



ICC 500-2014 Standard and Commentary

**ICC/NSSA Standard
for the Design and
Construction of Storm
Shelters**



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and Construction of Storm Shelters**



ICC 500—2014 Standard and Commentary: ICC/NSSA Design and Construction of Storm Shelters
(ICC 500 Commentary—2014)

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ICC 500—2014 Standard and Commentary: ICC/NSSA Design and Construction of Storm Shelters

PREFACE

Purpose and Application

The principal purpose of this commentary is to provide a basic volume of knowledge as it pertains to the regulations set forth in ICC 500—14.

In the chapters that follow, discussions focus on the full meaning and implications of the text of the standard. Illustrations and photos are provided to aid understanding. Where illustrations are provided to demonstrate a method of compliance, they do not necessarily illustrate the only methods of compliance. The commentary text is not part of American National Standard ICC 500—2014 and has not been processed in accordance with ANSI's requirements for an American National Standard (ANS). As such, the commentary text will contain material that has not been subjected to public review or a consensus process.

The format of this document includes the full text of each section, table, and figure in ICC 500—2014, followed immediately by the commentary applicable to the section. Each section's introduction includes a discussion about the objective of the section and usually some discussion about why the requirements are contained in the standard. Standard text and commentary text are easily distinguished from each other. All standard text is shown as it appears in ICC 500—2014, and all commentary is indented below the standard text with the symbol ❖.

Readers should note that the commentary is to be used in conjunction with ICC 500—2014 and not as a substitute for the standard itself. The commentary is advisory only; the code official alone possesses the authority and responsibility for interpreting the codes and standards.

Additional background information on the history and development of ICC 500—2014 provisions is available in the Federal Emergency Management Agency (FEMA) publication FEMA P-361, *Safe Rooms for Tornadoes and Hurricanes: Guidance for Community and Residential Safe Rooms* (Third Edition, 2015). Note, "safe room" is FEMA terminology for storm shelter, although there are some modest differences. FEMA defines a safe room as follows: "A storm shelter specifically designed to meet FEMA safe room Recommended Criteria and provide near-absolute protection in extreme-wind events, including tornadoes and hurricanes." Near-absolute protection is defined as "Level of protection afforded to the occupants of a safe room built according to the guidance in the most current edition of FEMA P-361. Our current knowledge of tornadoes and hurricanes indicates that safe room occupants will have a very high probability of being protected from injury or death" (FEMA 2015). The design guidelines for FEMA safe rooms begin with the provisions of ICC 500—2014 but include several modifications and additional requirements, all of which are more conservative than ICC 500—2014. The FEMA publication includes supplemental commentary for most provisions of ICC 500—2014, as well as identification of best practices. FEMA P-361 also provides guidance on a range of topics beyond the scope of ICC 500—2014, including planning, costs, operation, and maintenance of safe rooms—information that is also generally applicable to storm shelters.

The discussion provided in this commentary has been provided by members of the ICC 500—2014 Committee, as well as others who have experience with the design and construction of storm shelters and other hazard mitigation issues related to high-wind events. ICC would like to acknowledge contributions from the following individuals with thanks for their efforts in the writing of this document:

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The information contained in this preface is not part of the ANS and has not been processed in accordance with ANSI's requirements for an ANS. As such, this preface may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the standard.

Introduction

In May of 2002 the International Code Council (ICC) and the National Storm Shelter Association (NSSA) initiated a joint project to write a standard for the design and construction of storm shelters. A standard development committee was created, and the first meeting of that committee was in May of 2003. The scope of the standard is to provide minimum design and construction requirements for storm shelters that provide a safe refuge from storms that produce high winds, hurricanes and tornadoes. Hurricanes and tornadoes generate high winds that produce wind pressures on buildings and structures and that create flying debris at levels and intensities than are higher than those for which most commercial building and residences are designed. The magnitude of the wind speeds associated with these storms are such that building occupants and residents are required to evacuate the area or seek protection in a shelter designed for resistance to extraordinary loads and flying debris. ICC 500—2014 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.

Development

As of December 2014 the second edition of the International Code Council (ICC) and National Storm Shelter Association's (NSSA) *Standard for the Design and Construction of Storm Shelters* has been published. The standard was developed by the ICC/NSSA Consensus Committee on Storm Shelters (IS-STM), which operates under ANSI Approved ICC Consensus Procedures for the Development of ICC Standards. The consensus process of ICC for promulgating standards is accredited by ANSI. The Storm Shelter Committee is a balanced committee formed and operated in accordance with ICC rules and procedures.

The meetings of the ICC/NSSA IS-STM Consensus Committee were open to the public and interested individuals and organizations from across the country participated. The technical content of currently published documents on storm shelters, including documents of the National Storm Shelter Association, the Federal Emergency Management Agency (FEMA), the Red Cross, and the State of Florida, was reviewed and considered by the committee. The information from these documents helped form a basis for the regulations installed in ICC 500—2014, but the exact provisions adopted by the committee were determined based on the scope and intent of ICC 500—2014. The requirements of ICC 500—2014 are based on the intent to establish provisions consistent with the scope of the ICC family of codes and standards that are written to adequately protect public health, safety and welfare; provisions that do not necessarily increase construction costs; provisions that do not restrict the use of new materials, products or methods of construction; and provisions that do not give preferential treatment to particular types or classes of materials, products or methods of construction.

Adoption

ICC 500—2014, *Standard for the Design and Construction of Storm Shelters* is available for adoption and use by any jurisdiction. Its use within a governmental jurisdiction is intended to be accomplished through adoption by reference in accordance with proceedings establishing the jurisdiction's laws. At the time of adoption, jurisdictions should insert the appropriate information in provisions requiring specific local information, such as the name of the jurisdiction.

Interpretations

Requests for Interpretations on the provisions of ICC 500—2014 should be addressed to: ICC, Central Regional Office, 4051 Flossmoor Road, Country Club Hills, IL 60478.

