricane requirements do not apply, the feedback received suggested that additional discussion between the design community and BBS would help all involved parties better understand

requirements and lead to better and more cost-effective implementation. The group offered some alternative, lower cost compliance paths if certain code elements were modified. Clarification could also take the form of additional detailed guidance from BBS, local code officials, and training on the requirements. As Ohio gains more experience in these requirements, it is expected that the compliance cost will be reduced.

### **Neighboring State Implementation**

Ohio is not alone in addressing and evaluating the storm shelter requirements. Despite the adoption of the ICC 500, not all states in the 250 mph wind zone have adopted the storm shelter requirement. For those neighboring states within the 250 mph zone, adoption of the requirements has been varied. Michigan initially adopted the storm shelter requirement for schools in 2017, but it then added emergency rules that suspended that adoption and implementation. Kentucky's mandatory requirement became effective on January 1, 2019. Indiana has no formal requirement, but this past summer, several news stories began reporting additional calls for its implementation. Outside of Ohio's border neighbors, Illinois adopted the requirement in 2014.

Other states in the 250 mph wind zone have considered adoption but have not yet made it mandatory. In 2013 the Governor of Oklahoma requested that schools consider constructing shelters, but that state has not adopted the code requirement. From all available accounts, resistance to mandatory adoption is primarily triggered by cost impact concerns. Ohio is unique in the scope of its state supported school construction program administered by OFCC.

### **Recommendations**

New building code requirements, especially those requirements that have cost impacts, are often met with initial concerns. This happened previously with Americans with Disabilities Act requirements. It also happened with non-code requirements for OFCC's implementation of the Leadership in Energy and Environmental Design (LEED) requirements. The initial concerns, consistent with the feedback received from this study's participants, are typically based on cost impacts, particularly for early adopters. And cost is certainly an important factor, especially when evaluating proposed new construction and renovation projects in the current tight construction market.

But history also shows that these concerns often dissipate once the early cost impacts are mitigated. As with other requirements, including OFCC's experience with the LEED implementation in its school programs, the additional cost associated with the storm shelter requirement is anticipated to decrease as the storm shelter designs become more widespread. With full implementation and much wider design and use of storm shelters, the storm shelters will become much less of a specialty item from a design and construction standpoint. Similarly, once the market widens for the products included in the storm shelters, then we anticipate that other cost reductions will follow.

Consistent with this context, these recommendations are made within the context of the moratorium ending and are offered for incorporating the storm shelter requirement for Ohio



schools scheduled to take effect on September 15, 2020. These recommendations should be implemented prior to the effective date of the requirement.

- 1) School district officials are encouraged to participate directly in the BBS rule development process, either formally or informally, to share their perspective on building code impacts on their districts.
- 2) BBS is encouraged to provide additional detailed guidance on the code requirement for school renovations and additions. This guidance should address the conditions under which the requirement is applicable, and the design occupancy for the shelter space in the case of renovations or additions.
- 3) BBS and the design community are encouraged to meet for technical discussions on the interpretation of ICC 500, with particular attention to requirements that may be modified for tornadoes. The focus should be on compliance paths that provide the necessary level of safety for the least cost. The result of these discussions could be communicated through written guidance and/or training opportunities
- 4) To the extent possible with a small sample size of projects, OFCC and the design and construction community should widely share real-world experiences on storm shelters in Ohio, with the goal of reducing risk and cost through lessons learned. Information may be shared through conferences, webinars, meetings or other appropriate venues.