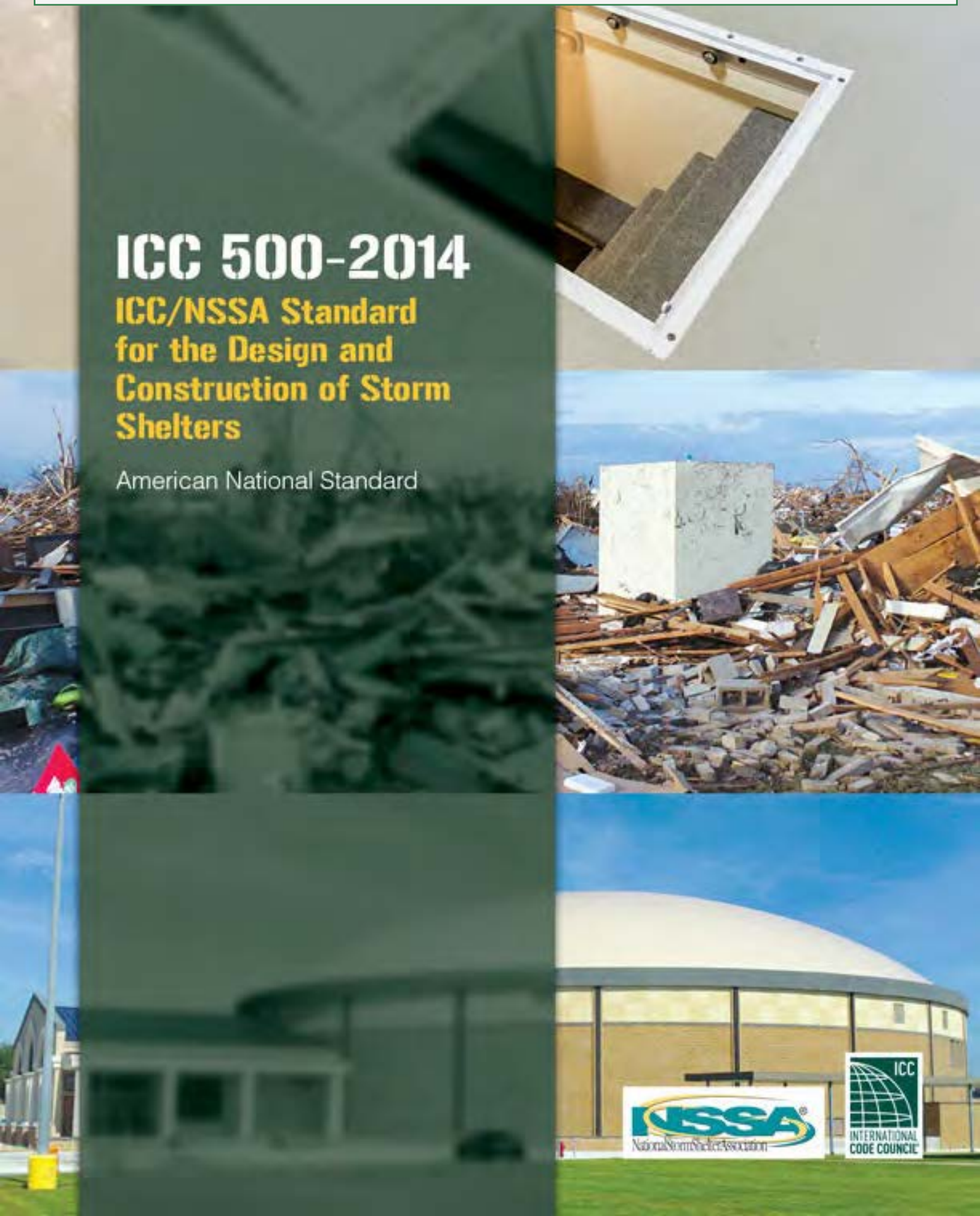

ICC 500-2014

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

American National Standard

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American National Standard

International Code Council
500 New Jersey Avenue, NW, 6th Floor
Washington, D.C. 20001

Approved October 7, 2014

American National Standards Institute
1899 L Street, NW, 11th Floor
Washington, D.C. 20036

ICC/NSSA Standard for the Design and Construction of Storm Shelters—2014
(ICC 500—2014)

First Printing: December 2014

ISBN: 978-1-60983-402-9

PRINTED IN THE U.S.A.