Maintenance—Submittal of Proposals

All ICC standards are periodically updated as required by ANSI. Proposals for revising the second edition are welcome. Please visit the ICC website at www.iccsafe.org for the official "Call for Proposals" announcement. A proposal form and instructions can also be downloaded from www.iccsafe.org.

ICC, its members and those participating in the development of ICC 500—2014 do not accept any liability resulting from compliance or noncompliance with the provisions of ICC 500—2014. ICC does not have the power or authority to police or enforce compliance with the contents of the standard. Only the governmental body that enacts the standard into law has such authority.

International Code Council/National Storm Shelter Association Consensus Committee on Storm Shelters (IS-STM)

Consensus Committee Scope: The ICC/NSSA Consensus Committee on Storm Shelters (IS-STM) shall have primary responsibility for minimum requirements to safeguard the public health, safety and general welfare through design, construction and installation requirements for storm shelters.

ICC 500—2014 was processed and approved for submittal to ANSI by the ICC/NSSA Consensus Committee on Storm Shelters (IS-STM). Committee approval of the standard does not necessarily imply that all committee members voted for its approval.

Representatives on the Consensus Committee are classified in one of three voting interest categories. The committee has been formed in order to achieve consensus as required by ANSI Essential Requirements. At the time it approved the standard, the IS-STM Consensus Committee consisted of the following members:

General Interest (G) - User Interest (U) - Producer Interest (P)

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Voting Membership in Each Category

Category	Number
General (G)	5
User (U)	5
Producer (P)	5
TOTAL	15

Interest Categories

General Interest: Individuals assigned to the General Interest category are those who represent the interests of an entity, including an association of such entities, representing the general public or entities that promulgate or enforce the provisions within the committee scope. These entities include consumers and government regulatory agencies.

User Interest: Individuals assigned to the User Interest category are those who represent the interests of an entity, including an association of such entities, which is subject to the provisions or voluntarily utilizes provisions within the committee scope. These entities include academia, applied research laboratory, building owner, design professional, government nonregulatory agency, insurance company, private inspection agency and product certification/evaluation agency.

Producer Interest: Individuals assigned to the Producer Interest category are those who represent the interests of an entity, including an association of such entities, which produces, installs or maintains a product, assembly or system subject to the provisions within the committee scope. These entities include builder, contractor, distributor, labor, manufacturer, material association, standards promulgator, testing laboratory and utility.

NOTE—Multiple Interests: Individuals representing entities in more than one of the above interest categories, one of which is a Producer Interest, are assigned to the Producer Interest. Individuals representing entities in the General Interest and User Interest categories are assigned to the User Interest.

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Chapter 1: Application and Administration

General Comments

This chapter provides provisions regarding the purpose, scope, application, and administration of subsequent requirements of ICC 500. In addition to the statement of purpose and scope of the standard, this chapter provides for the occupancy classification of a storm shelter when it is a stand-alone, dedicated facility and when it is

a room within a building used for other purposes. This chapter also details special inspection requirements and provides specific information that must be supplied on construction documents when submitted for permit approval. Finally, the chapter addresses labeling and signage for storm shelters.

SECTION 101 GENERAL

101.1 Purpose. The purpose of this standard is to establish minimum requirements to safeguard the public health, safety and general welfare relative to the design, construction and installation of storm shelters constructed for protection from high winds associated with tornadoes and hurricanes. This standard is intended for adoption by government agencies and organizations for use in conjunction with model codes to achieve uniformity in the technical design and construction of storm shelters.

- ❖ This standard provides minimum requirements for the design of hurricane and tornado shelters. Buildings or portions thereof constructed in accordance with ICC 500 are designed to resist the extreme wind loads generated by tornadoes and hurricanes and thus provide shelter to people during such events. The wind and rain loads specified in this standard exceed the typical design wind and rain loads mandated by building codes.

In keeping with the general intent of building codes and reference standards, the structural, fire, egress, and mechanical requirements in this standard are those considered by the ICC Storm Shelter Committee to provide adequate life safety protection and safeguard the health and welfare of individuals seeking shelter from a tornado or hurricane. The standard allows for selection of wind loads based on the climatology and historic risk to a particular region.

This standard is intended to be adopted as a legally enforceable document to regulate the design, construction, installation, and inspection of storm shelters. Since 2009 the *International Building Code*® (IBC®) and *International Residential Code*® (IRC®) have referenced ICC 500 as the applicable standard for the design and construction of storm shelters.

101.2 Scope. This standard applies to the design, construction, installation, and inspection of storm shelters constructed for protection from high winds associated with tornadoes and hurricanes. Storm shelters may be separate detached buildings or rooms and areas within buildings. Shelters designed

and constructed to this standard shall be designated as either hurricane shelters, tornado shelters, or combined hurricane and tornado shelters.

- ❖ Storm shelters can be buildings used solely for sheltering ("single-use"), or they can be buildings containing multiple occupancies, uses or functions ("multi-use"). Storm shelters can also be constructed external to another building, or internal as an area within a building. For example, a multi-use storm shelter at a school may also function as a classroom, a lunchroom, a laboratory, or an assembly room. In a commercial building, a storm shelter may also function as a restroom, conference room, or auditorium. A storm shelter intended to serve a manufactured housing community or development of single-family dwellings may also function as a community center. Storm shelter uses (either single or multi-use) may affect the type of storm shelter selected and its location.

101.3 Requirements not included. Where requirements are not provided by this standard, the applicable provisions of the construction codes adopted by the authority having jurisdiction shall apply to the storm shelter.

- ❖ The standard is not written to comprehensively deal with provisions that might be applicable to the construction of the shelter or the building containing the shelter. For instance, in areas where the IBC is applicable, the exterior wall of the shelter might need to have a fire-resistance rating because of the fire separation distance of the building to a lot line. The standard contains requirements for fire separation of a storm shelter from its host building but does not address fire-resistance ratings for the exterior wall and/or fire protection of exterior openings in accordance with the applicable code provisions. The importance of integrating sound storm shelter design with building codes is emphasized in Waller and Kiesling (2003).

101.4 Special needs. Provisions that are necessary for persons with special needs, including any special electrical or mechanical equipment, sanitary facilities or other special features, are outside the scope of this standard.

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❖ The ICC 500 is intended to provide basic requirements for a population of occupants without significant physical or mental conditions that require special equipment or special facilities. The possible types of required special amenities or facilities are so many and so varied that it would be unwise to try to identify any group of special needs that should require attention at any given time; however, planners and designers of facilities should take such special needs into consideration where it is likely that such a facility is required. For instance, if the shelter is in conjunction with a hospital, the designer should consider providing facilities for bedridden patients.

101.5 Referenced standards. The specific year, date and editions of the standards referenced by this standard are listed in Chapter 9.

❖ When the standard needs to rely on another standard referenced in this code, it is important to use the specific standard year and edition, which are referenced in Chapter 9. When composing the text with the reference, the committee made its decision to use the specific requirements as written in a certain edition of the standard. The only way to be sure that the intent of ICC 500 is followed in those cases is to use the document that the committee reviewed and referenced.

SECTION 102 COMPLIANCE ALTERNATIVES

102.1 Compliance alternatives. Nothing in this standard is intended to prevent the use of designs, technologies or products as alternatives to any prescriptions in this standard, provided equivalence is demonstrated and approved by the authority having jurisdiction.

❖ This language is very similar to language placed in all of the ICC codes and standards. It allows the possibility that new technology could become available in the future, which may not meet prescribed requirements but would meet the intent of the standard.

The standard is not intended to prohibit innovative ideas or technological advances. A performance-based approach is most applicable for providing a basis for the approval of an increasing number of newly developed innovative materials, systems and methods for which no code requirements or reference standards exist. The building official is expected to apply sound technical judgment accepting materials, systems or methods that can be demonstrated to offer equivalent performance. The building official is responsible for determining if a requested alternative provides the equivalent level of protection of public health, safety and welfare required by the provisions in the standard.

SECTION 103 CONVENTIONS

103.1 Dimensions. All dimensions that are not stated as “maximum” or “minimum” are nominal. All dimensions are subject to conventional industry tolerances unless otherwise noted.

❖ This is standard text common to construction standards. The intent is to clarify what the meaning of a dimension callout is.

SECTION 104 OCCUPANCY

104.1 Rooms or spaces within other uses. Where designated storm shelters are constructed as a room or space within a building which will normally be occupied for other purposes, the requirements of the applicable building code for the occupancy of the building, or the individual rooms or spaces thereof, shall apply unless otherwise stated in this standard.

❖ Quite often the storm shelter will be a designated room or space within a larger facility that is designed to function as a storm shelter in emergencies but also to be used for some other purpose normally. A common example is a classroom, study hall, gymnasium, or cafeteria space in a school building. The purpose of adding this statement to the standard is to establish that the standard is not intended to supplant the requirements for the normal use of the space. For instance, determination of occupant load for the use of the space as a shelter does not change the occupant load of the space in its “normal” function.

104.2 Dedicated facilities. Where a facility is designed to be occupied solely as a storm shelter, the designated occupancy shall be A-3 as defined by the *International Building Code*[®] for purposes of determination of applicable requirements that are not included in this standard.

Exception: Where the facility has an occupant load of less than 50 persons as determined in accordance with Chapter 5, the designated occupancy shall be in accordance with Section 303 of the *International Building Code*.

❖ Where a facility is provided for the sole purpose of functioning as a storm shelter, the committee determined that the facility would most likely resemble a Group A-3 facility as described in the IBC. For the 2015 edition an exception was added, which recognizes that a relaxation of wall and ceiling finish requirements in corridors, number of plumbing fixtures in restrooms and bathrooms, and slope and handrail requirements for means of egress may be appropriate for a small shelter serving at most a few dozen people. The exception points to a provision in the IBC that allows a building or structure used for

assembly purposes but having an occupant load less than 50 persons to be designated as a Group B occupancy rather than a Group A occupancy.

104.3 Combination storm shelters. Where the purpose of a storm shelter is to provide protection from both tornadoes and hurricanes, the entire storm shelter shall be designed and constructed using the most restrictive requirements for each hazard.

- ❖ This provision is consistent with the general philosophy of building codes and standards regarding the applicability of multiple provisions concerning an element or elements of construction. In cases where the standard establishes a specific requirement for a specific shelter, that requirement is applicable even if it is less restrictive than a general requirement specified elsewhere in the standard. However, in all cases, the most restrictive requirement applies.

SECTION 105 APPLICABLE BUILDING CODE

105.1 Applicable code. Where construction of a storm shelter is to take place where no applicable construction codes are adopted, the provisions of the *International Building Code* shall apply.

- ❖ In addition to the requirements provided in the standard, a storm shelter, whether single-use or multi-use, must comply with any applicable building code provisions adopted by the authority having jurisdiction. Storm shelters constructed in jurisdictions where no state or local building code has been adopted should be designed and constructed to ICC 500 and the provisions of the 2015 IBC.

SECTION 106 INSPECTIONS AND STRUCTURAL OBSERVATIONS

106.1 General. Construction of storm shelters and installation of all equipment shall be subject to inspections in accordance with the applicable building code.

- ❖ Building inspections are one of the more important functions of the building department or authority having jurisdiction. The authority having jurisdiction is authorized to inspect the work for which a permit has been issued and requires that the work to be inspected remain accessible until inspected and approved. Typical building department inspections include footings and foundations, concrete slabs, framing, and fire-resistant construction. Where mechanical, electrical and plumbing systems are required and included in the plans, rough-in inspections must be requested and approved before the construction moves forward.