American National Standard

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

FOREWORD

[The information contained in this foreword is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI's requirements for an ANS. As such, this foreword 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 this 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. This standard provides design requirements for the main wind-resisting structural system and components and cladding of these shelters, and provides basic occupant life safety and health requirements for these shelters, including means of egress, lighting, sanitation, ventilation, fire safety and minimum required floor space for occupants.

Development

This is 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*. This standard was developed by the ICC/NSSA Consensus Committee on Storm Shelters (IS-STM) that 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 this standard, but the exact provisions adopted by the committee were determined based upon the scope and intent of this standard. The requirements of ICC/NSSA 500 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/NSSA 500 *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 this 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 this standard. Only the governmental body that enacts this 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.

This standard 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 this standard, the IS-STM Consensus Committee consisted of the following members:

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

Mr. Julian Amaya (G), Housing Department City of Los Angeles, South Gate, CA

Mr. Brian Bishop (G), Iowa Department of Public Safety—State Fire Marshal's Office, Des Moines, IA

Mr. Gary J. Ehrlich, P.E. (P), National Association of Home Builders, Washington, DC

Mr. Carlos M. Flores, AIA, NCARB, CGC (P), CMF International Group Inc., Miami, FL

Ms. Cheri Bright Hainer, CBO (G), City of Virginia Beach/Planning/Permits & Inspections, Virginia Beach, VA

Mr. John T. Hutton, P.E., S.E. (U), Uzun & Case Engineers, Atlanta, GA

Mr. Christopher P. Jones, P.E. (U), Durham, NC

Dr. Ernst W. Kiesling (U), Wind Engineering Research Center, Texas Tech University, Lubbock, TX

Mr. Danny John Kilcollins (G), Florida Department of Community Affairs, Tallahassee, FL

Dr. Marc L. Levitan (U), National Institute of Standards and Technology, Gaithersburg, MD

Mr. Barry Mooneyham (G), Wake County Government, Raleigh, NC

Mr. Kurt A. Roeper (P), ASSA ABLOY Door Security Solutions, New Haven, CT

Mr. Corey Schultz (U), Schultz Architects, LLC, Wichita, KS

Mr. E. Scott Tezak, P.E. (U), TRC, Lowell, MA

Mr. James E. Waller, P.E. (P), Remagen Safe Rooms, Monteagle, TN

Committee Secretary: **David A. Bowman, P.E.,** Manager, Codes, Codes & Standards, International Code Council, Country Club Hills, IL

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

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.

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 either separate, detached buildings or rooms and areas within buildings. Shelters designed and constructed to this standard shall be designated as hurricane shelters, tornado shelters or combined hurricane and tornado shelters.

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.

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.

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

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.

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.

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 that 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.

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.*

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.

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.

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.

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

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 noncompliance with applicable codes and standards, and recommend acceptance or rejection of the storm shelter design or modifications to render the design 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.

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 fabricators 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.

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.

106.3.1 Special inspections to verify anchor installation. A special inspection shall be provided to verify the post-installed anchor installation and capacity 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 107.2.1 and 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.

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.

SECTION 107
CONSTRUCTION DOCUMENTS

107.1 General. Where required by the authority having jurisdiction, construction documents shall be prepared. Such documents shall contain information as required by the applicable building code and this section.

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.

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.

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.

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

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.

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.

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.

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.

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.
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.

107.3.2 Quality assurance plan preparation. A quality assurance plan prepared by a registered design professional shall be provided for each main windforce-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.

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.

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.

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.

CHAPTER 2

DEFINITIONS

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 equipment, material or product meets identified standards or has been tested and found suitable for a specified purpose.

LAYDOWN HAZARDS. See “Hazards, Laydown.”

LOCAL EMERGENCY PLANNING COMMITTEE. A group of citizens defined by the community as having responsibility for local emergency planning. The committee shall be recognized by the governing body as having this responsibility.

NATURAL VENTILATION. Passive ventilation, not requiring a power source, resulting from convection of heated air, movement of inside air and movement of outside air over and around the storm shelter resulting in air exchange through vent openings.

OCCUPANT SUPPORT AREAS. The areas required to ensure the health, safety and well-being of occupants. Occupant support areas include, but are not limited to, shelter management, food preparation, water and food storage, electrical and mechanical rooms, toilet and other sanitation rooms and first-aid stations.

OCCUPIED SHELTER AREAS. The designated storm shelter area.