The goal of a storm shelter is to provide life safety protection from wind events exceeding those normally designed for under building codes; therefore, a higher level of scrutiny is called for during the design and construction phases for storm shelters. To pro-

vide this oversight, the standard calls for special inspection over and above those typically mandated by the building code and authority having jurisdiction, and it additionally calls for independent peer review for large community storm shelters or storm shelters serving critical facilities.

106.1.1 Peer review. A peer review by an independent registered design professional for compliance with the requirements of Chapters 3, 5, 6 and 7 shall be conducted for the following storm shelter types:

1. Community shelters with an occupant load greater than 50.
2. Storm shelters in elementary schools, secondary schools, and day care facilities with an occupant load greater than 16.
3. Storm shelters in Risk Category IV (essential facilities) as defined in Table 1604.5 in the *International Building Code*.

- ❖ Surveys of storm shelter installations after hurricanes and tornadoes and reviews of construction documents during the design phase for storm shelters have uncovered issues, such as inadequate design, specification of noncompliant opening protective devices, insufficient useable space, and inadequate anchoring to foundations. For this reason, ICC 500 requires peer review by an independent registered design professional for shelters serving certain populations or facilities.

The original edition of ICC 500 triggered a peer review for community shelters with an occupant load greater than 300. That trigger was reduced in this edition to greater than 50 persons in recognition of the fact that storm shelters for many critical facilities, such as schools, police and fire stations, and emergency operation centers, may hold less than 300 occupants. To further capture shelters associated with critical and essential facilities, explicit peer review requirements were added for educational facilities (e.g., elementary, middle and high schools and day care centers) and essential facilities (e.g., emergency operation centers, hospitals, and power-generating facilities) in addition to the existing requirement for larger community shelters. The scope of the peer review was also extended to include means of egress and accessibility (Chapter 5), fire safety (Chapter 6), and ventilation, sanitation facilities, and lighting (Chapter 7). These additional criteria are deemed equally important to providing the desired level of protection to occupants of the shelter.

The peer review should be completed by design professionals with experience in the specific areas of practice under review. Where review involves specific technical fields outside the competence of the individual or firm performing the peer review, review of those specific areas should be conducted by design professionals (associates, consultants, and employees) who are qualified by education and experience in the applicable technical field. Thus, a peer review

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may involve multiple individual reviewers or design professional firms. The peer reviewers should not be the same design professionals who provide structural observation in accordance with Section 106.4.

Item 3 refers specifically to a storm shelter constructed in or accessory to a Risk Category IV building or structure (essential facility). IBC Table 1604.5 specifies what uses qualify a building or structure as Risk Category IV. While the IBC includes “designated earthquake, hurricane or fire shelters” in Risk Category IV, it is not the intent of the IBC or ICC 500 to require a storm shelter or its host building be designed as Risk Category IV unless the occupancy or use of the host building would otherwise require such a classification. This has been clarified by a formal ICC interpretation (ICC 2013).

106.1.2 Peer review report. Where a peer review is required by Section 106.1.1, a signed and sealed report shall be submitted to the authority having jurisdiction with the construction documents identified in Section 107 prior to issuance of a permit for construction. The report shall fully describe the items reviewed, their compliance or non-compliance with applicable codes and standards, and recommend acceptance or rejection of the storm shelter design, or modifications to render the design acceptable.

❖ This section specifies the required contents of the peer reviewer’s report and requires submission of the signed-and-sealed report to the code official at the same time the construction documents are submitted for review and permitting. The report should include detailed descriptions of the items reviewed, whether or not the items are compliant with the applicable standards and codes, and whether or not the storm shelter design is acceptable. If not acceptable, the report should also include recommendations to make it acceptable.

106.2 Special inspections. Special inspections shall be provided for construction and installation of materials as required by the authority having jurisdiction in accordance with the applicable building code and Section 106.3 of this standard.

❖ The authority to require special inspections, to specify the extent, number and timing of special inspections, and to approve special inspectors rests with the authority having jurisdiction, typically the local building department. The authority having jurisdiction has the power to require additional special inspections not detailed in the standard or in IBC Section 1705, or to waive any special inspection requirements of the IBC where permitted by IBC Section 1702. The special inspections of Section 106.3 cannot be waived except in the limited case specified in the standard for anchorage of residential storm shelters. Special inspection is usually desirable for, and specified for, construction activities requiring unique expertise or where additional assurance of quality beyond the standard building department inspections is deemed necessary. Common special inspections required by the building code include concrete placement,

masonry construction, welding of structural members, and installation of high-strength bolts.

The IBC provides requirements for the qualification of special inspectors, their retention by the owner or the engineer or architect of record, the duties and responsibilities of the special inspector, and the timing of special inspections (continuous versus periodic). With the exception of long-span trusses, the IRC does not require special inspection, nor does it provide specific requirements. Definitions of special inspector and special inspection are provided in Chapter 2 for cases where a storm shelter is installed in a building governed by the IRC or where no building code is adopted. It is noted that the design criteria for storm shelters exceed the limits of the prescriptive structural provisions of the IRC. Thus, the IBC should be considered to govern the design of the storm shelter, its structural elements, and its components, and special inspections per Chapter 17 of the IBC should be provided.

106.2.1 Inspection of fabricators. Where fabrication of structural load-bearing and debris-impact-resistant components and assemblies is being performed on the premises of a fabricator’s shop, special inspection of the fabricator shall be provided.

Exception: Prefabricated or panelized storm shelter components that have been inspected and labeled by an approved agency meeting the requirements of the applicable building code.

❖ Special inspections required by the building code or this standard apply to components, elements, or assemblies manufactured off-site in a fabricator’s shop, as well as to work performed on the building site. Typically, this would require the special inspector to travel to the fabricator’s shop as well as visiting the job site, or a special inspector in closer proximity to the fabricator’s shop be retained. The exception requires a shop-fabricated storm shelter or component of a storm shelter to be inspected by an approved agency and to have a label indicating the shelter or component complies with the requirements of ICC 500 and any applicable test standards.

106.3 Special cases. Special inspections shall be provided for proposed work comprised of:

1. Construction materials and systems that are alternatives to traditional materials and systems prescribed by the applicable code.
2. Unusual design and construction applications.
3. Anchors post-installed in hardened concrete and masonry, when used for anchorage of shelter components forming a part of the shelter enclosure or for anchorage of the shelter structure to foundations shall be in accordance with Section 106.3.1.

❖ This edition of the standard adds requirements for special inspection of certain anchors. In particular, special inspections are required for post-installed anchors used to attach storm shelters to existing

slabs-on-grade (e.g., a prefabricated residential shelter installed in a garage) as well as storm shelters provided in new construction but whose anchors are not installed until after the concrete for the new foundation has been set. Special inspection is also required for post-installed anchors used to attach shelter components such as door frames or opening protective devices to masonry or to existing or already-placed and hardened concrete walls, roofs, or other concrete or masonry components of shelters.

106.3.1 Special inspections to verify anchor installation.

Special inspection shall be provided to verify the post-installed anchor installation and capacity as specified in accordance with Section 107.2.1. For post-installed anchorage to foundations, special inspection shall be provided to verify foundation adequacy in accordance with Sections 308.

Exception: For residential shelters, where the authority having jurisdiction verifies that the anchorage and, where required, the foundation complies with the requirements of the shelter design as provided in documentation required by Section 107, special inspection is permitted to be waived by the authority having jurisdiction.

- ❖ Existing slab-on-grade foundations, particularly those provided in residential buildings, are typically not adequate to resist the extreme wind loads associated with a storm shelter. Therefore, the adequacy of the existing slab must be verified through engineering calculations, and the slab must comply with the minimum slab thickness and minimum steel reinforcement requirements of the standard. In addition to installing a storm shelter on an adequate slab, post-installed applications require extra attention to be paid to anchorage capacity, location, and proper installation. The installation of post-installed anchors should always be performed in accordance with the specifications within the manufacturer's printed installation instructions. If installers of storm shelters find different conditions in the field than required as shown on the storm shelter design plans, they should contact the designer and determine the appropriate course of action.

It is important for a special inspector to verify that the foundation being used, anchor specifications, and anchor locations are consistent with the design plans. Post-installed anchors typically depend on adhesive bonding for pull-out resistance, making the performance of the connection highly dependent on the installation. Furthermore, whenever an existing slab is used as the foundation for a storm shelter, the special inspector should ensure the adequacy of the slab to resist the wind loads acting on the storm shelter.

An exception allows the special inspection requirements to be waived for residential storm shelters if the authority having jurisdiction verifies that the foundation and anchoring complies with the installation requirements for the storm shelter. Particularly in rural areas, owners of dwellings or other residential buildings may have difficulty locating engineers, engineering firms or third-party inspection agencies to

perform special inspections. In these cases, the local building official or authority having jurisdiction is responsible for ensuring the installation of the storm shelter complies with the construction documents and manufacturer's installation instructions before granting a waiver for the special inspection.

The shelter designer or installer should provide all necessary information, including engineering calculations verifying the adequacy of the slab, documentation of the slab thickness and any required steel reinforcement, and data on any other relevant existing conditions, to the authority having jurisdiction prior to construction or installation of the storm shelter.

106.4 Structural observations. During construction of community shelters, the building owner shall employ a registered design professional to conduct visual observations of the construction of the structural system for general conformance to the approved construction documents at significant construction stages and at completion of the construction of the structural system. Structural observation shall not obviate the need for other inspections or testing required by this standard or the applicable building code.

Deficiencies shall be reported in writing to the owner and to the authority having jurisdiction. At the conclusion of the work, the registered design professional who made the structural observations shall submit to the authority having jurisdiction a written statement that the site visits have been made and shall identify any reported deficiencies that, to the best of the structural observer's knowledge, have not been resolved.

- ❖ This section requires the building owner to retain a registered design professional to visually observe the construction of the structural system for general conformance with the approved construction documents. These observations should take place at significant construction stages such as just prior to concrete placement when reinforcing can be seen, and when the structural system is completed (but before any wall, roof or ceiling finishes are installed). Structural observations do not eliminate the need for building department inspections, or for special inspections and testing, as specified by the standard or the applicable building code. The language on reporting deficiencies is consistent with the requirements for special inspections in Section 106.2.

For many projects the engineer of record will also be retained by the owner to provide construction phase services such as structural observations. The engineer of record should provide a schedule identifying the frequency and extent of structural observations to the owner and the authority having jurisdiction. IBC Section 1704 requires submission of this schedule to the authority having jurisdiction.

SECTION 107 CONSTRUCTION DOCUMENTS

107.1 General. Where required by the authority having jurisdiction, construction documents shall be prepared. Such doc-

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uments shall contain information as required by the applicable building code and this section.

❖ Not all jurisdictions require detailed construction documents, particularly for one- and two-family residential projects governed by the IRC. Given the higher performance requirements and expectations for a storm shelter, preparation of construction documents for the storm shelter are recommended. Construction documents are usually required for storm shelters funded by Federal Emergency Management Agency (FEMA) mitigation grants or other similar programs.

Building codes contain specific requirements for permit submittal documents. Construction drawings, specifications and other documentation should be sufficient to describe the structure in the permit application. A general statement such as "all work must comply with ICC 500" is not an acceptable substitute for showing the required information. Most jurisdictions require two sets of building plan documents to be submitted: one approved document to be retained by the building official and another returned to the applicant and available on-site to reference for inspections.

107.2 Information required. The following information applicable to construction and operation of the storm shelter shall be supplied as part of the construction documents.

❖ This section specifies the information that should be provided in the construction documents. Complete, detailed plans and specifications should be submitted to the authority having jurisdiction for each storm shelter design. At a minimum, the design parameters used in the structural design of the storm shelter and other key life safety requirements listed in Section 107.2.1 should be provided in the construction documents. Mechanical, electrical, and plumbing details should also be provided. In addition, for community shelters, ADA requirements should be shown.

To ensure that the proper design criteria have been applied and to facilitate peer review, the design information in Section 107.2.1 should ideally be provided on a single sheet; however, some rules of conduct and codes of ethics may constrain a design professional from providing criteria, plans or details on construction documents they prepare, sign and seal that are outside their area of practice or were not prepared under their direct supervision. Also, multiple design professionals may be involved in a project; therefore, the architectural, structural and mechanical criteria may appear on different drawings. The test reports documenting compliance with the pressure and missile impact tests also will be separate from any construction drawings.

107.2.1 Design information. For the areas of a building designed for occupancy as a storm shelter, the following information shall be provided within the construction documents:

1. Type of shelter: Residential or community tornado, hurricane or a combination of both.

2. A statement that the wind design conforms to the provisions of the ICC/NSSA *Standard for the Design and Construction of Storm Shelters*, with the edition year specified.
3. The shelter design wind speed, mph.
4. The wind exposure category (indicate all if more than one is used).
5. The internal pressure coefficient, GC_{pi} .
6. The topographic factor, K_{zt} .
7. The directionality factor, K_d .
8. A statement that the shelter has/has not been constructed within an area susceptible to flooding in accordance with Chapter 4 of this standard.
9. The Design Flood Elevation and Base Flood Elevation for the site (if applicable).
10. Documentation showing that components of the shelter envelope will meet the pressure and missile impact test requirements identified in Chapters 3 and 8 of this standard.
11. A floor plan drawing or image indicating location of the storm shelter on a site or within a building or facility; including a drawing or image indicating the entire facility.
12. A storm shelter section or elevation indicating the height of the storm shelter relative to the finished grade, finished floor and the host building, where applicable.
13. The lowest shelter floor elevation and corresponding datum, except for residential shelters outside of special flood hazard areas.
14. The occupant load of the storm shelter.
15. The usable storm shelter floor area.
16. Venting area (square inches) provided and locations in the shelter.
17. Calculations for the number of sanitation facilities for community shelters.
18. Minimum foundation capacity requirements.
19. Shelter installation requirements, including anchor location and minimum required capacity for each anchor.
20. For hurricane shelters, the rainfall rate of the roof primary drainage system.
21. For hurricane shelters, the rainfall rate of the roof secondary (overflow) drainage system where required.
22. For hurricane shelters, the rainwater drainage design rainfall rate for facilities subject to rainwater impoundment.

❖ This section lists all of the design criteria to be clearly identified on the storm shelter plans or otherwise incorporated into the construction documents. These include the location of the storm shelter in the building, the wind design criteria, design flood elevation and lowest floor elevation for compliance with this

standard and National Flood Insurance Program requirements, roof drainage criteria, ventilation area and number of toilets required.

Also required, and new to this edition of the standard, are criteria for shelter foundation connections and capacity. Providing these criteria help ensure proper anchoring of shelters, particularly prefabricated shelters that are the predominant choice for residential storm shelters, on foundations with sufficient capacity to resist uplift and overturning from tornado and hurricane winds. The shelter installation requirements (Item 19) should provide the manufacturer's information and product details so that the installers can ensure that they are using the anchors specified by the designer and following the manufacturer's printed installation instructions.

While the information listed in this section may typically be located throughout shelter construction documents, designers are encouraged to try to group this information together as much as possible in order to facilitate access to key information by installers, inspectors, building officials, peer reviewers and other applicable parties.

107.2.2 Enclosure. When a storm shelter is to be constructed as a portion of a host building, the walls and floors enclosing the shelter shall be clearly indicated on the drawings.

❖ This section requires clear identification of the protected storm shelter area when constructed as part of a host building. By clearly labeling where the storm shelter is located on the plans, floor plans can be shared with other relevant parties such as homeowners (for residential applications) and administrators and management of buildings (for community applications) to ensure that the correct areas are being used for shelter.

107.2.3 Signage. The type and location of signs required by this standard shall be indicated on the floor plans.

❖ Signs have a very important role in facilitating the ability of building occupants to locate the storm shelter in an emergency, and therefore this small detail needs to be highlighted in the plans and specifications. To that end, this standard calls out this requirement so that proper planning and verification of compliance is facilitated.

107.2.4 Inspections. Where any special details are utilized in the design of the structure, or where any special investigations are required in addition to those required by the applicable building code, the construction documents shall contain a schedule of the inspections required and the criteria for the special installation.

❖ This requirement is consistent with, and somewhat redundant, the requirements of the IBC for special inspections for special cases. Again, this call out is made to advise the designer to make sure that the myriad of special details are listed for inspection to allow verification and planning for proper execution of the design.

107.2.5 Special details. The construction documents shall provide or include any special manufacturer's details or installation instructions for systems or equipment designed for the storm shelter.

❖ See the commentary to Section 107.2.4.

107.2.6 Special instructions. The construction documents shall provide or include any special details or special instructions required for the functional operation of the storm shelter, such as:

1. Type and location of equipment and amenities required within the shelter, including water supply, sanitary facilities, fire extinguishers, batteries, flashlights, special emergency lighting equipment or any other equipment required to be installed in the shelter.
2. Specifications for any alarm system to be installed.
3. Instructions for the installation or deployment of any special protection equipment such as shutters, screens, special latching of doors or windows, any equipment or switching for mechanical, electrical and plumbing equipment.

❖ This section calls for specifications, and the plans explicitly call out instructions for important life safety equipment that might be necessary in the shelter.

107.3 Quality assurance plan. The construction documents for community shelters shall contain a quality assurance plan in accordance with Sections 107.3.1 through 107.3.3.

❖ This section provides minimum quality assurance requirements for the construction of community storm shelters. These are essentially the same requirements given in the IBC for quality assurance of main windforce-resisting systems and roof and wall component and cladding. These requirements supplement the testing and inspection requirements contained in the referenced standards given in other sections of the code. The wind provisions of the code are written to rely heavily on the concept of quality controls for good construction. The quality assurance program should cover both the materials used in the storm shelter and the construction methods used to build or install the storm shelter.

107.3.1 Detailed requirements. A quality assurance plan shall be provided for the following:

1. Roof cladding, soffits and roof framing connections.
2. Wall connections to roof and floor diaphragms and framing.
3. Roof and floor diaphragm systems, including connectors, drag struts and boundary elements.
4. Main windforce-resisting systems, including braced frames, moment frames and shear walls.
5. Main windforce-resisting system connections to the foundation.
6. Fabrication and installation of components and assemblies of the shelter envelope required to meet missile impact test requirements of Chapter 3.

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7. Wall cladding and wall cladding connections.
8. Corrosion resistance or protection of exposed metal connectors providing load path continuity.
9. Critical support systems and connections and debris impact protection of the components and connections.
10. Foundation design.
11. Prefabricated shelter installation requirements, including anchor location and minimum required capacity for each type of anchor.
12. Prefabricated shelter minimum foundation capacity requirements.

❖ This section designates the systems that the quality assurance plan must address. The systems required to be covered by the quality assurance plan are those whose performance are critical to the structural performance of the shelter during a tornado or hurricane. Similar to the requirements for design information provided on the construction plans (Section 107.2.1), the detailed requirements listed in this section include minimum foundation capacity and shelter installation requirements; however, this section also explicitly includes the foundation design, which applies to both prefabricated and site-built shelters. Therefore, prefabricated community storm shelters must have quality assurance plans that provide a prescriptive foundation design, and the installers must ensure that the foundation provided by the designer is constructed as specified.

107.3.2 Quality assurance plan preparation. A quality assurance plan prepared by a registered design professional shall be provided for each main wind force resisting system and each wind-resisting component.

The quality assurance plan shall identify the following:

1. The main windforce-resisting systems and wind-resisting components.
 2. The special inspections and testing to be required in accordance with Section 106.2.
 3. The type and frequency of testing required.
 4. The type and frequency of special inspections required.
 5. The structural observations to be performed in accordance with Section 106.4.
 6. The required distribution, type and frequency of reports of test, inspections and structural observations.
- ❖ The quality assurance plan must be prepared by a registered design professional. It may be a very simple listing of elements of each system designated as important enough to receive special inspections or testing. The extent and duration of the inspections must be set forth in the quality assurance plan, as well as the specific tests and frequency of testing required.

107.3.3 Contractor responsibility. Each contractor responsible for the construction, fabrication or installation of a main

windforce-resisting system or any component listed in the quality assurance plan shall submit a written statement of responsibility to the authority having jurisdiction, the responsible design professional and the owner prior to the commencement of work on the system or component. The contractor's statement of responsibility shall contain:

1. Acknowledgement of awareness of the special requirements contained in the quality assurance plan.
2. Acknowledgement that control will be exercised to obtain compliance with the construction documents.
3. Procedures for exercising control within the contractor's organization, the method and frequency of reporting and the distribution of reports.
4. Identification and qualifications of the person(s) exercising such control and their position(s) in the organization.

Exception: Fabrication of storm shelter components that have been inspected and labeled by an approved agency as meeting the requirements of the applicable building code and this standard.

❖ The authority having jurisdiction must approve the quality assurance plan and must obtain from each contractor a written statement that he or she understands the requirements of the quality assurance plan and will exercise the necessary control to obtain conformance. The exact methods of control are the responsibility of individual contractors, subject to approval by the authority having jurisdiction; however, special inspections of the work are required in specific situations to provide the authority having jurisdiction reasonable assurance that there is compliance with the approved construction documents.

The extent of the qualifications of the contractor and subcontractors can vary considerably. The quality assurance plan, therefore, is an opportunity to identify those areas of special concern that must be addressed during the construction process, including but not limited to, types of testing, frequency of testing, types of inspections, frequency of inspections and the extent of the structural observations to be performed. As detailed in Sections 107.3.1 and 107.3.2, a statement of responsibility is required from every contractor fabricating or installing a component of the shelter's main windforce-resisting system, for any component or cladding element exposed to the wind loads specified in the standard, and for impact-resistant components, impact-protective systems and other critical support systems.

The exception is logical given that manufacturers of prefabricated components have a quality control program for their products and are required to provide a label on prefabricated assemblies in conjunction with a third-party inspection agency. While installers are not responsible for the fabrication of components that have already been inspected and labeled by an approved agency, they are responsible for proper installation that follows the manufacturer's instructions.

SECTION 108

DESIGN INFORMATION SIGNAGE AND LABELING

108.1 Design information. All shelters shall have a sign on or within the shelter with the name of the manufacturer or builder of the shelter and the storm type(s) and respective design wind speed(s). The sign shall remain legible and visible.

❖ This section specifies the minimum criteria for storm shelter signage. The sign, which can be located either outside or inside the storm shelter, should remain “visible and legible.” Text and graphics on the sign should be large enough to be readable, and the sign should not be painted over or hidden from view. Information provided on the sign should include the name of the manufacturer or builder of the storm shelter, whether the storm shelter is a hurricane shelter, tornado shelter, or both, and the design wind speed (or speeds) used for the storm shelter. Chapter 5 provides additional signage requirements for community shelters, including the requirement for signage to comply with ICC A117.1. Examples of the signage required by this section can be found in FEMA P-361 (2014).

Only one sign on or within the shelter is required to provide all of the information required by this section. Other signage is not required to repeat all of the manufacturer details and design criteria or to comply with ICC A117.1 unless otherwise required by ICC 500 or the applicable building code.

108.2 Labeling. Impact-protective systems shall be labeled denoting compliance with this standard. Other than impact-protective systems, products, materials or systems shall be labeled by an approved agency when required by the applicable code or jurisdiction.

❖ This section specifies the requirements for labeling of impact-protective systems and other shelter components or systems that require labeling. Labeling for impact-protective systems should include the name or logo of the testing agency, the test missile size and speed, test pressure, and other required performance characteristics. An example of a typical label for an impact-resistant door can be found in FEMA P-361. Some manufacturers provide a label on both the door slab and the door frame. This emphasizes that the impact-resistant door assembly acts as a system to resist wind and impact loads.

As noted in the definition of “Labeled” in Section 202, a label must be applied by a “nationally recognized testing laboratory, approved agency, or other organization concerned with product evaluation that maintains periodic inspection of the production” of labeled items (which, as this section notes, must include impact-protective systems and may also include other components of the shelter as determined by the applicable building code). An “approved agency” would be determined by the authority having jurisdiction. Chapter 8 also provides requirements that the testing must be done by a qualified lab, and Section 106.2.1 calls for regular inspection on fabri-

cators but with an exception if the storm shelter components have been inspected and labeled by an approved agency; therefore, the intent of the standard with respect to both testing of shelter components and the labeling of those components is that the testing and labeling must be performed by a third-party testing agency that complies with all requirements in ICC 500.

Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the standard.

Federal Emergency Management Agency (2014). *Taking Shelter from the Storm: Building a Safe Room for Your Home or Small Business*, FEMA P-320, Washington, DC.

Federal Emergency Management Agency (2015). *Safe Rooms for Tornadoes and Hurricanes: Guidance for Community and Residential Safe Rooms*, FEMA P-361, Washington, DC.

Waller, J. E. and Kiesling, E. W. “Building Codes and Storm Shelter Safety”, *Building Safety Journal*, August 2003, International Code Council, p. 19.

Chapter 2: Definitions

General Comments

The words or terms defined in this chapter are deemed to be of some importance in either specifying the subject matter of the standard's technical provisions or in giving meaning to certain terms used throughout the

standard for administration or enforcement. The user of the standard should become familiar with the terms found in this chapter because these definitions can help clarify the provisions of the standard and facilitate better understanding and interpretation of the provisions of the standard.

SECTION 201 GENERAL

201.1 General. For the purposes of this standard, the terms listed in Section 202 shall have the indicated meaning.

201.2 Undefined terms. The terms not specifically defined in this standard or in standards referenced herein shall have ordinarily accepted meanings such as the context implies.

SECTION 202 DEFINITIONS

APPLICABLE CODE. The regulation for design and building construction of buildings and structures adopted by the authority having jurisdiction over the construction of the specific shelter.

AREAS OF CONCENTRATED FURNISHINGS. The areas of a storm shelter with furniture or fixtures that cannot be moved easily, including areas such as bathrooms, locker rooms and rooms with fixed seating or fixed tables.

AREAS OF UNCONCENTRATED FURNISHINGS. The areas of a storm shelter with furniture or fixtures that can be moved easily, including areas such as classrooms and offices.

AREAS OF OPEN PLAN FURNISHINGS. The areas of a storm shelter that are generally free of furniture or fixtures that cannot be moved easily and of interior partitions or other features that block movement through, or otherwise subdivide, the space.

AUTHORITY HAVING JURISDICTION. The organization, political subdivision, office or individual charged with the responsibility for administering and enforcing the provisions of this standard.

COLLAPSE HAZARDS. See "Hazards, Collapse."

CRITICAL SUPPORT SYSTEMS. Structures, systems and components required to ensure the health, safety and well-being of occupants. Critical support systems include, but are not limited to, potable and waste water systems, electrical power systems, life safety systems and HVAC systems.

DESIGN WIND PRESSURE. The wind pressure on a specific location of the shelter envelope, as determined in accordance with Section 304, Wind Loads, which controls the

design of components and cladding (C & C) of the shelter envelope or the main wind-force resisting system (MWFRS) for the shelter.

FIRE BARRIER. A fire-resistance-rated vertical assembly of materials designed to restrict the spread of fire in which openings are protected.

HAZARDS.

Collapse. Debris from wind damage to adjacent, taller structures that could fall onto the shelter.

Laydown. Nearby structures such as towers or large trees that could fall onto the shelter, if the shelter is within the laydown radius of the structure.

Rollover. Vehicles and small buildings, such as temporary classroom buildings, that could roll over due to extreme winds and impact the shelter.

HOST BUILDING. A building that is not designed or constructed as a storm shelter that totally or partially encloses, or is connected to, a storm shelter.

IMPACT-PROTECTIVE SYSTEM. A system or device such as a shutter, door or other device mounted on the inside or outside of the exterior wall of a shelter that has been demonstrated by testing to be capable of withstanding the impact of test missiles as detailed in this standard.

INTERIOR SURFACE OF THE SHELTER COMPONENT. The inside surface of any structural component of the storm shelter envelope.

LABEL. An identification applied on a product by the manufacturer that contains the name of the manufacturer, the function and performance characteristics of the product or material, and the name and identification of an approved agency and that indicates that the representative sample of the product or material has been tested and evaluated by an approved agency.

LABELED. Equipment, materials or products to which has been affixed a label, seal, symbol or other identifying mark of a nationally recognized testing laboratory, approved agency or other organization concerned with product evaluation that maintains periodic inspection of the production of the above-labeled items and whose labeling indicates either that the